INFLUENCE OF AN INCENTIVE PROGRAM ON HANDWASHING PRACTICES AND HANDWASHING PREVALENCE AMONG UNIVERSITY FOODSERVICE WORKERS

A THESIS

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To the Dean of Graduate Studies and Research:

I am submitting herewith a thesis written by Melissa Lea Witten entitled "Influence Of An Incentive Program On Handwashing Practices And Handwashing Prevalence Among University Foodservice Workers". I have examined this thesis for form and content for the degree of Master of Science with a major in Institutional Administration.

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ABSTRACT

Influence of an incentive program on handwashing practices and handwashing prevalence among university foodservice workers. Witten, Melissa L. Master of Science, Department of Nutrition and Food Science, Texas Woman's University, August 2001.

The purpose of this study was to determine handwashing practices and prevalence of university foodservice workers and assess what changes in practices and prevalence of handwashing occurred with the use of an incentive program. University foodservice workers (N=43) completed a questionnaire rating perceived level of importance of handwashing after foodservice activities. Significant associations were shown for workers' level of education (P = 0.005), years of foodservice work experience (P=0.005 and P=0.002), work experience (P = 0.02), and employment status (P = 0.03).

Two researchers observed and documented handwashing practices and prevalence of university foodservice workers (N=55) for 4-hour periods during normal working hours. Mean observed handwashing times for week 1, week 2 and week 4 were 20.6, 25.0, and 18.9 seconds respectively. Although foodservice workers mean handwashing time decreased from week 1 to week 4, handwashing frequency increased. At week 2 of the study, a handwashing incentive program using ECOLAB® newly designed Digitizer™ soap dispenser was implemented. The handwashing system used four color-dot groups and maintained a tabulation of handwashing frequencies for each color group. Over the 21 day incentive program period, university foodservice employees worked a total of 3,920 hours. The Digitizer™ system recorded 4,975 handwashing tabulations for a mean of 1.27 handwashes per hour, considerable lower than observed practices.

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CHAPTER I

INTRODUCTION

The contribution of poor hand hygiene to the spread of infectious diseases has been recognized for centuries and by early civilizations. An extensive review of world literature published from 1879 through 1986 provided evidence from experimental studies that handwashing is associated with a reduction in the risk of infection (1, 2).

While handwashing is a simple and easy task, personnel in both health care and foodservice industries have poor handwashing habits (3). The overall prevalence of handwashing is low. Handwashing compliance varies significantly by the task or activity performed. Proposed reasons for the discrepancy between recommended and practiced handwashing behavior includes busy employee schedules in which immediate needs take higher priority, inconvenient or inadequate handwashing facilities, and lack of education. A more basic reason may be that workers question the effectiveness of handwashing (1, 4).

The hands of foodservice workers have been shown to be contaminated with microorganisms including *Salmonellae*, *Escherichia coli*, and *Staphylococcus aureus* (5). Cross-contamination of foodborne pathogens on raw foods can occur in the kitchen from contact between contaminated hands and surfaces during food preparation. Treating hands with an antiseptic gel or handwashing agent following food preparation eliminates all detectable microorganisms (3, 6).

Hand drying practices are also a critical factor in determining the level of touch-contact associated with microbial translocation after handwashing. Recognition that a film of moisture left on the hands after washing enhances the transfer of skin micro-flora, may make a significant contribution towards improving hand care practices (2).

Numerous studies comparing the efficacy of using different soaps and handwashing agents have been reported in the literature. While one study may show one particular agent more useful in a specific setting, all agree that handwashing has a positive effect on reducing the level of cross-contamination (3). Studies have shown that knowledge of communicable diseases does not correlate with positive handwashing practices. Supervision and ease of using handwashing facilities were found to have more positive influence than education or training (3).

Purpose of the Study

The purpose of this study was to determine handwashing practices and prevalence of university foodservice workers and assess what changes in practices and prevalence of handwashing occurred with the use of an incentive program.

Objectives

Objectives of this study were to:

1. Determine handwashing practices and prevalence of university foodservice employees under usual working condition.
2. Determine type and years of foodservice experience, food safety education background and attitude about handwashing for university foodservice employees.

3. Implement a handwashing incentive program for university foodservice employees.

4. Determine handwashing practices and prevalence of university foodservice employees with the implementation of a handwashing incentive program.

Null hypotheses are as follows:

1. There is no significant relationship between the level of education completed and handwashing attitudes of university foodservice workers.

2. There is no significant relationship between years of foodservice experience and handwashing attitudes of university foodservice workers.

3. There is no significant relationship between area of foodservice worked and handwashing attitudes of university foodservice workers.

4. There is no significant relationship between types of foodservice facilities worked and handwashing attitudes by university foodservice workers.

5. There is no significant relationship between type of food safety education completed and handwashing attitudes by university foodservice workers.

6. There is no significant difference between observed handwashing practices before and after the handwashing incentive program.

CHAPTER II

REVIEW OF LITERATURE

As many as 9,000 deaths and 6.5 to 33 million illnesses in the United States each year are estimated to be food related (7). While numerous food safety mechanisms are already in place, emerging pathogens, new food products, increases in imported food, and increasing antimicrobial resistance among foodborne pathogens present new challenges to the existing system (8). In 1998, forty-three million dollars was budgeted by the United States government for a food safety initiative aimed at improving the safety of the nation's food supply. Main points of the food safety initiative are to expand existing surveillance programs, coordinate federal and state efforts in dealing with foodborne outbreaks, revise the inspection of commercial food processors, and improve employee training about the proper handling of foods (7).

Handwashing

Compliance of foodservice employees with handwashing recommendations is poor. Reasons for not washing hands include lack of education, habit, lack of perceived importance, lack of time or priority, concern about harm to skin, and inadequate facilities (1, 3, 9). Hands of foodservice employees can be vectors in the spread of disease due to poor personal hygiene or cross-contamination (10). *Salmonella* organisms have survived

on the fingertips even after handwashing, and experimental studies have shown microorganisms remaining on hands have contaminated food and surface area of counter-tops, handled by foodservice workers (11). To prevent this type of contamination, the *1999 Food Code* (12), states that foodservice employees should wash their hands and arms for 20 seconds. Frequent handwashing is the simplest, least expensive, and most effective way to reduce the spread of foodborne illness (10). Handwashing at appropriate intervals with correct technique and an effective handwashing agent reduces the concentration of resident and transient microbial flora (13).

As the largest organ in the body, the skin forms an effective barrier against harmful microorganisms penetrating underlying tissues and structures (14). Resident microorganisms that normally colonize in the skin and pores vary from person to person and pose little threat of infectious disease due to their low virulence. Organisms considered resident or parts of the normal flora are coagulase negative staphylococci and diptheroids (14, 15). The threat of transmission of pathogenic organisms via hands of foodservice workers comes from transient microorganisms. Transient microorganisms temporarily reside on the skin of hands. These organisms are acquired by being in contact with contaminated material such as food, feces, or money. The type of organism, may include several types of species and varies depending on the origin (14, 15).

The technique for handwashing can be classified as either routine/social handwashing or surgical handwashing. Routine/social handwashing is a simple technique using soap and water that removes transient microorganisms in the majority of cases. Surgical handwash technique reduces resident and transient microorganisms. This

technique consist of washing the hands and lower arms. The surgical technique is most often used before performing invasive medical procedure. Areas most often missed in handwashing are the backs of the hands, between the fingers and thumbs, under the fingernails, and tips of fingers (15).

Washing hands with ordinary soap and water removes the transient bacteria. The use of an antiseptic or sanitizer in the hand soap will control resident micro-organisms. The type of microorganisms that can live on the skin surfaces is influenced by the skin's pH. The pH of the skin is influenced by lactic acid secreted from sweat glands, bacterial production of fatty acids, and diffusion of carbon dioxide through the skin. The pH of the hand soaps should be acidic to prevent hand irritation. Repeated washings with alkaline soaps can raise pH level of the skin and result in irritation (16).

The perceived and/or the actual detrimental effects of handwashing on the skin may adversely influence handwashing practices. Since skin damage is associated with frequent handwashing, Larson, et al. (17) simultaneously studied the microbiological changes associated with frequent handwashing. Handwashing agents used in the study were water only, non-medicated hand soap (Dove^{TM}), antibacterial detergent containing 4% chlorhexidine gluconate, and two antibacterial detergents containing povidone-iodine. Fifty-two women participated in the study. Subjects washed their hands 15 seconds, 24 times per day for 5 days. Researchers noted subjects normally bathed or showered 3 to 14 times per week and washed their hands 2 to 10 times per day. There were significant changes in the amount of water loss ($p<0.001$) and assessments of skin condition ($p<0.05$) from pre to post test for all subjects. Skin damage was assessed by visualizing

desquamating stratum corneum cells, which shed in large aggregates when detergents injure the skin. Subjects using water alone had significantly less cell damage than those using bar soap and chlorhexidine solution, which suggest that friction and frequent wetting of the hands are not the primary cause of skin damage.

A complex etiological relationship exists among the factors: food, environment, and food handlers. Controlling all three factors so that their interactions do not cause a food safety hazard is important. The overall goal of a hand sanitation program is to implement measures to control and prevent contamination of food products (16). When food handlers wash their hands, there is variability in the time spent washing, manual scrub pressure applied, and the amount of soap and water exchange on the hands (18).

In order to break the food contamination vector, Paulson (18) used 9 subjects to evaluate three handwashing methods: manual wash (Ivory™ soap and water), standard iodine dip procedure, and the use of the CleanTech™ automated hand-cleansing system using 2% chlorhexidine gluconate. Subjects were randomly assigned to one of the three handwashing methods, 3 subjects per method. The subjects' hands were inoculated with *Serratia marcescens*. Each subject performed five consecutive wash configurations and samples were taken 3 times: at baseline, and after washes 1 and 5, using the glove juice method. After following the prescribed wash and rinse, subjects put on non-powered surgical gloves and an aqueous solution was instilled into the glove . The glove was secured at the wrist and the hand massaged through the glove for 60 seconds. Aliquots of the glove juice were removed, diluted in a solution, and spread onto Trypticase Soy Agar plates (glove juice method). Results show the use of either the manual or automated

machine wash method to be more effective in reducing contamination, $\log_{10}$ reduction ($p<0.05$). The iodine dip procedure was significantly less than $\log_{10}$ reduction. No skin irritation from any of the three wash methods was noted (18).

Turner, et al. (13) investigated an alternative method for assessing the adequacy of handwashing by comparing an automated handwashing system with manual handwashing. The effectiveness of handwashing was indicated by the removal of an oil-based suspension of a fluorescent powder when exposed to long-wave ultraviolet light (Glo-Germ™, Bevis Corp., Salt Lake City). The hands were measured for the amount of fluorescent powder before and after handwashing. Results showed that the manual wash removed 73.1% of the fluorescence, whereas the automated handwashing system removed 23.2% of the fluorescence (13).

Hand drying is as important as handwashing for good hand hygiene. A film of moisture left on the hands after washing enhances the transfer of skin micro-flora (2). There are a variety of hand drying methods from which to choose (15). The first method, rarely used, is cloth towels. Second are hot air dryers that have been shown to increase bacterial count on the skin, as well as increasing the bacterial contamination of the surrounding environment. The third and most popular hand drying method is a paper towel. Paper towels are simple, quick, and effective at rubbing away transient microorganisms and dead skin cells from the surface of the hands (15).

Coates, et al. (19) investigated the ability of campylobacters (*Campylobacter jejuni* NCTC 11168, *Camplobacter jejuni* NCTC 11392, *Camplobacter coli* NCTC 11353, and *Camplobacter laridis* NCTC 11352) to survive on fingertips after washing

with soap and water, water alone, and 70% isopropyl alcohol. The survival of campylobacters on fingertips after drying was also measured. After inoculation, the hands were decontaminated by one of the following methods:

1. Using soap and water, hands were washed for 20 seconds, rinsed for 20 seconds, and dried on two paper towels for 30 seconds.
2. Similar to method one except the hands were shaken dry for 10 seconds.
3. Using water alone, hands were rubbed under water, simulating handwashing for 20 seconds, rinsed for 20 seconds, and dried on two paper towels for 30 seconds.
4. Similar to method three except the hands were shaken dry for 10 seconds.
5. Fingertips were rubbed with 70% isopropyl alcohol for 15 seconds and then air dried for 30 seconds (19).

Results showed that handwashing with either soap and water or water alone combined with drying on paper towels for (30 seconds) removed all of the campylobacters from the fingertips. However, when hands were shaken dry after washing (10 seconds), some campylobacters remained. Rubbing the fingertips with 70% isopropyl alcohol for 15 seconds killed all of the campylobacters (19). In foodservice kitchens, observations show that foodservice workers preparing food commonly rinse their hands with water when moving from one task to another. Unfortunately, the hands are given a quick wipe on a cloth and rarely dry properly. Greater attention to completely drying hands after washing would help to reduce the risk of cross-contamination (19).

Handwashing Agents

According to Emery (3), numerous researchers comparing the efficacy of different handwashing agents have reported one agents more beneficial in a specific setting, but all agree that handwashing has a positive effect on reducing the level of cross-contamination (3). Handwashing agents are categorized into two types: soaps and antiseptic agents. Some of the commonly used antiseptic agents are chlorhexidine gluconate, iodophors, alcohols, triclosan, and hexachlorophane (14).

The efficacy of 4% chlorhexidine gluconate and 1% triclosan was examined to determine the composition of the hand bacterial flora of clinical staff in a surgical unit. Pre and post handwash samples were collected on three separate occasions and handwashing techniques were observed (20). Four-percent chlorhexidine gluconate and 1% triclosan solutions were found to effectively reduce total bacterial count of methicillin-resistant *Staphylococcus aureus* and coliforms. However, 1% triclosan reduced methicillin-resistant *Staphylococcus aureus,* whereas 4% chlorhexidine gluconate failed to reduce the microorganism.

Escherichia coli and *Pseudomonas fluorescents*, in ground beef, were rubbed onto hands to evaluate the efficacy of germicidal handwash agents for control of transient bacteria. Two separate experiments were conducted, a 7x7 and a 5x5 Latin Square design. In the first experiment, 7 agents were tested: (a) non-germicidal liquid hand soap, (b) 4% chlorhexidine gluconate, (c) antibacterial gel cleanser containing 0.3% 2,4,4' trichloro-2'-hydroxy diphenyl ether (Irgasan DP 300); (d) germicidal liquid soap diluted to 0.25% Irgasan DP 300, (e) andtiseptic liquid hand soap containing 0.65% para-chloro-

meta-xyneol (PCMX), (f) iodophor containing 0.75% available iodine, and (g) germicidal bar soap containing 1.0% trichlorocarbanilide (TCC). Five agents were tested in second experiment: (a) non-germicidal liquid hand soap (same as in experiment one) (h) iodophor handwash containing 0.005% available iodine; and (i) three hand dips consisting of iodophor solution containing 25 ppm available iodine, (j) sodium hypochlorite solution containing 50 ppm available chlorine, and (k) quaternary ammonium (QAC) solution containing 930 ppm benzalkonium chloride. Agents were used in 5 ml amounts and subjects were exposed to each agent in the study. Subject's hands were washed two times with the same solution and one hand randomly selected for sample, using hand rinse method (27).

Efficacy of germicidal agents against *Escherichia coli* show all agents, including non-germicidal soap, gave greater than 90% reduction in count. After one-15 second wash, the iodophor containing 0.75% iodine gave a significantly greater reduction than all other agents, except 4% chlorhexidine gluconate. After two 15 second washes, 4% chlorhexidine gluconate was not significantly more effective against *Escherichia coli* than iodophor containing 0.75% iodine, 0.3% Irgasan DP 300 gel, and PCMX (0.325%) antiseptic hand soap. Results for *Pseudomonas fluorescens* similar to those for *Escherichia coli* were observed, except that the TCC bar soap, one 15 second wash and dip methods of handwashing gave only 80 to 90% reduction (21).

Barrier creams are used for skin protection. Hydrophobic barrier creams may prevent microorganisms from being released from the skin. Some barrier creams are formulated with germicidal agents to reduce bacterial contamination on hands.

Germicidal handwash agents and two barrier creams for use on hands were compared by Sheena and Stiles (22) to determine their ability to reduce the number of microorganisms on the fingertips. Two separate experiments were completed. Each subject (N=7) was exposed to each agent over the course of the study. Experiment I solutions were: (a) non-germicidal liquid hand soap, (b) iodophor containing 0.75% available iodine, (c) protective hand cream #311, and (d) agent D without the addition of 0.5% quaternary ammonium. Experiment II solutions were all of the above plus, (e) 4% chlorhexidine gluconate liquid detergent, (f) iodophor handwash containing 0.005% available iodine, and (g) antibacterial skin cleanser containing 0.3% Irgasan DP 300 in gel. In both experiments, a significant effect ($p<0.001$) on the mean number of microorganisms released from fingertips and the percentage released after treatment with barrier creams or germicidal handwash agents was attributed to treatments. The barrier creams are designed to protect hands from dryness, chapping and dermatitis. It was assumed that barrier creams might also prevent or reduce the release of microorganisms from hands providing a dual protetive effect of skin and foods. The barrier creams, iodophor containing 0.75% iodine, and 4% chlorhexidine gluconate treatments resulted in a significant decease in microorganisms released. The other agents, including non-germicidal soap, iodophor handwash containing 0.005% available iodine, and the Irgasan DP 300 gel resulted in an increase in the number of microorganisms released from the fingertips. The effect of the barrier creams were diminished after rinsing with water,and after washing with soap the number of microorganisms released was remarkedly increased (22).

Food and Drug Administration's Antimicrobial Guideline defines handwash as safe, non-irritating preparation designed for frequent use, which reduces the number of transient organisms on intact skin to an initial baseline after adequate washing, rinsing, and drying (23). Aly, et al.(23) compared the antimicrobial effect of 0.5% chlorhexidine and 70% isopropyl alcohol on hands contaminated with *Serratia marcescens.* The hands of seventy-two male subjects were contaminated and disinfected with each antiseptic 25 times over an 8 hour day (23). Subjects were randomly assigned to one of the two treatment groups. Six milliliters of stock containing *Serratia marcescens,* approximately 10^8 microorganisms/ml, was pipetted onto subjects' hands and air dried for 60 seconds. Following sampling, subjects treated hands with assigned agent. Twenty-five contamination and treatments were performed on each subject and samples were obtained every fifth contamination and treatment, using the glove juice method. The difference between the two treatments was statistically significant at each handwash ($p<0.01$). There were statistically significant downward trends from wash 5 to 25 chlorhexidine ($p<0.01$) but not for alcohol treatment ($p>0.20$). Following 5 contamination handwash treatments, chlorhexidine and alcohol produced significant reductions of 3.4449 log mean and 1.6753 log mean respectively. Although both solutions produced a significant decrease of bacteria from baseline counts to wash five, 0.5% chlorhexidine reduction was greater (23).

Kjolen, et al. (24) studied the efficacy of ethanol 70%, isopropanol 40%, and alcoholic chlorhexidine (70%) from heavily infected hands by regular handwashing. Subjects' fingertips were heavily contaminated with *Entercoccus faecalis,*

Staphylococcus aureus, *Escherichia coli*, and *Enterobacter cloacae*. Fingerprint plate agar samples were taken 1 minute before and after contamination. Handwashing with liquid soap alone did not reduce growth of bacteria on fingertips for any of the contaminating microorganisms. Alcoholic chlorhexidine (70%) had a significant effect on *Staphylococcus aureus*. In reducing *Entercoccus faecalis*, the most effective decontaminates were Ethanol 70% and alcoholic chlorhexidine (70%). Kjolen's study demonstrates that ordinary handwashing followed by disinfectant solution is not enough to eliminate bacteria from heavily contaminated hands (24).

The potential for food handlers to be a vector in transmitting foodborne disease continues to be a significant issue. There is some confusion as to the actual antimicrobial effectiveness of commercially available products. To aid food sanitarians in choosing the most appropriate hand cleansing products for their needs, Paulson (25) investigated the immediate and persistent antimicrobial properties as well as product irritation to the hands upon repeated use. Products tested included non-antimicrobial lotion soap, antimicrobial lotions soap (0.6% PCMX), E2 sanitizing soap (2.5% PCMX), alcohol gel sanitizer (62% ethanol), non-antimicrobial lotion soap with alcohol gel sanitizer (62% ethanol), and antimicrobial lotion soap plus alcohol gel sanitizer (0.6% PCMX plus 62% ethanol). Subjects' hands were contaminated with *Serratia marcescens* and after one-minute air dry, the glove juice sampling procedure was performed. Each product caused a statistically significant reduction in the baseline population by at least 2 logs ($p<0.05$). Non-antimicrobial lotion soap reduced base line microbial counts by approximately 2 logs (99.00%). E2 sanitizing soap reduced microbial counts approximately 2 logs

(99.00%). All of the other products produced the same results; however, a slight build-up in microorganism populations was noted with alcohol gel sanitizer (25).

Handwashing versus Glove Use

Handwashing occurs with varying frequencies. Intensive interventions, including education appear to have minimal long-term effect on handwashing practices. Gloving seems to have replaced handwashing (26). According to Fendler, et al. (15, 27), the contamination vector between foodservice employees and consumers is a topic of intense debate. One view maintains that foodservice employees must eliminate bare hand contact with regard to ready-to-eat food by the use of gloves and utensils while the other position holds that a well managed handwashing and sanitizing program is sufficient to insure protection. These widely differing opinions have been debated throughout literature and clearly demonstrate that there is insufficient evidence to support the premise that the use of gloves on the hands of foodservice workers prevents the transfer of microorganisms to food (15, 27).

According to Best, et al. (28), the emphasis on gloving has led to accounts of health care workers washing gloves instead of changing them partly due to the economic advantage and partly to the shortage of the disposable gloves. Best, et al. (28) examined the efficacy of various disinfectants and handwashing agents in decontaminating vinyl and latex gloves for the purpose of glove re-use. The potential problem of leakage defects were also examined. Using a water tightness test, gloves were initially tested for perforations and results showed 43% of unused vinyl gloves had perforations on the

palms, thumbs, knuckles, or finger tips, and one latex glove tested hand a perforation on the palm (28). After wear and wash of the latex gloves in each of the four handwashing agents, soap, chlorhexidine gluconate, ethanol, and sodium hypochlorite, perforations did not appear. Vinyl gloves showed perforations after washing with each of the four handwashing agents. The handwashing agents were able to reduce *Staphylococcus aureus* (ATCC 25923) contamination. However, the mechanical action of handwashing with water alone did not reduce the bacterial count on the vinyl or latex gloves.

To evaluate the effectiveness of handwashing compared to gloving, Fendler, et al. (15) evaluated the ability of hand contaminant bacteria to penetrate through compromised vinyl glove barriers. The results show that at zero and one hours of testing, *Escherichia coli* bacteria penetrated gloves, thus increasing potential risk for contamination of food by food-handlers. According to Fendler, et al. and Roberts. Et al. (15, 29), the use of gloves alone provides insufficient protection against transmission of microorganism that cause disease and glove use does not decrease the need for handwashing.

Food Safety Education

A causal link between hand hygiene and reduced risk of infections has been demonstrated. According to Larson, et al. (26), despite voluminous research on the study of handwashing practices, very little research exists on how to increase and sustain handwashing compliance behaviors. Educating, motivating, and maintaining hand hygiene compliance has been costly and extremely challenging. Rooney (30) examined

Bandura's concept of self-efficacy and its role in motivation of employees in the foodservice industry. Two populations, of food management professionals, including those who were certified by the Educational Foundation of the National Restaurant Association and those who were not certified, were analyzed to determine differences in level of general self-efficacy. Rooney concluded that certification does not significantly add to the degree of general self-efficacy; however, completing the certification test qualifies as positive feedback and this is the key to building self-efficacy (30).

Over a 14-month period, Larson (26) examined handwashing frequencies, self-reported practices, beliefs and opinions about handwashing using the health education model PRECEDE (predisposing, reinforcing, enabling factors in educational and health diagnosis, and evaluation). The PRECEDE model takes into consideration the multi faceted nature of behavioral changes. Follow-up after several months showed a return of handwashing frequencies to baseline. According to Larson (26), in the context of the PRECEDE model, predisposing and enabling factors continued, but the reinforcing factors such as feedback and education did not.

Geller, et al. (31) used behavioral effects of visual recording equipment, food safety training, and response feedback to improve the sanitation practices of foodservice employees This educational approach improved the frequency of handwashing only on the first day. Feedback intervention more than doubled from the mean of 2.0 to 5.0 for handwashing frequency. Also Watanakunakorn, et al. (1) conducted an observational handwashing and infection control study of healthcare workers over a 6 week period. Researchers observed handwashing practices of the health care workers and recorded

whether or not the worker washed hands after performing patient-care activity and documeted, the type of activity, patient care area, and glove practices. The overall prevalence of handwashing was 30.2% (207 of 686 patient encounters). Researchers found that there was no difference in the prevalence of handwashing practices among the three work shifts.

Emery (3) developed a test instrument to provide information on handwashing habits and knowledge of food safety. The test instrument was administered to a group of foodservice managers, and the results showed that knowledge of food safety did not correlate with handwashing habits. Furthermore, when asked about handwashing habits, only 75% stated that they always washed their hands after visiting the toilet (3).

According to Lertwongtham (32), motivating employees is extremely challenging due to the varying needs and desires that drive people's behavior. Managers cannot force their employees to be motivated, but if managers know what their employees need and want from work, they can design educational programs and rewards that help employees motivate themselves. Nonetheless, the final responsibility for sanitation rests with the foodservice manager. If employees are not familiar with the sanitation and do not know how to use HACCP (hazard analysis critical control points) to maintain food safety, the manager's job of protecting the food is impossible (33).

CHAPTER III

METHODOLOGY

The following research methods were approved by the Texas Woman's University and the University of North Texas Human Subjects Review Committees (Appendix A). The researcher worked together with the Associate Director of the University of North Texas Dining Services as an integral part of an initiative on food safety and sanitation. This study was conducted at one of the University of North Texas dining halls. The focal point of the food safety initiative was employee training. The University of North Texas Dining Services identified a need for training to provide foodservice employees with the knowledge, skills, and attitudes necessary to follow the policies and procedures established for sanitation to decrease risks for cross-contamination. The plan for employee training included:

1). Reviewing the flow of foods and identifying critical control points from receiving, preparation, holding, and service (HACCP).

2). Observation and practice of proper handwashing techniques.

3). Reviewing chemicals for dishwashing and sanitation and identifying use and correct use for each chemical for sanitation to decrease risks of cross-contamination.

4). Learning the process of thermometer calibration, time and temperature ranges

for service of foods and cooling down process for storage. Observation and practice of taking and documentating temperatures of foods for service and storage.

Employee Questionnaire

Three foodservice professionals assisted the researcher in the design of a questionnaire focusing on years and types of foodservice experience, food safety education, and level of importance of handwashing following specific activities (Appendix B). A pilot study was conducted with foodservice employees (N=11) at the University of North Texas. Based on the responses to questions during the pilot study and faculty committee recommendations, the questionnaire was revised. Completion of the questionnaire by university foodservice workers during the study was voluntary.

Handwashing Observational Survey

Three foodservice professionals assisted the researcher in the design of a handwashing observational survey on handwashing practices focusing on the use of soap and nail brush, cross-contamination, and length of time for handwashing (Appendix C). Two researchers observed handwashing practices on three different days during a 4-week period (28-days). All university foodservice employees (N=55) were included in this phase of the study. Observations on handwashing practices took place at one of the university dining halls during normal working hours for 4-hour periods between 10:00 a.m. to 2:00 p.m. At the research study dining hall, there are three handwashing facilities located near the production area, cafeteria serving line, and dish room sanitation area,

respectively. Handwashing facilities are also located at the exterior of the employee lockers and restroom area; however, these handwashing facilities were not included in this research study. Researchers were unable to observe handwashing practices using these facilities because locations are the basement and outside dock of the foodservice operation. Each handwashing facility included hot and cold water, a Digitizer™ soap dispenser, and a nail brush. A standard stopwatch was used to measure the length of time for handwashing. The first handwashing observation occurred at day 1 of the study prior to the implementation of the handwashing Digitizer™ incentive program. At week 2, the handwashing Digitizer incentive program was implemented and the researchers again observed handwashing practices by the subjects at the beginning of week 2 (day 8) and at the end of week 4 (day 26) of the incentive program.

Digitizer™ Incentive Program

The researcher implemented an incentive program using a newly designed handwashing soap dispenser (Digitizer™ soap dispenser), provided by ECOLAB® and Human Nutrition Research funding from the Department of Nutrition and Food Sciences, Texas Woman's University, Denton, Texas. The handwashing system used four color-dot groups and maintained a tabulation of handwashing frequencies for each color group. The researcher trained the foodservice workers on how to use the Digitizer™ soap dispenser system and also explained how the incentive program would work. The subjects were randomly placed into a color group and were asked to press their color dot each time they washed their hands. At the end of the incentive phase, employees in each

color group were given incentive prizes. Prizes were awarded based on tabulations from the Digitizer™ soap dspenser. The color dot group with the highest number of handwashings received first place prize. Incentive prizes included $15 to a local discount retail store, $10 for local entertainment, and $5 and $3 to a local fast-food establishment for first, second, third, and fourth places, respectively. All foodservice workers participated in the incentive phase of the study.

Analysis of Data

Statistical Package for the Social Sciences software (SPSS) for windows 10.0 was used to perform statistical analysis (34). Analysis of variance (ANOVA) was used to determine the mean time for handwashing in seconds and significant differences between handwashing observation 1, observation 2, and observation 3. Chi-square test was used to analyze observed handwashing practices by university foodservice workers. Chi-square test of Association was used to cross-tabulate grouped variables in order to assess a relationship to handwashing attitudes. Variables include education, previous foodservice experience, years foodservice experience, and employment status.

CHAPTER IV

RESULTS

Demographics and Background

The dining hall at the University of North Texas employs 55 foodservice workers. Forty-three foodservice workers (19 full-time and 24 part-time) completed the employee questionnaire, a response rate of 78 %.

Table I shows the level of education successfully completed by these university foodservice workers. The majority (N=22) had completed one or more years of college. Twelve others had successfully completed one or more years of high school. Seven workers had acquired a General Equivalency Diploma (G.E.D.). Two employees completed education only through the fifth grade and eighth grade, respectively.

Table 2 shows the years and type of foodservice experiences by university foodservice workers. The majority of university foodservice workers had 1 to 5 years of foodservice experience. Six had more than 21 years of experience, while 15 had no prior experience in the foodservice industry.

The majority of university foodservice workers had prior foodservice experience in another university foodservice establishment (N=17) or fast food restaurant (N=10). Other foodservice experiences included military foodservice, grocery store deli, and motel foodservice.

Table 1. Level of education successfully completed by university foodservice workers (N=43)

Education	Number of Employees
Level of Education	
General Equivalency Diploma (G.E.D.)	7
High school	
9th grade	1
10th grade	3
11th grade	3
12th grade	5
Other	
5th grade	1
8th grade	1
College	
1 year	4
2 years	3
3 years	4
4 years	6
5 or more years	5

Table 2. Years and type of foodservice experience by university foodservice workers (N=43)

Experience	Number of Employees[a]
Years of foodservice experience	
9 months or less	7
1 to 5 years	16
6 to 10 years	6
11 to 15 years	4
16 to 20 years	4
21 or more	6
Employment status	
Full time	19
Part time	24
Previous foodservice work experience	
University foodservice	17
Fast food restaurant	10
Fine dining restaurant	9
Other	7
Cafeteria chain restaurant	4
Hosp/Nursing/Retirement Home foodservice	4
Public school foodservice	2
None	15
Job Position most often worked	
Cafeteria serving line	16
Dishroom/Sanitation/Porter	9
Cook/Hot food preparation	6
Other	6
Baker/Desserts	5
Cold food preparation/Salads	5

[a] A number of university foodservice workers check-marked more than one area worked most often and more than one type of previous work experience.

The majority of the 55 foodservice workers at the university dining hall are scheduled to work in the cafeteria serving line area (N=16). The other employees are rather evenly distributed among the positions as shown in Table 2.

Food Safety Education and Training

Table 3 shows the level of food safety education successfully completed by university foodservice workers.

Table 3. Level of food safety education successfully completed by university foodservice workers at the University of North Texas (N=43)

Food Safety Education	Number of Employees[a]
Employee inservice or workshop	31
Local health department food handler's class (less than 5 hours)	13
State certification program (16-hour class)	2
Other	3
None	4

[a] A number of university foodservice workers had successfully completed more than one type of food safety education program.

The majority of foodservice workers (N=31) had successfully completed in-house food safety education and training taught by university foodservice management personnel as part of their food safety initiative. Thirteen university foodservice workers had successfully completed the local health department's program to acquire a food

handler's card. However, as shown in Table 4, over 60% of university foodservice workers consider new employee training (N=29) and the in-house training workshops (N=27) important factors in teaching good food safety habits. About one-third of university foodservice workers consider the local health department food handler's class and supervision important in teaching good food safety habits. About one-fifth of the workers consider immediate feedback, (DigiGlo™ box) important in teaching good food safety habits. The DigiGlo™ box is part of ECOLAB® Incorporated, DIGITS™ system developed to heighten awareness of proper handwashing procedures. Foodservice employees apply DigiGlo™ hand lotion, which has phosphorescent properties, thoroughly onto hands, wash hands, and place hands inside the DigiGlo™ Box. The phosphorescent lotion will reveal areas of the hands that were missed during handwashing.

Foodservice Worker's Attitudes on Handwashing

Table 5 shows university foodservice workers' perception of how many times per day they wash their hands. The majority of responses (N=29) show that foodservice workers thought that they washed their hands 0 to 10 times per day. However, nine foodservice workers thought that they washed their hands 11 to 20 times per day and three workers 21 or more times per day.

The university foodservice workers were asked to indicate the number one reason for not washing hands during a working shift. Fourteen workers indicated that there is no reason not to wash hands and that they wash their hands often. Sixteen foodservice workers indicated that hands were not washed because gloves are changed often. Other

reasons were that work schedules are too busy, handwashing facilities are too far from the work area, and the employee works little with food production or serving of food. One response for not washing hands was that hands were always in sanitation water for cleaning cafeteria tables.

Foodservice workers were asked to rate the level of importance of handwashing following specific activities. Response categories were very important, important, somewhat important, and not important. Activities were divided into three main groups: activities relating to food, activities relating to personal hygiene, and other activities.

Table 4. Factors university foodservice workers consider most important in teaching good food safety habits (N=43)

Factors	Number of Employees[a]
New employee training	29
Employee inservice or workshops	27
Supervision	15
Local health department food handler's class (less than 5 hours)	13
Immediate feedback (hand glow box)	9
Pressure from co-workers	5
State certification program (16-hour)	3
Other	1

[a] A number of university foodservice workers consider many factors important in teaching good food safety habits.

Table 5. Reasons that university foodservice workers do not wash hands during a working shift and perception of times per day hands are washed (N=43)

Factors	Number of Employees
Reasons for not handwashing[a]	
Change gloves often	16
No reason not to wash hands	10
Work little with food production or service	7
Work schedule too busy	5
Wash hands often	4
Handwashing sinks too far from work area	2
Dining room beverages only	2
Clean tables, hands in sanitation water	1
Other	2
Perception of times per day hands are washed[b]	
Hand wash 0 to 5 times per day	1
Hand wash 6 to 10 times per day	16
Hand wash 11 to 18 times per day	7
Hand wash 16 to 20 times per day	2
Hand wash 21 or more times per day	3

[a] A number of university foodservice workers consider that more than one factor contributes to not washing hands.

[b] Responses for times hands washed per day does not equal 43 due to missing responses.

Table 6. Attitudes of university foodservice workers on handwashing following specific activities (n=43)

Activity[a]	Number of workers rating as: Very Important	Important	Somewhat Important	Not Important
Food activities				
Handling raw food, such as meat and poultry	34	6	3	0
Before and after changing gloves	16	13	12	1
Cracking eggs to be cooked	26	13	3	0
Washing fresh fruit and vegetables	22	12	9	0
When switching between working with raw food and working with ready-to-eat food	39	4	0	0
Total	137	48	28	1
Personal hygiene				
Using the restroom	41	1	0	1
Touching face, nose, and exposed arm	34	7	2	0
Smoking	32	5	4	2
Returning to work area after break	29	9	3	1
Coughing or sneezing	39	3	1	0
Eating food	29	13	1	0
Total	204	38	11	4
Other activities				
Scraping and washing dishes	32	6	4	1
Handling cleaning chemicals	35	5	2	0
Taking out the trash	42	1	0	0
Total	109	12	6	1
Overall Total	450	98	45	2

[a] Responses for each activity may not equal 43 due to missing responses.

Results in table 6 make it clearly evident that university foodservice workers have a positive attitude concerning handwashing. Ninety-two percent considered hand washing to be very important or important following food related, personal hygiene, and other activities, whereas 8% thought handwashing was somewhat important or not important following the same activities.

Chi-Square, cross-tabulation (2 x 2) was used to determine significant associations of university foodservice workers perceived importance of handwashing following activities as related to education, years of foodservice work experience, previous foodservice work experience and employment status (full-time and part-time). For this analysis, data for "very important" and "important" were grouped as were "somewhat important" and "not important". Perceived importance of handwashing after switching between working with raw food and working with ready-to-eat-food and taking out the trash showed no variability; all foodservice workers perceived handwashing to be important following these activities.

Table 7 shows how foodservice workers' education was related to perceived importance of handwashing following foodservice activities. Perception of importance of handwashing before and after changing gloves was significantly related ($P = 0.005$). A greater number of employees with a high school education or less perceived handwashing to be more important before and after changing gloves than workers with some college education. Fifty percent of workers with some college education perceived handwashing to be important before and after changing gloves, whereas 50% perceived it not important.

Table 8 shows how foodservice workers' years of foodservice work experience was related to perceived importance of handwashing before and after changing gloves ($P = 0.005$) and after washing fresh fruits and vegetables ($P = 0.002$). Ninety percent of foodservice employees with greater than 5 years of foodservice experience perceived handwashing to be important before and after changing gloves. For foodservice workers with 5 years or less of experience, 50% perceived handwashing to be important before and after changing gloves, whereas 50% perceived it not important. All foodservice employees with greater than 5 years of foodservice experience perceived handwashing to be important after washing fresh fruits and vegetables. Sixty-one percent of the university foodservice workers with 5 years or less experience perceived handwashing to be important after washing fresh fruits and vegetables while 39% perceived handwashing not important.

Table 9 shows how foodservice workers' previous foodservice work experience was related to perceived importance of handwashing following foodservice related activities. Perception of importance of handwashing after washing fresh fruits and vegetables was significantly related ($P = 0.02$) to previous foodservice work experience. Foodservice employees with some previous work experience perceived handwashing to be more important after washing fresh fruits and vegetables than workers with no previous foodservice work experience.

Table 10 shows how foodservice workers' employment status was related to perceived importance of handwashing following food related activities. Perception of

importance of handwashing after washing fresh fruits and vegetables was significantly related ($P = 0.03$) to employment status. Full-time foodservice workers perceived handwashing after washing fresh fruits and vegetables more important. Two-thirds of part-time workers perceived handwashing important after washing fresh fruits and vegetables, whereas one-third perceived it not important.

Table 7. University foodservice workers perceived importance of handwashing following activities as related to education (N=43)[a]

Food related activites:	Education			
	High School or less		Some college	
	Important[b]	Not important[c]	Important[b]	Not important[c]
A+ Handling raw food, such as meat and poultry	20	1	20	2
B+ Using the restroom	20	1	22	0
C* Before and after changing gloves	18	2	11	11
D+ Cracking eggs to be cooked	19	1	20	2
E+ Scraping and washing dishes	19	2	19	3
F+ Washing fresh fruit and vegetables	17	4	17	5
G+ Touching face, nose, and exposed arms	19	2	22	0
H+ When switching between working with raw food and working with ready-to-eat-food	21	0	22	0
I+ Returning to the work area after break	18	2	20	2
J+ Handling cleaning chemicals	20	1	20	1
K+ Smoking	17	4	20	2
L+ Coughing or sneezing	20	1	22	0
M+ Eating food	20	1	22	0
N+ Taking out the trash	21	0	22	0

* P = 0.005.

+ P value not valid based on the assumptions of Chi-Square (some cells had expected counts less than 5).

[a] Responses for each activity may not equal to 43 due to missing responses.

[b] Responses for "very important" and "important" were combined.

[c] Responses for "somewhat important" to "not important".

Table 8. University foodservice workers perceived importance of handwashing following activities as related to years of foodservice work experience (N=43)[a]

Food related activites:	Years of foodservice work experience			
	5 years or less		Greater than 5 years	
	Important[b]	Not important[c]	Important[b]	Not important[c]
A+ Handling raw food, such as meat and poultry	20	3	20	0
B+ Using the restroom	23	0	19	1
C* Before and after changing gloves	11	11	18	2
D+ Cracking eggs to be cooked	20	2	19	1
E+ Scraping and washing dishes	21	2	17	3
F**Washing fresh fruit and vegetables	14	9	20	0
G+ Touching face, nose, and exposed arms	22	1	19	1
H+ When switching between working with raw food and working with ready-to-eat-food	23	0	20	0
I+ Returning to the work area after break	20	3	18	1
J+ Handling cleaning chemicals	21	1	19	1
K+ Smoking	20	3	17	3
L+ Coughing or sneezing	23	0	19	1
M+ Eating food	23	0	19	1
N+ Taking out the trash	23	0	20	0

* P = 0.005.

** P = 0.002.

+ P value not valid based on the assumptions of Chi-Square (some cells had expected counts less than 5).

[a] Responses for each activity may not equal to 43 due to missing responses.

[b] Responses for "very important" and "important" were combined.

[c] Responses for "somewhat important" to "not important".

Table 9. University foodservice workers perceived importance of handwashing following activities as related to previous foodservice work experience (N=43)[a]

Food related activites:	Foodservice work experience			
	No previous experience		Some experience	
	Important[b]	Not important[c]	Important[b]	Not important[c]
A+ Handling raw food, such as meat and poultry	14	1	26	2
B+ Using the restroom	15	0	27	1
C+ Before and after changing gloves	7	7	22	6
D+ Cracking eggs to be cooked	13	1	26	2
E+ Scraping and washing dishes	14	1	24	4
F* Washing fresh fruit and vegetables	9	6	25	3
G+ Touching face, nose, and exposed arms	14	1	22	0
H+ When switching between working with raw food and working with ready-to-eat-food	15	0	28	0
I+ Returning to the work area after break	13	2	25	2
J+ Handling cleaning chemicals	13	1	27	1
K+ Smoking	13	2	24	4
L+ Coughing or sneezing	15	0	27	1
M+ Eating food	15	0	27	1
N+ Taking out the trash	15	0	28	0

* P = 0.02.

+ P value not valid based on the assumptions of Chi-Square (some cells had expected counts less than 5).

[a] Responses for each activity may not equal to 43 due to missing responses.

[b] Responses for "very important" and "important" were combined.

[c] Responses for "somewhat important" to "not important".

Table 10. University foodservice workers perceived importance of handwashing following activities as related to employment status (N=43)[a]

Food related activities:	Employment status			
	Part-Time		Full-Time	
	Important[b]	Not important[c]	Important[b]	Not important[c]
A+ Handling raw food, such as meat and poultry	22	2	18	1
B+ Using the restroom	24	0	18	1
C+ Before and after changing gloves	14	10	15	3
D+ Cracking eggs to be cooked	11	2	17	3
E+ Scraping and washing dishes	22	2	16	3
F* Washing fresh fruit and vegetables	16	8	18	1
G+ Touching face, nose, and exposed arms	23	1	18	1
H+ When switching between working with raw food and working with ready-to-eat-food	24	0	19	0
I+ Returning to the work area after break	20	3	18	4
J+ Handling cleaning chemicals	23	0	17	2
K+ Smoking	20	4	17	2
L+ Coughing or sneezing	24	0	18	1
M+ Eating food	23	1	19	0
N+ Taking out the trash	24	0	19	0

* P = 0.03.

+ P value not valid based on the assumptions of Chi-Square (some cells had expected counts less than 5).

[a] Responses for each activity may not equal to 43 due to missing responses.

[b] Responses for "very important" and "important" were combined.

[c] Responses for "somewhat important" to "not important".

Handwashing Observation Study

Fifty-four university foodservice workers participated in the incentive program and handwashing observation phase of the study. Three handwashing observations took place over a four-hour period during normal foodservice operation times (10:00 a.m. to 2:00 p.m.). Two hundred and fifty total observations of employees were made during pre-test, post test I, and post test II periods, day 1, day 8, and day 26 respectively (Table 11). Analysis of variance (ANOVA) was used to determine mean time for handwashes in seconds and significant associations between pre-test and post-test handwashing observation periods.

Table 11. Length of time spent washing hands by university foodservice workers

Time Period	No. of observations	Number of workers[a]	Handwashing time in seconds		
			Minimum	Maximum	Mean
Day 1	79	21	2.0	78.9	20.6
Day 8	71	22	5.5	139.2	25.0
Day 26	100	18	1.3	86.0	18.9

[a] Number of workers is the number of foodservice employees working during the four hour observation period for each test period.

On day 1 of the study prior to the incentive program, the first observation was made and the mean handwashing time was 20.64 seconds. The incentive program was implemented at week 2, and the second observation was made on day 8. The mean handwashing time increased to 24.96 seconds. At the end of the incentive program (day 26), the third handwashing observation was made, and the mean handwashing time

decreased to 18.92 seconds, which was below baseline (day 1). Although handwashing times dropped below baseline, handwashing frequency increased above baseline with fewer employees working during the third observation period (Table 12). The increase in handwashing frequencies may be the effect of the handwashing incentive program or perhaps influenced by the presence of two research observers.

Table 12. Handwashes per hour by university foodservice workers during three hand-washing observation over a four-hour period

Time Period	Number of observations	Number of workers[a]	Handwashes per hour	Handwashes per worker
Day 1	79	21	19.8	0.94
Day 8	71	22	17.6	0.80
Day 26	100	18	25.0	1.4

[a] Number of workers is the number of foodservice employees working during the four hour observation period for each test period.

Table 13 shows observed positive and negative handwashing practices. Observed positive practices by university foodservice workers were: use of soap, use of paper towel to turn off faucet handle, and avoidance of touching self (face and hair). The most commonly observed negative practices were not using a nail brush and cross contamination by touching faucet handles. In 90% of observed handwashing practices (N=250), a nail brush was not used. However this practice did not show a significant association. Cross contamination by touching the faucet handle during handwashing showed a significant association ($P = 0.04$). Cross-contamination by touching faucet

handle increased above baseline (day 1) at the end of the incentive program (day 26) after showing a decrease in the number of contaminations below baseline on day 8 of the study.

Table 13. Observed handwashing practices of university foodservice workers (N = 250)[a]

Characteristics	Observed handwashing practices					
	Positive Day 1[b]	Negative Day 1[b]	Positive Day 8[c]	Negative Day 8[c]	Positive Day 26[c]	Negative Day 26[c]
Use of soap	74	3	72	0	99	2
Use of nail brush	10	66	4	66	3	90
Total incidence cross-contamination (CC)	72	5	64	8	86	15
*CC by touching faucet handle(s)	12	60	6	57	25	75
Towel used to turn off faucet handle	64	8	60	3	94	7
CC by touching self (face,hair)	69	3	61	2	96	5
CC by other means	62	10	54	9	88	13

[a] Responses for each characteristic may not equal 250 due to missing responses.
[b] Observed practices prior to incentive program.
[c] Observed practices with implementation of incentive program.
* P = 0.04.

Digitizer™ Incentive Program

The Digits™ incentive program was implemented on day 8 of the handwashing observation study. This phase of the study occurred over a 21 day period (3 weeks). Employees were randomly placed into one of the four-color dot groups. Over the 21 day period, the researcher documented and tabulated each color dot group from each of the

handwashing dispensers. The researcher documented the total number of employees scheduled each day less employees absent from the work place. The university dining hall is open seven days a week with a different number of scheduled hours on weekdays and weekends. Monday through Friday production hours scheduled equaled 14 hr, 15 min, Saturday 13 hr, 15 min, and Sunday 8 hr, 30 min. Table 14 shows hours worked by full-time and part-time foodservice workers during the 21 day handwashing incentive period. Total hours worked by foodservice workers was 3,920.

Seventy eight percent of hours worked by foodservice workers was on weekdays, 13%, and 9% on Saturdays and Sundays, respectively. The researcher documented the number of handwashes per color-dot group and soap dispenser location (Table 15). The total number of handwashes during the incentive period using the Digi™ color-dot soap dispensers was 4,975, showing a handwashing prevalence of 1.27 handwashes per hour, considerably lower than observed handwashes per hour, as shown in Table 12.

Handwashing throughout the foodservice facility production areas was rather evenly distributed with 1,840 washes at the production area sink (37%), 1,275 at the cafeteria serving line (26%), and 1,860 in the dishroom area (37%). The handwashing incentive results were the following: Red group 1,658 handwashes, Blue group 1,260 handwashes, Yellow group 1,115 handwashes, and Green color dot group 942 handwashes. First, second, third, and fourth place prizes were distributed respectively.

Null hypotheses rejected were:

1. There is no significant relationship between the level of education completed and handwashing attitudes of university foodservice workers.
2. There is no significant relationship between years of foodservice experience and handwashing attitudes of university foodservice workers.

3. There is no significant relationship between types of foodservice facilities worked and handwashing attitudes by university foodservice workers.

4. There is no significant difference between observed handwashing practices before and after the handwashing incentive program.

The following null hypotheses could not be tested by Chi-square analysis since data could not readily be categorized to meet the assumptions of Chi-square.

1. There is no significant relationship between area of foodservice worked and handwashing attitudes of university foodservice workers.

2.. There is no significant difference between type of food safety education and handwashing attitudes of university foodservice workers.

Table 14. Hours worked by university foodservice workers (full-time plus part-time) over the 21 day incentive program study period

Scheduled production days	Hours worked		Total hours worked by foodservice workers	Percentage of scheduled hours for week days and weekend days
	Full-time Employees[a]	Part-time employees[b]		
Weekdays 15 days	1,840	1,216	3,056	78%
Saturday 3 days	320	172	492	13%
Sunday 3 days	192	180	372	9%
Total	2,352	1,568	3,920	100%

[a] Full-time employees worked 294 8-hour shifts.
[b] Part-time employees worked 392 4-hour shifts.

Table 15. Handwashing by university foodservice workers who participated in a 21 day incentive program

Date	Number of handwashings according to color dot group[a]					Total
	Soap dispenser	Green color group	Blue color group	Red color group	Yellow color group	
21-Jul	1	14	10	17	23	64
	2	10	9	9	9	37
	3	1	23	50	0	74
24-Jul	1	54	24	103	87	268
	2	35	26	42	44	147
	3	3	40	106	3	152
27-Jul	1	114	82	146	118	460
	2	34	128	100	99	361
	3	180	242	187	137	746
29-Jul	1	28	29	39	47	143
	2	24	28	22	42	116
	3	11	72	42	9	134
31-Jul	1	44	7	17	33	101
	2	18	21	40	36	115
	3	58	28	75	14	175
3-Aug	1	61	51	88	88	288
	2	36	42	39	54	171
	3	36	83	65	11	195
7-Aug	1	51	34	49	64	198
	2	47	26	32	43	148
	3	11	36	75	3	125
10-Aug	1	42	58	123	95	318
	2	19	59	46	56	180
	3	11	102	146	0	259
	Total	942	1260	1658	1115	4975

[a] Workers were grouped into 4 color groups (green, red, blue, and yellow).

CHAPTER V

DISCUSSION AND CONCLUSIONS

DISCUSSION

Handwashing Observation

This study was designed to determine handwashing practices and prevalence of university foodservice workers and to determine if a change in practices and prevalence of handwashing occurred with the use of an incentive program.

There were three limitations to the study. First the University of North Texas Human Subjects Committee required a cover letter to research subjects discussing the purpose and design of the study (Appendix A). The Associate Director of the University of North Texas Dining Services was required to discuss the research project with managers and supervisors at the dining hall. Whether information discussed with managers and supervisors remained confidential is unknown to the researcher, but there is a possibility that some of the employees were aware that their handwashing practices were being observed.

A second limitation was that the handwashing observations did not include the restroom areas for foodservice workers. The restrooms for foodservice workers at the dining hall are located on the back dock and in the basement area of the building, areas which were not visible and/or safely visible by the researchers. Therefore, there is no documentation and research analysis of handwashing practices of university foodservice

workers in the restroom areas.

The third limitation to this study occurred during the incentive phase of our handwashing study, week 2 through week 4, using the Ecolab's DIGITS™ program. Some university foodservice workers succumbed to dishonest behavior in order to obtain first place prize for their color-dot group. During observations on day 8 and day 26, a few foodservice workers were observed handwashing at one sink, pressing the color dot group and soap dispenser and then moving immediately to another sink and repeating the same practice, thus increasing handwashing tabulation. Also a few foodservice workers were observed pressing the color-dot group and the soap dispenser multiple times during one handwash, increasing the handwash tabulation for their color dot group. Level of dishonest behavior for days when researchers were not present in the foodservice kitchen is unknown, and therefore dishonest behavior may have skewed data for handwashing prevalence by university foodservice workers. Although the DIGITS™ program is an incentive, the foodservice managers must continue to monitor and observe practices by foodservice employees.

At the time of this study, the Digitizer™ soap dispensers cost $80 per dispenser plus the cost of handwashing soap. ECOLAB®, Incorporated and Texas Woman's University Department of Nutrition and Food Sciences provided the Digitizer™ soap dispensers. All foodservice workers (N = 55) participated in the incentive phase of the study. At the end of the incentive phase, employees in each color group were given incentive prizes. Prizes were awarded based on tabulations from the Digitizer™ soap dispenser. The color-dot group with the highest number of handwashings received first

place prize. Incentive prizes included$15 to a local discount retail store, $10 for local entertainment, and $5 and $3 to a local fast-food establishment for first, second, third, and fourth places, respectively. The total cost for incentive prizes was $462.

Handwashing prevalence varied among workers. The same university foodservice workers tended to wash their hands a multitude of times, whereas other workers were observed not washing their hands at appropriate intervals following preparation and/or sanitation activities. Observed handwashing practices during pre-test, post test I, and post test II revealed negative and positive practices among university foodservice workers. The most common negative practice was that university foodservice workers did not pay attention to details during the handwashing process. Turner et al. (13), states that washing at appropriate intervals with correct technique reduces the concentration of resident and transient microbial flora on hands. Furthermore, observed practices by the university foodservice workers included hands barely being rubbed, not creating enough friction to loosen microbial bacteria. Workers were observed not thoroughly rinsing hands after washing and touching faucet handles during the rinsing process. The use of a nailbrush was a scarce practice among the foodservice workers. Additionally, university workers were observed air-drying hands after handwashing. In the literature, hand drying has been found to be as important as handwashing in removing microbial flora that remains loosely on the hands (2). The most common hand drying technique is a paper towel. Paper towels are simple, quick, and effective at rubbing away transient microorganisms that remain on the hands after washing (15). Furthermore, university foodservice workers were observed hand drying with the paper towel used to turn off the

faucet handles causing cross-contamination to hands.

During each observation period, university foodservice workers were observed rinsing and/or washing gloves. According to Fendler et al. and Roberts et al. (15, 29), the use of gloves alone provides insufficient protection against transmission of micro-organisms that cause disease, and glove use does not decrease the need for hand washing. One foodservice worker was observed rinsing gloves in the vegetable sink after working with hard-boiled eggs over vegetables soaking for preparation. Another foodservice worker was observed thoroughly washing gloves after cleaning equipment and then proceeded to the serving line and served food patrons of the dining hall.

University foodservice workers were observed not handwashing when reporting for work, duty, or returning from break. One employee was observed returning from break with a drink and did not wash hands prior to working with food preparation. Another employee was observed washing hands approximately 30 minutes after reporting to work and had already initiated food preparation. Some university foodservice workers performed handwashing practices 5 to 15 minutes apart at times when handwashing was not necessary, implicating possible subject awareness of study design.

As the handwashing study proceeded, university workers became familiar with the researchers' presence in the foodservice working environment and reverted to habitual handwashing practices. As the subjects' comfort level increased with researchers, violations of proper handwashing practice that greatly increased the risk for cross-contamination were observed. One university worker was observed rinsing hands after washing pots and pans with noticeable soapsuds on forearms prior to working with

ready to serve food. After loading dirty dishes onto the dish machine, one university worker washed hands 9.56 seconds with poor technique and proceeded to remove clean dishes from the dish machine to be used for serving patron meals. On the other hand, another foodservice worker was observed washing hands with proper technique, and after hand drying, the worker removed a paper towel from the backed-up sink and did not rewash hands before working with ready to eat food.

While there were a great number of handwashing practice violations, there were also positive practices that may result in long-term compliance if reinforced by continued observation and training from the foodservice manager. Comparison of practices between post test I and II demonstrate these positive handwashing practices. At post test I, there were 22 employees observed working and 71 handwashing observations with a mean handwashing time of 24.96 seconds. At post test II there were 18 employees observed working and 100 handwashing observations with a mean handwashing time of 18.72 seconds. Although the mean time of handwashing was greater in post test I, exceeding food code policy for length of time for handwashing, 20 seconds (12), the researchers observed improved handwashing technique by foodservice workers on the day 26 handwashing practices observation. On day 26, fewer employees were observed working; however, there was greater frequency in handwashing from workers at appropriate intervals with a more even distribution of employee participation, as compared to handwashing practices observation on day 8. A greater number of employees were observed washing hands as they reported to work and returning from breaks prior to handling food on day 26. Researchers observed employees paying more

attention to the handwashing practice and making noticeable efforts to decrease cross-contamination during the handwashing process.

As part of a personal hygiene program, Luby's, Inc. enacted a strict handwashing policy in 1999. In addition to washing their hands between tasks, employees are required to double-wash their hands using a nailbrush before they start to work and each time they use the restroom. The restaurant chain also enforces a mandatory hand wash once an hour (36). Luby's also implemented Ecolab's DIGITS™ program to record and monitor hand washing. Employees wear colored dots on their name tags that correspond to one of four color groups. Employees are assigned a specific time to wash their hands on the hour, quarter-hour, half-hour, or three-quarter hour. The employees push the corresponding color dot at the handwashing station and managers are able to monitor who uses the handwashing stations to help ensure compliance (33).

Employee Questionnaire

Chi Square, cross tabulation (2 x 2) statistical analysis was used to determine significant associations of university foodservice workers perceived importance of handwashing following activities as related to education, years of foodservice work experience, previous type of foodservice experience and employment status (Tables 7 to 10). All of these university foodservice workers perceived handwashing to be important after taking out the trash and switching between working with raw food and working with ready-to-eat food, as related to education, years of foodservice work experience, previous type of foodservice experience and employment status.

Level of education and years of foodservice experience (Table 7, Table 8) illustrated a significant relationship, P = 0.005 as related to perceived importance of handwashing before and after changing gloves. It was found that foodservice workers' level of education had an inverse relationship with years of foodservice experience as a result of confounding factor. The majority of international students working at the university dining hall had some college education and 5 years or less of foodservice work experience and perceived handwashing to be less important before and after changing gloves. However, foodservice workers who had completed high school or less had more foodservice work experience and perceived handwashing to be more important before and after changing gloves.

Perceived importance of handwashing after washing fresh fruits and vegetables was significantly related to years of foodservice experience, previous type of foodservice experience, and employment status, P = 0.002, P = 0.02, P = 0.03 (Table 8, Table 9, Table 10), respectively. University foodservice workers with previous foodservice experience and 5 or more years of foodservice experience thought handwashing was more important after washing fresh fruits and vegetables. More full-time than part-time workers also thought handwashing to be more important following the same foodservice activity.

Handwashing Incentive Program

The Digitizer™ incentive program was implemented in a university foodservice operation over a 21 day period, and handwashing prevalence and practices were documented by the researchers. During the incentive phase of the study, university

foodservice employees were scheduled to work a total of 3, 920 hours (Table 14). Over the 21 day period, using the Digitizer™ soap dispenser, total number of handwashes by university foodservice workers was 4,975. The results show handwashing prevalence of 1.27 handwashes per hour by university foodservice workers which is considerably lower than observed practices. This supports the theory that some workers may have been aware of handwashing practices being observed, as a result bringing about exaggerated employee performance on observation days. Watanakunakorn, et al. (1) conducted an observational handwashing and infection control study over a 6 week period at a teaching hospital affiliated with the Norther Eastern Ohio University, College of Medicine. The overall prevalence of handwashing was 30.2% (207 of 686 patient encounters). Researchers found that there was no difference in the prevalence of handwashing practices among the three work shifts.

CONCLUSIONS

The results of this study indicate that a handwashing incentive program alone does not increase handwashing prevalence. Handwashing prevalence during the 21 day incentive program was 1.27 handwashes per hour, lower than observed practices (Table 12). It appears that some of the foodservice workers became aware that their handwashing practices were being observed, and as a result, increased performance. Geller, et al. (31) compared the relative effect of sanitation training and response feedback on the rate of behavior in two categories, microorganism collecting and microorganism removing behaviors and showed. The results showed that handwashing

following behaviors contributing to the microbial contamination of food increased above baseline levels as a function using three interventions: handwatching (observation), sanitation training, and feedback. This study indicated only minimal behavioral effects of the popular education approach to improving sanitation practices, but showed promising behavioral consequences of a feedback intervention.

University foodservice workers attitudes' concerning perceived importance of handwashing showed an inverse relationship between level of education completed and previous foodservice work experience. Workers with higher level of education had less foodservice work experience and perceived handwashing to be less important following foodservice activities. University workers with 5 more years of foodservice experience perceived handwashing to be more important following foodservice activities. Furthermore, workers employeed full-time at the dining hall perceived handwashing to be more important following food related activities.

Observations of handwashing practices revealed negative and positive practices among these university foodservice workers. Not surprisingly, there was a significant relationship with cross-contamination by touching the faucet handles ($P = 0.04$). Observations also indicated an uneven distribution of handwashing prevalence by university foodservice workers. With the implementation of the Digits™ incentive program there was a rather evenly distributed handwashing prevalence at each of the handwashing sinks.

At this time the cost of implementing an incentive program with incentive prizes does not appear to be as cost effective as the presence of foodservice managers who can

provide immediate feedback. Handwashing prevalence was higher in all three of the observation periods than the incentive period. However, a future study using recordable visual equipment positioned at handwashing facilities might better determine the influence of a handwashing incentive program among foodservice workers. Nonetheless, university workers enjoyed the program and observed practices did show improvement in handwashing techniques. Managers cannot force their employees to be motivated, but if managers know what their employees need and want from work, they can design educational programs and rewards that help employees motivate themselves (33).

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APPENDICES

APPENDIX A

TEXAS WOMAN'S
UNIVERSITY
DENTON / DALLAS / HOUSTON

HUMAN SUBJECTS
REVIEW COMMITTEE
P.O. Box 425619
Denton, TX 76204-5619
Phone: 940/898-3377
Fax: 940/898-3416

April 21, 2000

Ms. Melissa Witten
8613 McArthur Blvd. #3016
Irving, TX 75063

Dear Ms. Witten:

Re: Influence of an Incentive Program on Handwashing Practices and Handwashing Prevalence among University Foodservice Workers

The above referenced study has been reviewed by a committee of the Human Subjects Review Committee and was determined to be exempt from further TWU HSRC review.

If applicable, agency approval letters obtained should be submitted to the HSRC upon receipt prior to any data collection at that agency. Because you do not utilize a signed consent form for your study, the filing of signatures of subjects with the HSRC is not required.

Another review by the HSRC is required if your project changes. If you have any questions, please feel free to call the Human Subjects Review Committee at the phone number listed above.

Sincerely,

Dr. Linda Rubin, Chair
Human Subjects Review Committee - Denton

cc. Dr. Carolyn Bednar, Department of Nutrition & Food Sciences
Graduate School

UNIVERSITY of NORTH TEXAS

Office of Research Services

June 2, 2000

Melissa Witten
8613 N. MacArthur Blvd. #3016
Irving, TX 75063

RE: Human Subjects Application No. 00-106

Dear Ms. Witten,

Your proposal titled "Influence of An Incentive Program on Handwashing Practices and Hand Washing Prevalence Among University Foodservice Workers," has been approved by the Institutional Review Board and is exempt from further review under 45 CFR 46.101.

The UNT IRB must review any modification you make in the approved project. **Federal policy 21 CFR 56.109(e) stipulates that IRB approval is for one year only.**

Please contact me if you wish to make changes or need additional information.

Sincerely,

Reata Busby, Chair
Institutional Review Board

RB:sb

P.O. Box 305250 ◆ Denton, Texas 76203-5250 ◆ (940) 565-3940
Fax (940) 565-4277 ◆ TDD (800) 735-2989 ◆ www.unt.edu

UNIVERSITY of NORTH TEXAS

Office of Research Services

July 10, 2000

Melissa Witten
8613 N. MacArthur Blvd. #3016
Irving, TX 75063

Institutional Review Board for the Protection of Human Subjects in Research (IRB)
RE: Human Subject Application #00-106

Dear Ms. Witten,

The UNT IRB has received the modification to your study entitled "Influence of An Incentive Program On Hand Washing Practices and Hand Washing Prevalence Among University Foodservice Workers." As required by federal law and regulations governing the use of human subjects in research projects, the UNT IRB has examined the modification. Your modification to this research project is hereby approved for the use of human subjects.

Enclosed is the modified consent form with stamped IRB approval. Please copy and **use this form only** for your study subjects.

The UNT IRB must re-review this project prior to any other changes you make in the approved project. **Federal policy 21 CFR 56.109(e) stipulates that IRB approval is for one year only.**

Please contact me if you wish to make changes or need additional information.

Sincerely,

Reata Busby, Chair
Institutional Review Board

RB:sb

P.O. Box 305250 • Denton, Texas 76203-5250 • (940) 565-3940
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APPENDIX B

To: Foodservice Employees at Kerr Hall

From: Melissa Witten, R.D.
Texas Woman's University Master's Student

RE: Research Study Cover Letter

Date: June 1, 2000

Dear Kerr Hall Employees,

A research study is being conducted with all Kerr Hall foodservice employees at the University of North Texas to determine food safety attitudes and practices. The researcher, Melissa Witten, R.D., is working together with the Assistant Director of the University of North Texas Dining Services, Kathy Butler, M.S., R.D., L.D., as an integral part of their food safety and sanitation initiative. Kerr Hall foodservice employees will be asked to complete a questionnaire regarding food safety habits. There is **NO RISK** to yourself and **NO RISK** to your job by completing the questionnaire. **ALL** questionnaire information will be kept confidential and handled only by the researcher. Two research observers will observe foodsafety practices of employees in the Kerr Hall production area over a 5-week (35-day) research period. There is **NO RISK** to yourself and **NO RISK** to your job by participating in the observation phase of the study. **ALL** data obtained will be kept confidential and handled only by the researcher. Benefits to the subject include an improving food safety education training program, decreasing the risk of foodborne illness. **Note participation is voluntary and the subject may withdraw from this study at anytime without penalty or prejudice.** If at any time you, have questions or concerns please contact:

Melissa Witten, R.D.
Texas Woman's University
(817) 368-3230 or
G_Witten@twu.edu

OR

Kathy Butler, M.S., R.D. L.D.
University of North Texas
(940) 565-2462
KSB@hsl.unt.edu

Sincerely,

M. Witten RD

Melissa Witten, R.D.

APPROVED BY THE UNT IRB
FROM 6/2/00 TO 6/1/01
KM

To: Foodservice Employees at Kerr Hall

From: Melissa Witten, R.D.
Texas Woman's University Master's Student

RE: Research Study Cover Letter

Date: July 10, 2000

Dear Bruce Hall Employees,

A research study is being conducted with all Bruce Hall foodservice employees at the University of North Texas to determine food safety attitudes and practices. The researcher, Melissa Witten, R.D., is working together with the Associate Director of the University of North Texas Dining Services, Kathy Butler, M.S., R.D., L.D., as an integral part of their food safety and sanitation initiative. Bruce Hall foodservice employees will be asked to complete a questionnaire regarding food safety habits. There is **NO RISK** to yourself and **NO RISK** to your job by completing the questionnaire. **ALL** questionnaire information will be kept confidential and handled only by the researcher. Two research observers will observe foodsafety practices of employees in the Bruce Hall production area over a 5-week (35-day) research period. There is **NO RISK** to yourself and **NO RISK** to your job by participating in the observation phase of the study. **ALL** data obtained will be kept confidential and handled only by the researcher. Benefits to the subject include an improving food safety education training program, decreasing the risk of foodborne illness. **Note participation is voluntary and the subject may withdraw from this study at anytime without penalty or prejudice.** If at any time you, have questions or concerns please contact:

Melissa Witten, R.D.
Texas Woman's University
(817) 368-3230 or
G_Witten@twu.edu

OR

Kathy Butler, M.S., R.D. L.D.
University of North Texas
(940) 565-2462
KSB@hsl.unt.edu

Sincerely,

M. Witten, RD

Melissa Witten, R.D.

APPROVED BY THE UNT IRB
FROM 6/2/00 **TO** 6/1/01
RB

APPENDIX C

Code: _____

Foodservice Workers Survey

"I understand that the return of my completed questionnaire constitutes my informed consent to act as a subject in this research study."

1. Check mark (✓) highest level of education successfully completed.
   ___ G.E.D.

   ___ High School (Please check mark (✓) highest grade successfully completed):

   ____ ____ ____ ____ _____
   9 10 11 12 Other (please describe): _____

   ___ College (Please check mark (✓) number of years successfully completed):

   ____ ____ ____ ____ ____
   1 2 3 4 5ormore
2. How many years of foodservice experience do you have? _____
3. How many hours a week do you currently work in University of North Texas foodservice? _____
4. Check mark (✓) the **ONE** area of foodservice where you **currently** work **MOST** time.

   ___ Baker/Desserts
   ___ Cold food preparation/Salads
   ___ Cafeteria Service Line
   ___ Cook/Hot food preparation
   ___ Dishroom/Sanitation/Porter
   ___ Other (please describe): _____
5. Check mark (✓) types of foodservice facilities where you have worked in the past.

   ___ Fast Food Restaurant
   ___ Fine Dining Restaurant
   ___ Public School Foodservice
   ___ University Foodservice
   ___ Cafeteria Chain Restaurant
   ___ Hospital or Nursing/Retirement Home foodservice
   ___ Other (please describe): _____

6. Check mark (✓) type of food safety education you have successfully completed.

___ Employee inservice or workshops

___ Local health department food handler's class (less than *5* hour class)

___ A state certification program (16-hour class)

___ Other (please describe: _____

___ None

7. Please check mark (✓) factors you consider important in teaching you good food safety working habits.

___ New employee training

___ Employee inservice or workshops

___ Local health department food handler's class (less than *5* hours)

___ Supervision

___ Pressure from co-workers

___ Immediate feedback (hand glow box)

___ State Certification program (16-hour class)

___Other (please describe): _____

8. Please check mark (✓) reasons for **not** **washing** your hands during a working shift.

___Work schedule too busy

___ Handwashing sinks too far from work area

___ Work little with food production/service

___ I change my gloves often

___Other (please describe): _____

9. How many hours is your typical work shift? _____

10. Approximately how many times do you wash your hands during a daily working shift? _____

11. Please check mark (✓) the **box of importance** of washing your hands **AFTER EACH** of the following **activities**, using the following scale.

ACTIVITY	VERY IMPORTANT	IMPORTANT	SOMEWHAT IMPORTANT	NOT VERY IMPORTANT
A. Handling raw food, such as meat and poultry				
B. Using the restroom				
C. Before and after changing gloves				
D. Cracking eggs to be cooked				
E. Scraping and washing dishes				
F. Washing fresh fruit and vegetables				
G. Touching face, nose, and exposed arms				
H. When switching between working with raw food and working with ready-to-eat-food				
I. Returning to the work area after break				
J. Handling cleaning chemicals				
K. Smoking				
L. Coughing or sneezing				
M. Eating food				
N. Taking out the trash				

APPENDIX D

Handwashing Observational Survey

1. Use of Soap:

   _____YES _____ NO

2. Use of Nail Brush:

   _____YES _____ NO

3. Cross-Contamination:

   _____YES _____ NO

4. Type of Cross-Contamination (Answer to No. 4 is no; omit question):

   _____ Touch faucet handle(s)

   _____ Touch towel used to turn off faucet handle(s)

   _____ Touch door handle (restroom area)

   _____ Touch self (face, hair, etc.)

   Other: _____

5. Length of Time Handwashing:

   Time: _____