Relationship of the Physical Dining Environment and Service Styles to Plate Waste in Middle/Junior High Schools

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EXECUTIVE SUMMARY

The National School Lunch Program (NSLP) is an important factor in meeting the nutritional needs of many school children. On any given school day, the program provides about 27 million children with a nutritionally balanced meal prepared according to guidelines set forth by the Food and Nutrition Service of the United States Department of Agriculture (USDA, 2002). The program costs about $6.2 billion to administer (Buzby & Guthrie, 2002).

According to a recent review of literature concerning the NSLP, about 12 percent of the calories provided go uneaten (Buzby & Guthrie, 2002). Estimates of plate waste in the school lunch program have varied widely over the years, and most studies were undertaken before significant changes such as offer-versus-serve were implemented. Consumption of lunch items in public schools has ranged from 55 to 90 percent in one study (Jansen, 1978), meaning that in some cases children are eating only half of the lunch provided at school. In a 1996 survey by the US General Accounting Office (GAO), almost one-fourth of responding cafeteria managers considered plate waste to be at least a moderate problem (US General Accounting Office, 1996). Studies on plate waste have mostly focused on improving the accuracy of measurement (Anderson, 1994; Dubois, 1990; Comstock, St. Pierre, & Mackiernan, 1981; Kirks & Wolff, 1985).

While the recent estimate of 12 percent does not seem significant, it does represent a loss of economic efficiency in the administration of the program and a corresponding loss of nutrition for the children involved. This loss of nutrients takes on added importance when one considers

that the children participating in the program are generally the ones most in need of supplemental nutrition.

Some studies have focused on causes of plate waste and strategies to prevent it. Possible causes of plate waste may include wide variations in student appetites and energy needs, differences between meals served and student preferences, scheduling constraints that interfere with meal consumption or result in meals being served when children are less hungry, and availability of substitute food from competing sources. Buzby and Guthrie (2000) concluded from a review of plate waste studies that:

> [S]everal strategies may reduce plate waste, including the offer vs. serve provision, rescheduling of lunch hours, and improving the quality of the food. … Other strategies, such as tailoring serving sizes to student appetites via self-service, and nutrition education tailored to cafeteria offerings, may also be useful in reducing plate waste, and there is some evidence of their success. (p. iii)

While various causes were investigated and solutions based on those causes were explored, the effects of the physical environment on children's eating habits and food consumption are conspicuous by their absence in the literature. Given the importance of attaining optimal efficiency of the NSLP and delivering the greatest nutritional value to those it serves, this significant source of behavioral influence bears investigation.

Environmental influences on human behavior have been studied repeatedly over the years (Baron, 1994), including the interaction between factors of the physical environment and the perceptions and preferences of school-age children (Read, Sugawara, & Brandt, 1999). Studies have also focused on children's satisfaction with lunches offered in public schools (Meyer, 2000). However, the studies that did focus on environmental influences on plate waste or the amount of food children consume have generally evaluated the social environment and efforts at educating children on nutrition (Wechsler, Devereaux, Davis, & Collins, 2000). No research has been found that explores the possible relationship between the physical environment and its influence over the amount of school lunches actually consumed by the children for whom the lunches are intended.

This report describes a research project designed to measure aspects of the physical environment in relation to actual food consumption during lunch. Four schools were selected in a West Texas city for inclusion. A determining factor for selection was the cooperation of the administration and cafeteria management at the schools. For at least one week in each school, researchers measured illumination, noise, temperature, and humidity in the serving area of the cafeteria. Surveys were administered to determine the children's perceptions of the physical environment of the cafeteria and their satisfaction with the food and service of the school cafeteria.

Researchers measured environmental factors—lighting, noise, temperature, and humidity—and plate waste at four public junior high schools in a West Texas city. Appropriate instruments were used to collect the environmental data. The plate waste data were gathered through the scrape/weigh method, along with a survey on the children's satisfaction with the food offered and the physical aspects of the cafeteria setting.

Data collection was rotated among schools week by week. The schools offered menus that differed during the 5-day data collection periods. Researchers noted that plate waste tended to decrease when students were served menu items that proved more popular with them. Hence, setting aside environmental factors examined in the study, the popularity of certain menu items emerges as a possible factor contributing to plate waste. Plate waste as a percentage of the total amount of food produced was determined.

The only positive correlation between environmental conditions and plate waste was humidity. A regression analysis corroborated the finding that when the relative humidity was higher, the amount of plate waste also increased. Relative humidity varied by school and was within the limits recommended by The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) at all the sites. This relationship makes sense on an intuitive level, as discussed earlier, and could bear further study. However, a causal relationship between cafeteria humidity levels and plate waste could not be established.

Crowdedness or student density in the cafeteria indicated that there were different conditions at the schools. However, the surveys indicated no differences in student perceptions of crowdedness.

Average plate waste varied from lunch period to lunch period daily at the same school. Within the same school, overall average plate waste varied on a daily basis. However, when averaging the plate waste by days, the difference on average plate waste between schools was not large enough to be significant, indicating similar averages on schools.

A slight positive correlation was found between noise and illumination levels. Noise levels during lunchtime were higher in cafeterias with the highest density (number of students per square foot of cafeteria space). The perception of students, as indicated by the surveys, was that noise levels were acceptable.

Illumination levels differed from school to school, and a weak positive correlation was found between illumination levels and temperature. Illumination levels, according to the surveys, were acceptable.

Temperatures were found to be higher in the cafeterias with a larger student density. Temperature levels were within ASHRAE recommendations, and the surveys indicated that students found dining room temperatures acceptable.

With the preponderance of research indicating that human behavior is undeniably affected by factors in the physical environment—amount and quality of light, noise, air quality, temperature—it would seem obvious that the physical aspects of the dining room setting would affect the appetites of school children and the effect should be measurable by the amount of plate waste. However, only a small and highly suspectible influence was revealed by this study.

Introduction

The National School Lunch Program (NSLP) provides inexpensive or free lunches to more than 27 million children on an average school day. More than 97,000 public and non-profit private schools and other facilities participate in the program. The meals served must meet nutritional requirements set forth by the United States Department of Agriculture (USDA) and provide one-third of the Recommended Daily Allowances of major nutrients.

The National School Lunch Program is an important factor in meeting the nutritional needs of many school children. On any given school day, the program provides about 27 million children with a nutritionally balanced meal prepared according to guidelines set forth by the Food and Nutrition Service of the USDA (USDA, 2000). The program costs about $6.2 billion to administer (Buzby & Guthrie, 2002). To realize the full benefits of the NSLP meal, however, children must consume it. Nutrition is extremely important for children in middle grades who are experiencing great changes in their physical and psychological development (Meyer, Conklin, Lewis, Marshack, Cousin, Turnage, & Wood, 2000).

According to a recent review of literature concerning the NSLP, about 12 percent of the calories provided go uneaten (Buzby & Guthrie, 2002). Estimates of plate waste in the school lunch program have varied widely over the years, and most studies were undertaken before significant changes such as offer-versus-serve were implemented. Consumption of lunch items in public schools has ranged from 55 to 90 percent in one study (Jansen & Harper, 1978), meaning that in some cases children are eating only half of the lunch provided at school. In a survey by the U.S. GAO (1996), almost one-fourth of responding cafeteria managers considered plate waste to be at least a moderate problem. Studies on plate waste have mostly focused on improving the accuracy of measurement (Anderson, 1994; Dubois, 1990; Comstock, Pierre, & Mackiernan, 1981; Kirks & Wolff, 1985).

In 1978, Jansen and Harper reported the results of a study in which researchers weighed individual menu items left on trays by 30-50 children in the fifth and tenth grades each day for two weeks. Jansen and Harper reported that children in the study ate 67 to 91 percent of the entrees they were served at lunch in school; 72 to 84 percent of starches; about half of all vegetables; and 53 to 54 percent of salads served, by weight. Acknowledging the possibility of influence by factors such as time available to eat and factors in the cafeteria environment, including the "lighting and general atmosphere of the lunchroom, [and] the noise level in the lunchroom …" (p. 399), their recommendations primarily addressed menu planning, surveys, and nutrition education as possible methods of reducing plate waste.

In an effort to provide more convenient methods of gathering plate waste data, which would enable researchers to gather data on more children, Comstock et al. (1981) found that indirect measurements could yield results comparable in accuracy to the scrape/weigh method. Visual estimates and children's ratings were studied as possible alternatives.

Researchers collected data on 500 children from five schools. Plates were matched with children's ratings through the use of identification cards; and the leftover food was then visually estimated, using a six-point scale, and weighed. Comstock et al. (1981) reported a high positive correlation between the percent of weighed plate waste and the visual estimates, ranging from 0.90 in one school to 0.96 in two others. The correlation between the children's ratings and the weighed percentages ranged from 0.39 to 0.84.

Visual estimates, while often providing results comparable to those obtained by weighing, were reported to be inconsistent by Kirks and Wolff (1985). Researchers gathered data in three school districts in northern California that were instituting a new nutrition curriculum. A total of 343 children were tested on nutritional knowledge and attitude before and after the implementation of the curriculum, and their trays were identified through the use of identification cards. Visual estimates of plate waste were made; then the trays were weighed.

There was a strong positive correlation between the visual estimates and the weights in most categories—protein, vegetable, salad, bread, fruit, milk—with a "noticeable" contrast in the correlation for the total: 0.59. The weights of plate waste showed a reduction of 32 percent, an indication that the program was successful. However, the visual estimate of the difference was not significant, a finding that could have wrongly concluded the nutrition education program had failed.

Dubois (1990) elaborated on the problems with the visual estimation of plate waste. Specifically, Dubois pointed out the loss of granularity when converting from a weight, which could be expressed on a continuous scale of measure, to a six-point scale. "If that score is then converted back to a waste weight by multiplying the weight of the individual full serving by the percent corresponding to the quarter measure on the Comstock scale, there will not be perfect agreement between the two values" (p. 384).

Regardless of the debate over measurement methods, about one-fourth of the foodservice managers responding to a survey agreed that plate waste remains "at least a moderate problem" (U.S. Government Accounting Office, 1996, p. 2). Of foodservice managers in 81,911 public schools that participate in the NSLP, 80 percent responded to a survey eliciting their views on plate waste. They agreed strongly on some reasons and ways to reduce plate waste: 78 percent said students' attention was on "recess, free time, or socializing" instead of eating lunch; nearly 80 percent said that "allowing students to select only what they want to eat would reduce plate waste" (U.S. Government Accounting Office, p. 2).

Giving students more freedom to "select only what they want to eat"—the offer versus serve option—has become a common way of attempting to reduce plate waste. Nutrition education programs have emerged as another popular method of addressing the problem. More recently, Wechsler, Deveraux, Davis, & Collins (2000) considered the school setting holistically as a way of influencing healthier behaviors in children. Among the factors considered were recess, intramural programs, exercise and sports facilities, foods available apart from school meals, and education and role modeling to promote exercise and healthy diet.

Results of a study about school nutrition environment indicated that environments in middle age grades are not conducive to healthy eating habits. Some of the elements creating this atmosphere were overcrowded facilities, very noisy cafeterias, dining area décor, and seating arrangements (Meyer et al., 2000). The position of the American Dietetic Association (ADA) about nutrition integrity in school addresses the possibility that dining room environments may inhibit effectiveness of the NSLP and limit opportunities for students to participate (Position of The American Dietetic Association, 2000).

The field of organizational research has produced a number of studies examining the effects of environmental factors on human performance and mood (Baron, 1994). A number of studies have shown that temperature, noise levels, air quality, and the amount and quality of illumination can affect the task performance of individuals in a number of ways and also affect the way they feel about the workplace and their coworkers.

Some of the most common complaints about the environment of the workplace concern temperature. Though individuals may become acclimated to temperatures within a certain range, warm temperatures especially have been found to reduce task performance and also give rise to an increase in anger and aggression.

Baron (1994) is careful to draw a distinction between sound and noise: Sound that individuals find annoying or distracting, whether because of the volume or unpredictable occurrence, would be considered noise according to Baron. Some of the studies reviewed by Baron suggest that moderate levels of predictable noise can enhance the performance of some tasks, while task performance tends to drop off when noise levels exceed 100 decibels. Unpredictable noise, however, tends to have a uniformly deleterious effect on task performance. Noise in general has been shown to have a negative affect on interpersonal relations, with an increase in aggression being among the negative affects. Exposure to high levels of carbon monoxide, cigarette smoke, and other forms of air pollution contribute to negative mood and impair task performance, according to the studies cited by Baron. In addition, fragrances and higher levels of positive ions tend to enhance performance and mood.

While earlier organizational research studies examined the illumination levels necessary for the performance of certain tasks, the effect on mood has become prominent in more recent research. The body of evidence cited by Baron suggests that warm, white light had a number of positive influences on the individuals studied. They tended to have a more positive mood, which improved their appraisals of others, influenced them to act in a more cooperative manner, and enhanced their confidence in their own ability to perform tasks.

By the time children reach school age, Cohen and Trostle (1990) reported, "their capacity to discriminate among different environmental setting characteristics and to selectively respond to those of preference is well developed" (p. 763). Such preferences can shape the cognitive development of children, the authors suggested.

Read, Sugawara, and Brandt (1999) found that the physical layout of a space was related to different ways in which children interact with one another. Specifically, a play area with differentiation in the ceiling height or one with walls of different colors were related to higher levels of cooperation than play areas with no differentiation or in which both wall color and ceiling height were different.

In a study for which temperature and noise was tightly controlled, Knez and Enmarker (1998) reported no significant effect of lighting quality on the performance of cognitive tasks. Subjects' moods were enhanced, however, by light of a redder, or warmer, color temperature. Interestingly, female test subjects identified 4000K light as warmer, while men identified 3000K light as warmer. In a later study, Knez and Kers (1998) found that the warmer color temperature preserved a positive mood for younger test subjects, whose mean age was 23.3 years for women and 23.9 years for men. Cooler color temperatures had the same effect on older test subjects, with mean ages of 65.2 and 65.5 for women and men, respectively.

There were no studies found that examined the two areas of primary interest for this study: factors in the physical environment and plate waste. The relationships among environmental factors and human affect and behavior have been well established, and plate waste has been examined in a number of studies. The present study offers the first attempt at exploring the influence of the cafeteria setting on what proportion of nutrition served to school children is actually consumed.

Perception can be defined as a process by which individuals organize and interpret their sensory impressions in order to give meaning to their environment. However, what one perceives can be substantially different from objective reality. People's perceptions are important because their behavior is based on their perception of what reality is, not in reality itself (Robbins, 2001).

Perceptions of one's environment have been found to be affected by sociological needs, psychological state, and individual differences. The environment itself also influences human behavior (U. S. Army Corps of Engineers, 1997). Peer pressure and the need to socialize also affect children's behavior. "If food is not considered *cool* or does not provide pleasure from taste, kids will not eat it" (Meyer et al., 2000, p. 15). For instance, crowding results in an excess of undesired social contact. However, psychological discomfort may be experienced if the crowding is perceived as too confining (U.S. Army Corps of Engineers, 1997). In the study done by Brown, Gilmore, and Dana (1997), junior high students perceived short lines and adequate time to eat as important factors to have in a dining environment.

Methodology

The project was administered through the Department of Education, Nutrition and Restaurant Management, in the College of Human Sciences at Texas Tech University in Lubbock, Texas. Dr. Luis Rene Contreras, Assistant Professor at University of Texas at El Paso, collaborated on preparation of the study.

Data collection sites and schedules

Data were collected in four junior high schools from the Lubbock Independent School District, Lubbock, Texas. Four schools with an NSLP participation rate of about 50 percent were selected based on the consent of school district administrators and foodservice managers. The foodservice operations in these schools were operated by an independent contractor to the school district. Housekeeping operations were carried out by a separate contractor who was responsible for collection and disposal of cafeteria waste.

The Lubbock Independent School District has an average enrollment of 6,019 students in grades seven through nine. Prior to data collection, the school foodservice managers, school principals, custodians, and lunch monitors were contacted at the four sites to familiarize them with the study.

Subjects for the study were all the students participating in the NSLP (reimbursable meal components only). Measurements were taken daily during a 5-day period at each school based on the schedules of participating schools and the availability of research assistants. A minimum of five days of data collection was spent at each of the four schools during the 2001 fall semester, beginning in September and ending in November. All the junior high schools studied had closed campuses, so students were not allowed to leave the campus during lunch. Data collection was performed at each site prior to the days actually included in the study. This was done to train the research assistants in data collection and to familiarize them with the layout of each school and the conditions under which data collection would be conducted. These "extra days" were also intended to minimize the influence of data collection on the students who were the subject of the study (i.e., the "Hawthorne effect").

School 1: During the eight-day study period, Atkins Junior High School served approximately 238 reimbursable meals per day for a 48 percent participation rate. The school was 44 years old with 8,665 square feet of cafeteria space with a ceiling height of 11.7 feet. Illumination in the cafeteria was provided by standard fluorescent lighting. One of the walls of the cafeteria had windows to the exterior with older blinds that obstructed some of the outside light. The walls were not decorated. Each class was allotted 30 minutes for lunch, and there were two lunch periods per day. Lunch was served and eaten in a common cafeteria setting. A bell sounded three times during the lunch period: at the start of the lunch period, 25 minutes later, and 5 minutes later at the end of lunch period. Meals were served from four serving lines, three of which were for reimbursable lunches and one for á la carte menu items. At the end of the line, each student entered an identification number on a keypad; and the cashier checked the computer monitor for the student account balance and the free/reduced status. Students were allowed to choose their own seats in the cafeteria. After eating, students emptied the remaining food from their trays into one of 11 garbage containers located throughout the cafeteria.

Students were allowed to leave or remain in the dining room. When the second bell rang, 5 minutes before the end of the lunch period, cafeteria monitors indicated that students were to bus their trays to the garbage containers. The only other time the dining room monitors intervened was when noise levels were deemed unacceptably loud in the cafeteria.

School 2: During the 8-day study period, Slaton Junior High served an average of 410 students a day for a 50 percent participation rate. The school was 54 years old with 3,412 square feet of cafeteria space with a ceiling height of 15.1 feet. There were some decorations on the wall. The only exterior wall had windows; another wall, facing the hallway, consisted of about one third windows. The serving method consisted of three lines including reimbursable lunches and one line for á la carte food items. There were three lunch periods of 30 minutes each. At the end of the serving line, students punched their ID code into a keypad next to the cashier. Bells sounded three times during the lunch period: the first to indicate the start of the lunch period, a second after 25 minutes, and the last one to indicate the end of the lunch period. Five garbage containers were located next to the doorways.

School 3: During the 7-day study period, Hutchinson Junior High served an average of 397 reimbursable meals per day for a 60 percent participation rate. The school was 54 years old similar to School 2. Each student had 25 minutes to receive and eat their lunches in one of three 30-minute lunch periods. The serving lines consisted of three reimbursable lunch lines and one á la carte line. The layout of the school, including the dining room, was identical to that of School 2. However, there were two important differences in the way lunchtime was conducted at this school: After being served, students were directed by cafeteria monitors to assigned seats; and after eating, students were to remain seated. After 20 minutes, those students who had finished their meals were allowed to bus their trays to one of seven garbage containers near the exit of the cafeteria, after which they were free to spend the last 5 minutes of the lunch period on the patio just outside the dining room. Students were released by table, one table at a time. In this school, dining room monitors had strict control on the students' behavior.

School 4: During the 6-day study period, Cavazos Junior High served an average of 520 reimbursable meals per day for a 62 percent participation rate. The school was 8 years old, with 5,049 square feet of cafeteria space and a 15.1-foot ceiling. Several television sets were mounted on the walls and turned on without sound during the lunch period. There were no decorations on the walls. Windows and glass doors on one exterior wall and about half of another exterior wall added natural illumination to the cafeteria. Artificial illumination was provided by fluorescent lamps. Each class was allotted 30 minutes for lunch in three separate lunch periods.

There were four serving lines: three reimbursable lunch lines and one á la carte line. Following selection of food, the student proceeded to the end of the line to punch their ID number into the keypad that was located next to the cashier. Students were allowed to sit where they liked and dining room monitors observed continuously to maintain discipline. Following consumption of their meals, the students remained seated. Students bused their dishes to garbage cans located on the way to the exit/entrance of the cafeteria. They were released by lines one at the time, starting with the line farthest from the exit. There were nine garbage containers located on the way to exit the cafeteria.

Data collection: equipment and research assistants

Data collection equipment consisted of: stopwatches (The Ultimate Edge, Spalding, model SF 002) capable of timing to a hundredth of a second, attached to legal-size clipboards; a digital sound level meter with accuracy of 2 dB and measuring range of 35 to 100dB and 0.1 dB resolution; a humidity and temperature meter with accuracies of 3% RH, 0.8 °C ; a digital light meter for field illumination measurements with removable sensor and resolution of 0.01 lux; and electronic digital scales of 1000g capacity, switchable between grams and ounces, with tare function, 1g resolution.

Three research assistants were assigned to measure the time students spent in line, one research assistant for each serving line. Stopwatches and data collection forms were attached to the clipboards for easy access. The data collection forms are included in the Appendix.

Before the research began, research assistants were recruited from among the undergraduates in the Restaurant, Hotel, and Institutional Management Program and the Food and Nutrition Program at Texas Tech University. These research assistants met with researchers and were informed of the nature, purpose, and scope of the study. They were trained in the tools and methods to be used in data collection. Research assistants gathered the data according to the following procedures:

- They were trained in the use of all data collection equipment before undertaking data collection.
- Research assistants took part in data collection at each site to increase their familiarity with the equipment and study sites and to minimize Hawthorne effects.
- All research assistants reviewed the menu items available to the students as part of the reimbursable meal and familiarized themselves with the physical layout of the site.
- All research assistants were trained at each site prior to actual data collection to alleviate any data collection problems that may have been present at each site.
- Three research assistants (position A) each used one stopwatch attached to the clipboard with the appropriate data collection form to record the time required for students to travel to the cafeteria, receive their lunch, and be seated.

- Three or four research assistants (position B) each used a digital scale and the appropriate data collection to weigh individual plate waste. Food items were weighed and their weights recorded in grams. Some food items that were difficult or messy to handle such as beans or casseroles were weighed along with the serving tray, in which case this was indicated on the data-recording sheet. Wrapped food items like hamburgers with aluminum foil were weighed with their wrapping.
- One research assistant weighed and recorded five samples of each food item prior to the start of the lunch period. Food items chosen to be included in the sample were those most representative of the group. The tare function was used to exclude the weight of the container.
- Some research assistants were responsible for ensuring that no plate waste was lost (i.e., discarded). At the beginning of the data collection period at each school, they stationed themselves at the waste containers and gathered trays from students as the students bused their trays. As students and researchers became accustomed to the routine of the study, research assistants would sometimes gather the trays from the students while the latter were still seated.
- One research assistant recorded temperature, humidity, noise, and illumination of the cafeteria.
- Illumination was measured before students arrived to the cafeteria.
- Temperature, humidity, and noise were measured at nine different points in the cafeteria during each lunch period.
- On the last day of data collection, surveys were administered to junior high school students as they waited in the serving line.

Data analysis

Data were statistically analyzed using programs in the Statistical Analysis System (SAS System for Windows, Release 8.00) and Statistical Program for the Social Sciences (SPSS for Windows, Release 10.05). Frequency distributions were calculated using Microsoft Excel (Microsoft® Excel 2000). The analysis included a calculation of mean scores, standard deviation and frequency distribution of time available to eat lunch, perceptions of the cafeteria, and percentage of plate waste. Further analysis included correlation analysis of environmental variables (relative humidity, temperature, illumination, and noise level) and total plate waste. Analysis of variance was used to determine differences among schools for environmental variables. Regression analysis with indicator (dummy) variables was conducted on environmental variables, total plate waste, and schools. Significance level was set at $p < .05$.

Results and Discussion

Noise level

The highest noise levels were recorded at the beginning of the lunch period when students were waiting in line to be served. The noise level was generally observed to decrease as students were seated. Noise levels were observed to be higher for high student density cafeterias. Noise reduces comfort and increases fatigue since people must increase their concentration (Konz, 1999). Standards set by the Occupational Safety and Health Administration (OSHA) (1995) indicated that continued exposure to noise over 85 dB will eventually harm hearing.

A one-way ANOVA between groups design was used to analyze noise levels per lunch period by schools (Table 1). There was a significant difference in the noise levels at schools during lunch periods ($F(3,51) = 7.065$, $p < .0001$, $R^2 = .293$). The average noise level was 74.93 decibels with a range of 70.3 dB to 79.3 dB. School 3 had the greatest noise level recorded (See Figure 1). Noise levels above 80 decibels can cause permanent damage to the hearing.

Table 2 shows a positive weak correlation between noise level and illumination ($r(55) = .270$, $p = .046$). This could indicate that higher levels of illumination affect students' moods so that they have a greater desire to talk and interact. Also, it might indicate that the cafeteria monitors allow more chatting when light intensity increases. However, the opposite might be true, that with low illumination levels (usually caused by cloudy or rainy weather) teachers' and students' behavior is affected adversely. In this case, bad weather could influence dining room monitors to more greatly restrict student behavior, students to act more subdued, or both.

Crowdedness of the cafeteria is also an important factor for noise levels. For the same number of students during lunch, a smaller cafeteria results in a greater concentration of noise and, therefore, higher noise levels. Schools 2 and 3 had the smallest cafeterias, with an area of 3,413 square feet. According to the number of seats in the cafeteria, School 2 had the smallest area per student (10.2 sq.ft./student) followed by School 3 (12.1 sq.ft./student).

However, if the difference between lunch periods is ignored and the average noise level is determined daily by school, a one-way ANOVA between groups design could not find a significant difference on average noise levels between schools ($F(3,16) = 0.383$, $p = .767$, $R^2 = .07$) as shown in Table 3. This result indicates that there was not enough change on the average noise level by schools to be considered as significant and the changes in noise level between lunch periods tend to cancel each other.

Table 1: One-Way ANOVA for Environmental Variables During Lunch Periods at Junior High Schools

		Sum of Squares	df	Mean Square	F	Sig.	R^2
Temperature	**Between Groups**	44.087	3	14.696	5.210	.003	.236
	Within Groups	143.865	51	2.821			
	Total	187.952	54				
Relative Humidity	**Between Groups**	2004.114	3	668.038	10.760	.000	.387
	Within Groups	3166.281	51	62.084			
	Total	5170.395	54				
Noise	**Between Groups**	64.122	3	21.374	7.065	.000	.293
	Within Groups	154.291	51	3.025			
	Total	218.413	54				
Illumination	**Between Groups**	75853.166	3	25284.389	36.708	.000	.683
	Within Groups	35128.313	51	688.790			
	Total	110981.478	54				
Average Plate Waste	**Between Groups**	3390.510	3	1130.170	3.328	.027	.164
	Within Groups	17318.851	51	339.585			
	Total	20709.361	54				
Opportunity Time to Eat (sec)	**Between Groups**	5209.769	3	1736.590	.471	.704	.027
	Within Groups	187925.585	51	3684.815			
	Total	193135.354	54				

Table 2: Correlations for Environmental Variables at Junior High Schools

		Avg. Plate Waste	Square Foot per Student	Illumination	Noise	Relative Humidity	Temperature	OTE
Avg. Plate Waste	**Pearson Correlation**	1.000	-.202	.158	.079	** .361	-.119	-.110
	Sig. (2-tailed)	.	.139	.248	.568	.007	.386	.424
	N	55	55	55	55	55	55	55
Square Foot per Student	**Pearson Correlation**	-.202	1.000	-.255	-.244	** .440	.085	-.029
	Sig. (2-tailed)	.139	.	.060	.073	.001	.537	.833
	N	55	55	55	55	55	55	55
Illumination	**Pearson Correlation**	.158	-.255	1.000	* .270	.176	* .308	.042
	Sig. (2-tailed)	.248	.060	.	.046	.198	.022	.760
	N	55	55	55	55	55	55	55
Noise	**Pearson Correlation**	.079	-.244	* .270	1.000	-.098	.154	* .267
	Sig. (2-tailed)	.568	.073	.046	.	.475	.263	.049
	N	55	55	55	55	55	55	55
Relative Humidity	**Pearson Correlation**	** .361	** .440	.176	-.098	1.000	-.060	.085
	Sig. (2-tailed)	.007	.001	.198	.475	.	.661	.535
	N	55	55	55	55	55	55	55
Temperature	**Pearson Correlation**	-.009	.085	.308	.154	-.060	1.000	-.044
	Sig. (2-tailed)	.386	.537	.022	.263	.661	.	.749
	N	55	55	55	55	55	55	55
Opportunity Time to Eat (OTE) (sec)	**Pearson Correlation**	-.110	-.029	.042	* .267	.085	-.044	1.000
	Sig. (2-tailed)	.424	.833	.760	.049	.535	.749	.
	N	55	55	55	55	55	55	55

** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed)

Figure 1: Cafeteria Noise Level (dB) During Lunch
Junior High School 3

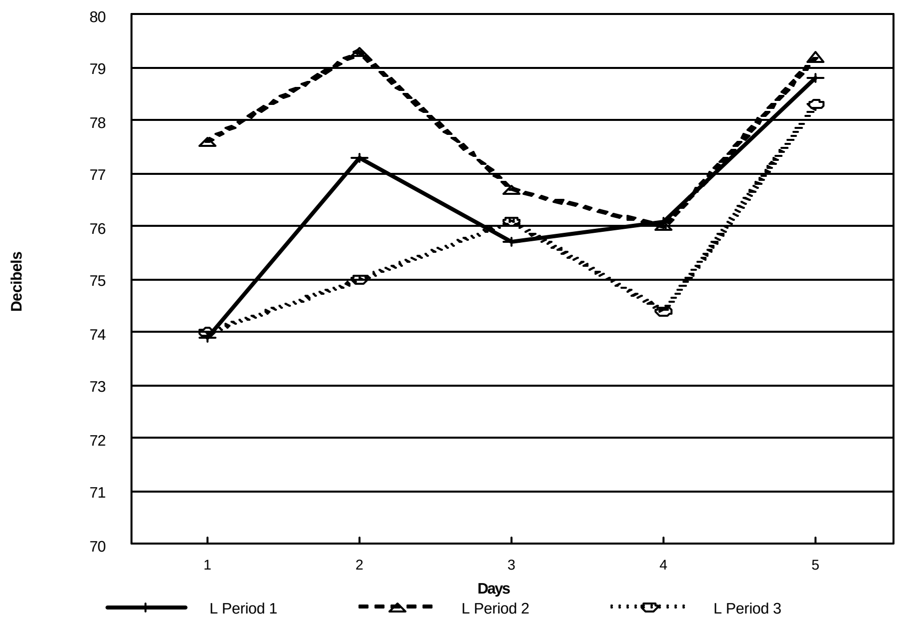


Figure 2: Cafeteria Noise Level (dB) During Lunch
Junior High School 4

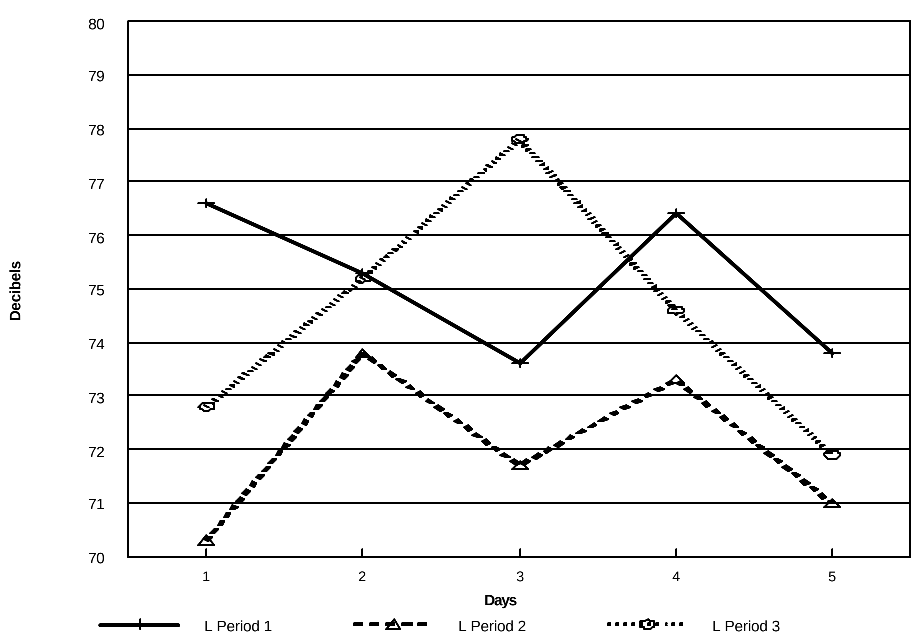


Table 3: One-Way ANOVA for Daily Averages of Environmental Variables at Junior High Schools

		Sum of Squares	Df	Mean Square	F	Sig.	R^2
Temperature	**Between Groups**	14.414	3	4.805	3.78	.032	.415
	Within Groups	20.336	16	1.271			
	Total	34.750	19				
Relative Humidity	**Between Groups**	625.538	3	208.513	4.850	.014	.477
	Within Groups	687.260	16	42.954			
	Total	1312.798	19				
Noise	**Between Groups**	34.770	3	11.589	0.38	.767	.067
	Within Groups	485.556	16	30.347			
	Total	520.326	19				
Illumination	**Between Groups**	28289.194	3	9429.731	12.74	.000	.705
	Within Groups	11847.124	16	740.445			
	Total	40136.318	19				
Average Plate Waste	**Between Groups**	1216.106	3	405.368	1.51	.250	.221
	Within Groups	4294.516	16	268.407			
	Total	5510.622	19				
Opportunity Time to Eat (sec)	**Between Groups**	2009.206	3	669.735	0.38	.767	.067
	Within Groups	27964.985	16	1747.811			
	Total	29974.188	19				

Illumination level

Light influences behavior. Light communicates subjective impressions of the environment and also provides suggestions for behaviors (Konz, 1999). There is evidence about the relationship between light and mental attitude. For a number of years, doctors have used light therapy to treat mental depression (Peterson, 1999). Daylight and artificial lighting provide the illumination of the cafeteria; and in general, both remain constant during lunch time. A one-way ANOVA between groups design was used to analyze illumination levels per school. A significant difference was found in the illumination levels among the schools ($F(3,16) = 12.74$, $p < .0001$, $R^2 = .705$) as shown in Table 3. The average illumination level was of 325.4 lux with a minimum of 255.4 and a maximum of 421.8. School 3 had the greatest amount of illumination, even compared to School 2 with its identical layout. School 3 had the exterior windows facing north, whereas School 2 had them facing east. School 4, the newest school with the greatest window area, had the most constant level of illumination (350 lux) during the 5 days of data collection (See Figure 3). The school with the lowest illumination level was School 1, an older school with Venetian blinds, which reduced the amount of daylight in the dining room.

Moreover, if the difference between lunch periods is ignored and the average illumination level is determined daily by school, a one-way ANOVA between groups design found a significant difference on average illumination between schools ($F(3,16) = 12.74$, $p = .0002$, $R^2 = .705$) as shown in Table 3. This result indicates that there was a change on the average illumination level by schools. Figure 4 shows the overall averages for illumination by school.

No correlation between average plate waste and illumination levels ($r(55) = .158$, $p = .248$) was found (Table 2). However, a positive correlation was found between illumination and temperature ($r(55) = .308$, $p = .022$). There is some preliminary indication that satisfaction and improved mood may also effect task performance and motivation (Veitch, 2000), and the ability to control lighting has been found to have a positive affect on workers' moods and satisfaction (Newsham & Veitch, 2000). A recent study found that improved student performance is positively associated with more daylight in schools (Heschong Mahone Group, 1999).

Figure 3: Cafeteria Illumination Level (Lux) During Lunch in Junior High Schools

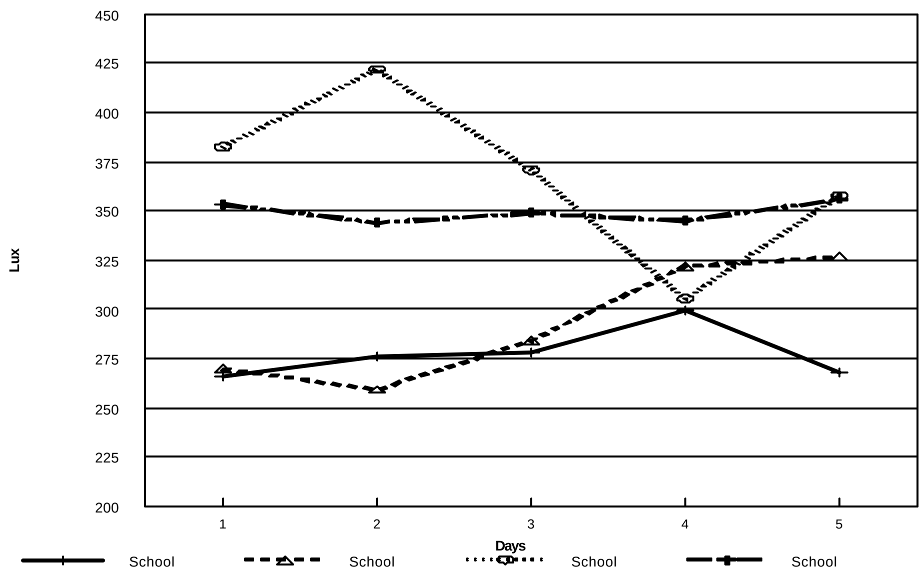
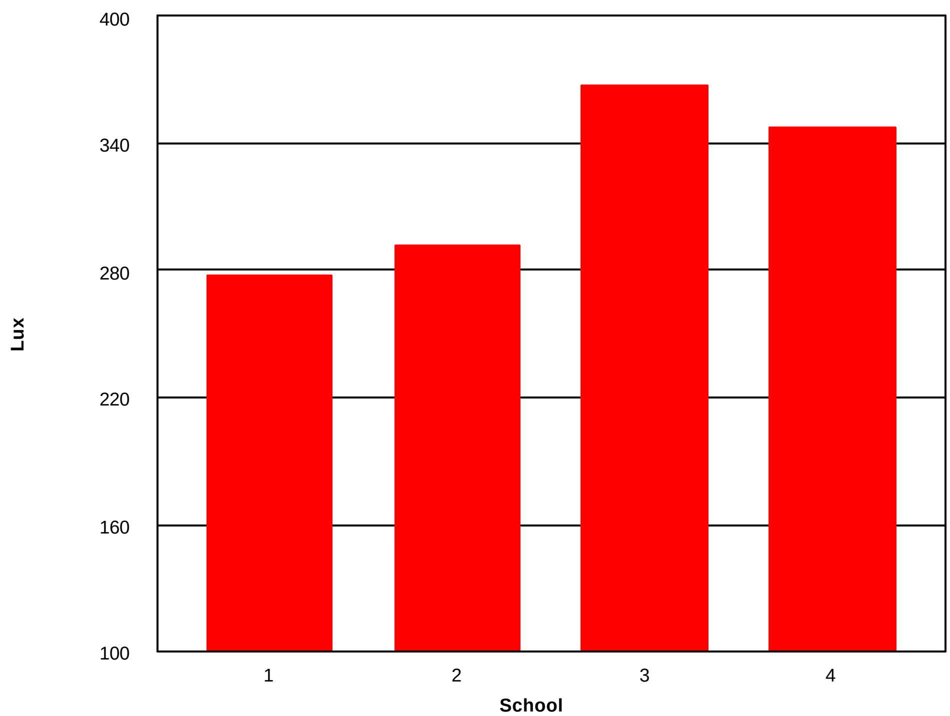


Figure 4: Daily Illumination Average in Junior High Schools



Temperature level

Temperature and humidity have been known to influence human behavior. A combination of high temperature and high humidity seems to encourage poor behavior (Rosen, 1979). A one-way ANOVA between groups design was used to analyze daily temperature levels per lunch period by schools. It was found that temperature varied significantly among schools during the study ($F(3,51) = 5.25$, $p = .0031$, $R^2 = .236$) as shown in Table 1. The overall average temperature was 73.6 ºF, with a range of 62.8 ºF to 81.7 ºF. The more crowded the dining room, the higher the temperature.

Figure 5 shows that for School 2 the temperature during the first lunch period was consistently lower than during the second and third lunch periods. This might indicate a flaw in the design of the heating, air conditioning and ventilation system, as heat generated during the first lunch period was not dissipated, and the temperature gradually increased during the later lunch periods. This was not the case in School 3 which, though it had the same floor plan, had 160 fewer students than School 2. These schools also had the smallest cafeterias (3,413 square feet) of the schools in the study.

Moreover, if the difference between lunch periods is ignored and the average temperature level is determined daily by school, a one-way ANOVA between groups design found a significant difference on average illumination between schools ($F(3,16) = 3.78$, $p = .0318$, $R^2 = .415$) as shown in Table 3. This result indicates that there was a change on the average temperature level by schools. Figure 6 shows the overall averages for temperature by school. There was a significant correlation between temperature and illumination ($r(55) = .308$, $p = .022$) as shown in Table 2. This makes sense since part of the illumination comes from artificial lighting, and more illumination means more artificial light which generates more heat in the cafeteria. The ASHRAE (1992) recommended a comfort zone of 68 ºF to 78 ºF, which the schools generally maintained during the study. This indicates that, for most of the students, the cafeteria temperature should have been comfortable. There has been no research published relating temperature and appetite, and the present study found no significant correlation between average plate waste and temperature ($r(55) = -.119$, $p = .386$).

Figure 5: Cafeteria Temperature Levels During Lunch in Junior High School 2

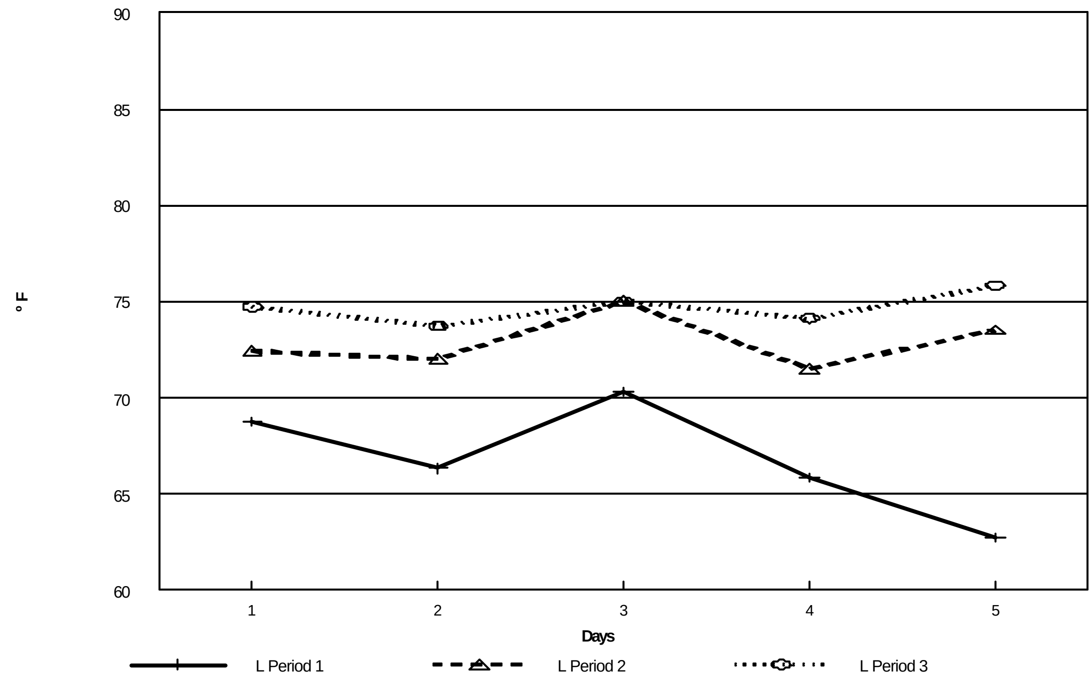
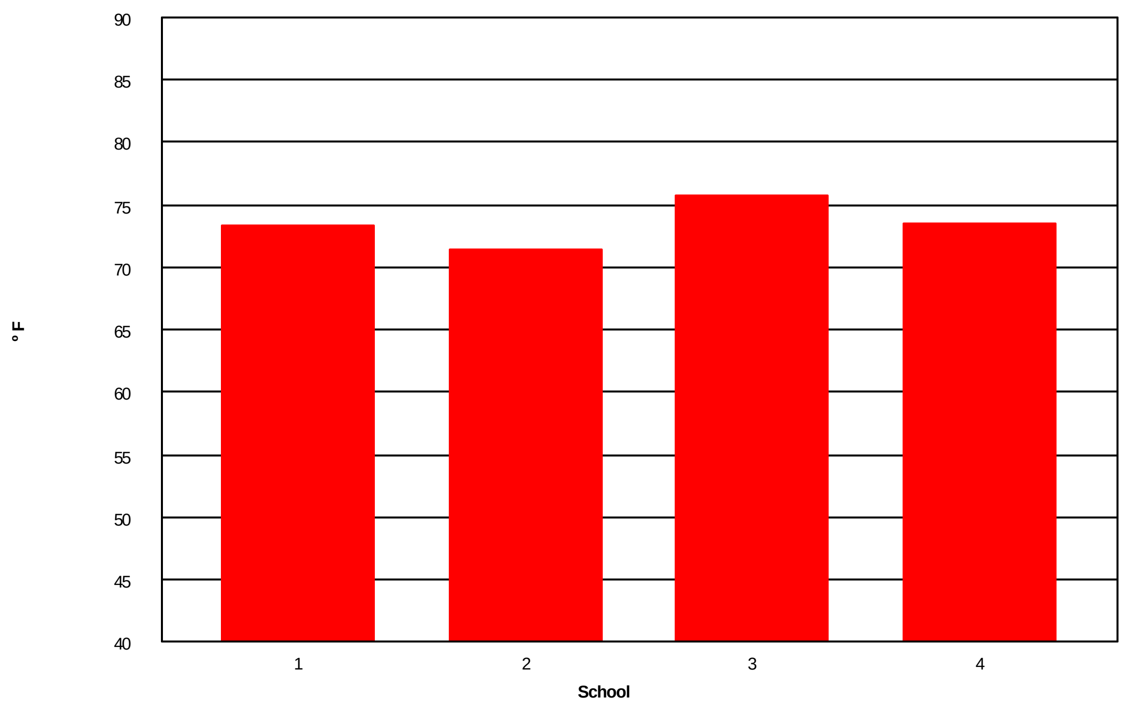


Figure 6: Daily Temperature Average in Junior High Schools



Humidity level

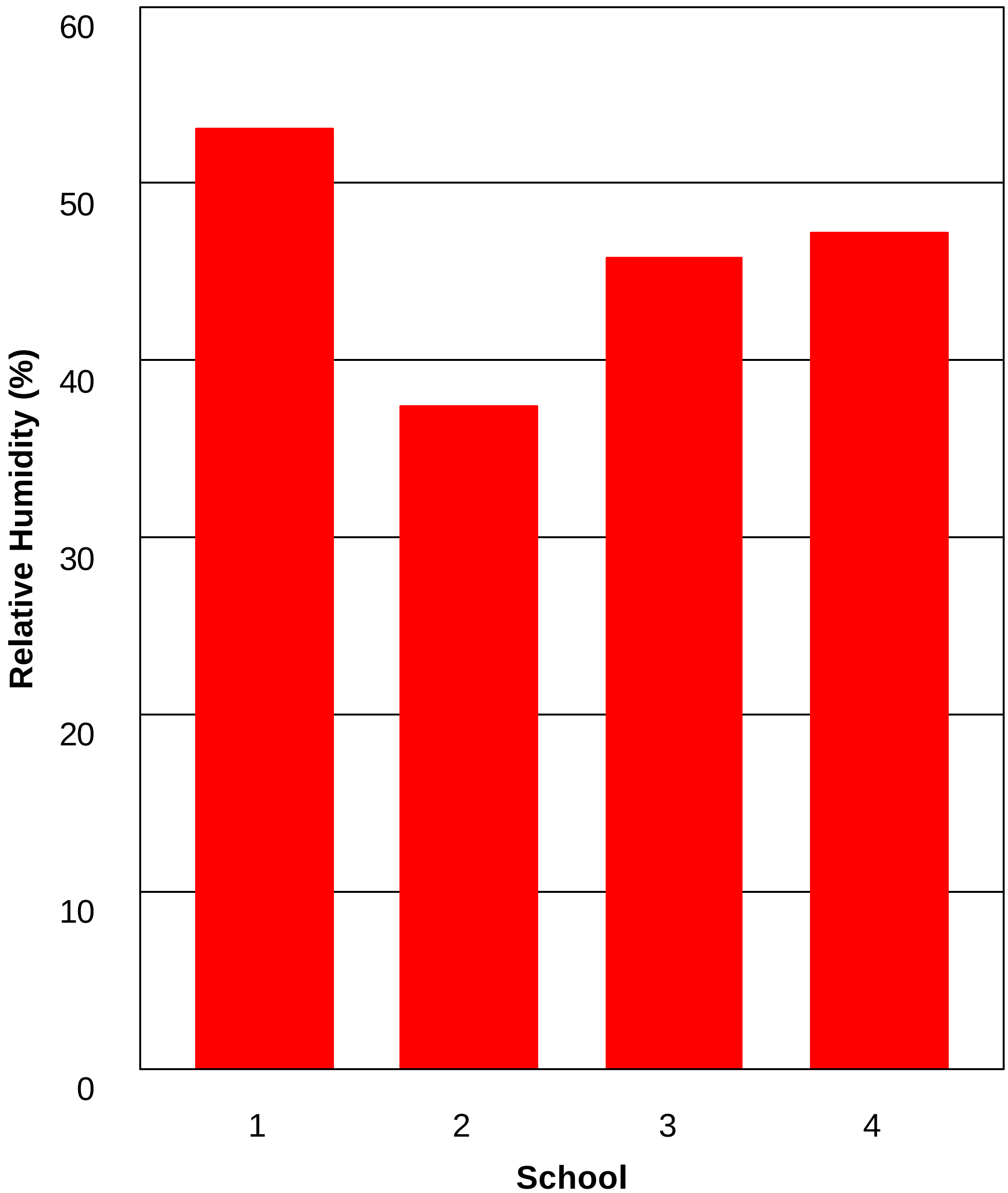
A one-way ANOVA between groups design was used to analyze daily relative humidity levels per lunch period by schools. There was a significant difference in the relative humidity levels recorded among the schools studied ($F(3,51) = 10.76$, $p < .0001$, $R^2 = .387$), indicating that the humidity changed for schools during the study. The average percentage of relative humidity (%RH) was 46.3, with a minimum of 30.1 to a maximum of 67.8. Moreover, if the difference between lunch periods is ignored and the average relative humidity level is determined daily by school, a one-way ANOVA between groups design found a significant difference on average relative humidity between schools ($F(3,16) = 4.85$, $p = .014$, $R^2 = .477$) as shown in Table 3. This result indicates that the relative humidity levels between schools varied as shown in Figure 7.

There was a positive correlation found between plate waste and relative humidity ($r(55) = .361$, $p = .007$) as shown in Table 2. Even though the correlation does not seem high, it might indicate some connection between plate waste and relative humidity. From personal observation by the researcher, it makes sense that an increase in relative humidity would affect mood, and thereby possibly influence appetite, in this region of the country. In West Texas, where the weather is predominantly sunny, it has been noted that discipline problems increase on overcast and rainy days—precisely those days most likely to be more humid than usual. According to anecdotal accounts, teachers' and students' moods are adversely affected those days, which could have an adverse effect on appetites and result in an increase in plate waste. This agrees with Robbie Patton's research that indicated children react to changes in adult behavior due to weather changes.

It would seem plausible that this change in mood might negatively influence the appetites of children, which would be accompanied by an increase in plate waste. Whether this mood change could be attributed to the increase in relative humidity or the decrease in illumination (or coincidental offering of less popular menu items) could not be established by the present study.

The ASHRAE (1992) suggested that relative humidity levels should be maintained within the comfort range of 30 percent relative humidity to 60 percent relative humidity, which was generally the case for most of the days of the study. North Carolina State Board of Education (2000) recommended a 60 percent relative humidity for dining rooms and auditorium.

Figure 7: Daily Relative Humidity (%) Average in Junior High Schools



Opportunity time to eat

Opportunity time to eat (OTE) has been defined as the elapsed time when the child sits down in the cafeteria with the food tray to the moment when the child buses the dishes (Sanchez, Hoover, Sanchez, & Miller, 1999). Opportunity time to eat reflects the efficiencies of the school lunch system. Insufficient serving lines, insufficient cashiers, and not enough food available at the line will reduce OTE, making an unpleasant lunch experience. In the past there was concern about plate waste increasing due to children not having enough time to eat as pointed by Brown, Gilmore, and Dana (1997). In the study done by Sanchez et al. (1999) it was found that children do have enough time to eat. This study found similar results that on the average, children have enough time to eat (M = 21 min, SD = 4.7 min).

A one-way ANOVA between groups design was used to analyze daily OTE per lunch period by schools. A significant difference in OTE recorded among the schools studied ($F(3,51) = 0.47$, $p = .702$, $R^2 = .027$) was not found, indicating that the times did not vary enough for schools during the study. Moreover, if the difference between lunch periods is ignored and the OTE is determined daily by school, a one-way ANOVA between groups design did not find a significant difference on OTE between schools ($F(3,16) = 0.38$, $p = .767$, $R^2 = .067$) as shown in Table 3.

A frequency distribution (Fig 8) on the overall OTE shows that 41.8 % of the students have 22.5 minutes or more to eat, that 58.7 % have 20 minutes or more to eat, and that 74.5 % have at least 17.5 minutes to eat lunch. Table 2 shows that there exists a small significant correlation between available time to eat and noise level in the cafeteria ($r(55) = 2.67$, $p = .049$). It seems like where the food lines move faster, the students tend to make more noise while they are in line. As food lines move faster, the time available to eat is longer. As depicted in Figures

9 and 10, School 3 had the highest noise level (76.6 dB) and had the second longest OTE (21.2 min). Although the lines proved similar between schools with regard to capacity, the speed at which students navigated the line was primarily determined by the rate at which a cashier completed a transaction with each student.

Figure 8: Frequency Distribution for Junior High School Students: Opportunity Time to Eat (OTE)

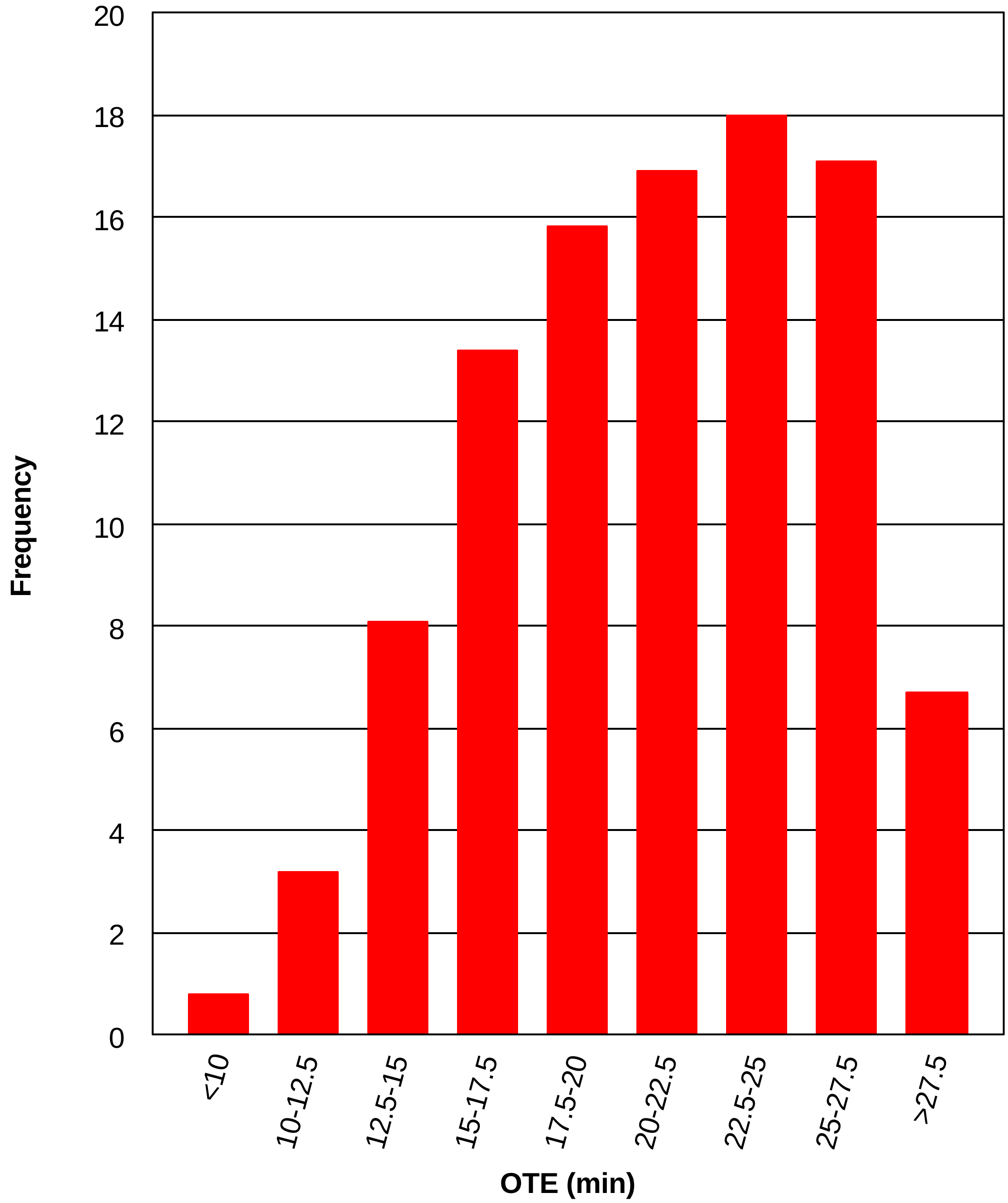


Figure 9: Daily Average Opportunity Time to Eat for Junior High School Students

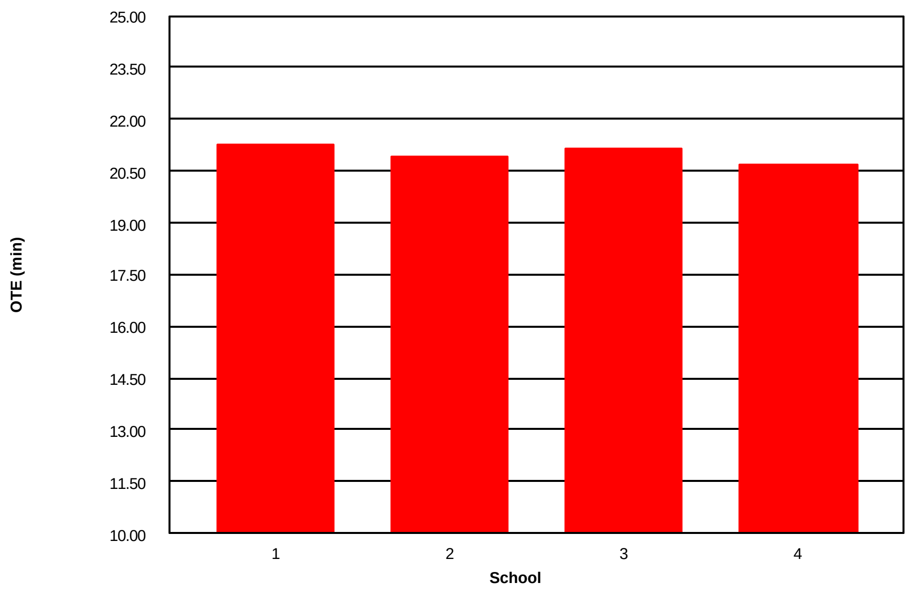


Figure 10: Daily Average Noise Levels at Junior High Schools

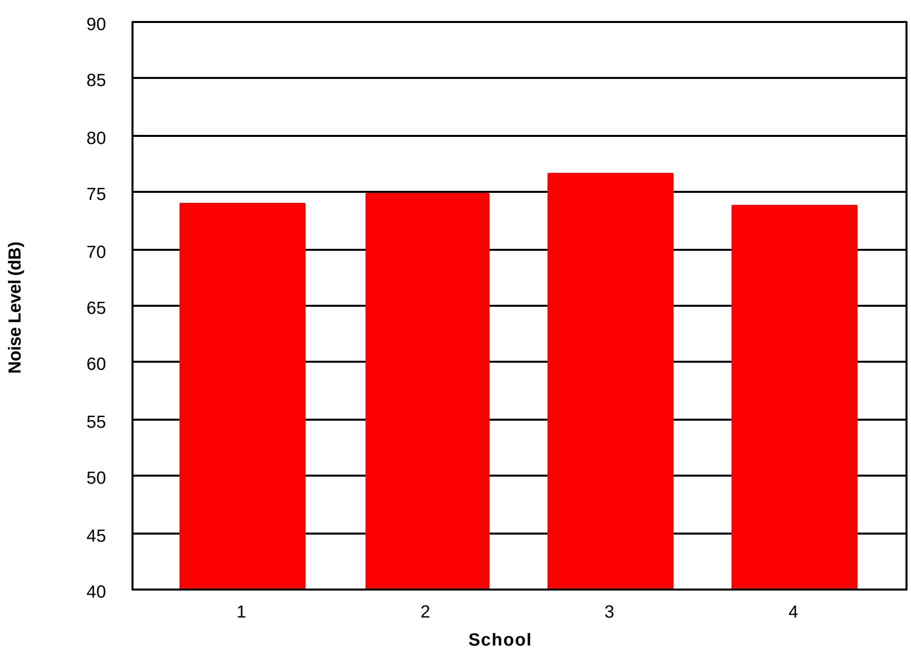


Plate waste

A correlation analysis was done for average plate waste per student and environmental variables. A positive correlation was found between average plate waste and relative humidity ($r(55) = -.361$, $p = .007$) as is shown in Table 2. Although the correlation explained only 13% ($.361^2$) of the variation observed in plate waste, it indicated some connection between plate waste and relative humidity. As humidity increased, plate waste increased. A regression analysis on the influence of environmental variables and schools (indicator or dummy variable) on average plate waste resulted with relative humidity and schools significant with 50 percent of the variance of plate waste explained ($F(8,46) = 5.67$, $p < .0001$, $R^2 = .4965$). In this model opportunity (available time to eat) was almost significant ($p = .0528$). After eliminating the non-significant variables, a reduced model explained only 30 percent of the variation of the average plate waste ($F(4,50) = 5.53$, $p = .0009$, $R^2 = .31$).

A one-way ANOVA between groups design was used to analyze the average plate waste per lunch period by schools (Table 1). A significant difference in the average plate waste ($F(3,51) = 3.328$, $p = .027$, $R^2 = .16$) was found indicating the variation on plate waste during the different lunch periods through schools. The overall average plate waste per lunch period went from 56.11 grams to a maximum of 132.53 with a mean of 88.27 grams and a standard deviation of 19.58 grams. Schools 3 and 4 appeared to have a higher average amount of plate waste per student than School 1. School 1 also had the fewest students of the four schools studied, but this appears to be coincidental.

Data collection could not take place at each school simultaneously; consequently, researchers rotated among schools week by week. The schools offered menus that differed during the 5-day data collection periods. Researchers noted that plate waste tended to decrease when students were served menu items that proved more popular with them. Hence, setting aside environmental factors examined in the study, the popularity of certain menu items emerges as a possible factor contributing to plate waste.

Plate waste appeared to vary at each school during the lunch periods of the 5 days of data collection as shown in Figures 11-14. This trend was similar during the lunch periods, with the exception of the third day at School 2. Student comments indicated that this difference could be attributed to the preference of some menu items over others; i.e., more popular menu items, according to student comments, corresponded with lower levels of plate waste.

Nevertheless, if the difference between lunch periods is ignored and the average plate waste is determined daily by school, a one-way ANOVA cannot find a significant difference on average plate waste between schools ($F(3,16) = 1.512$, $p = .249$, $R^2 = .22$). This result indicated that there was not enough change on the average plate waste by schools to be considered as significant and the changes between lunch periods tend to cancel each other.

Plate waste as a percentage of the total amount of food produced was determined. Food samples, food consumed by staff and teachers, and food consumed by students on detention were deducted from the total amount produced. The overall percentage of plate waste was 21.99 with a standard deviation of 5.13 percent. A one-way ANOVA between groups design found a significant difference on the percentage of waste by schools ($F(3,16) = 5.67$, $p = .0077$) where the school with smallest percentage of plate waste was School 1 (M = 17.32, SD = 3.97) and the school with the largest percentage was School 3 (M = 27.25, SD = 5.80). Figure 15 shows the plate waste percentages by school and by day.

Figure 11: Average Plate Waste at Junior High School 1

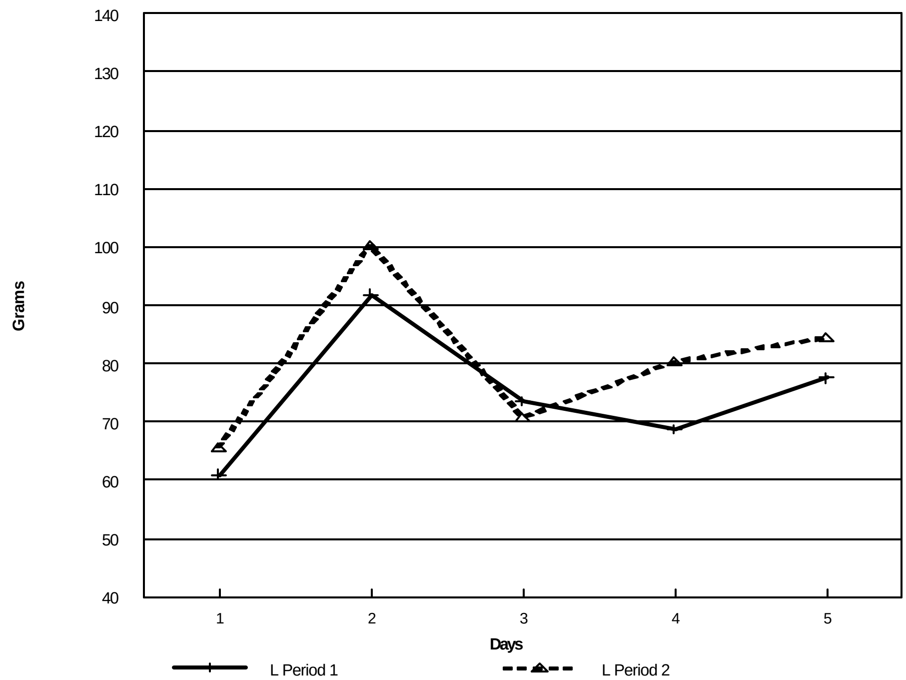


Figure 12: Average Plate Waste at Junior High School 2

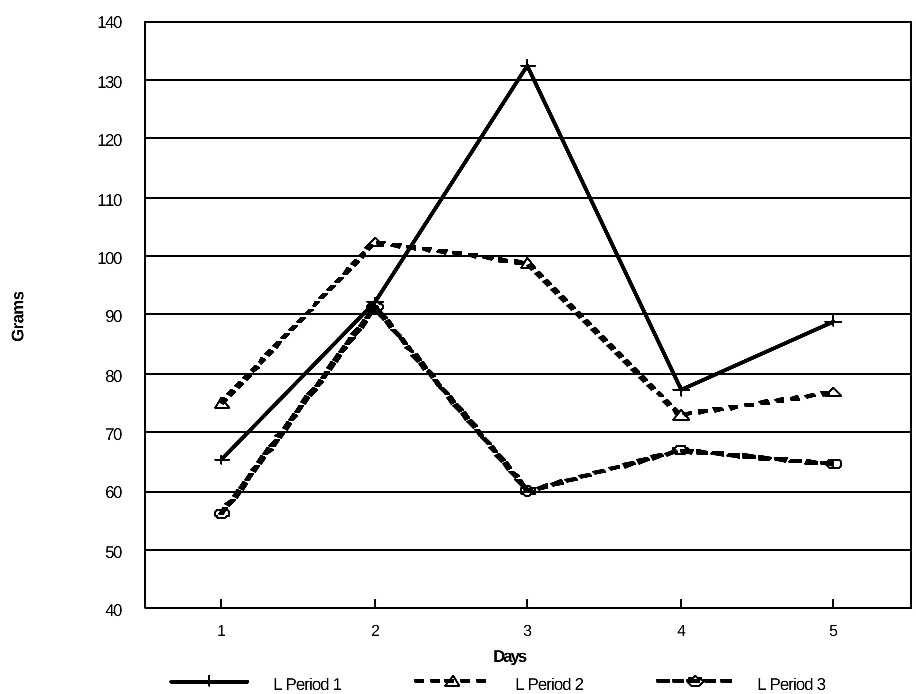


Figure 13: Average Plate Waste at Junior High School 3

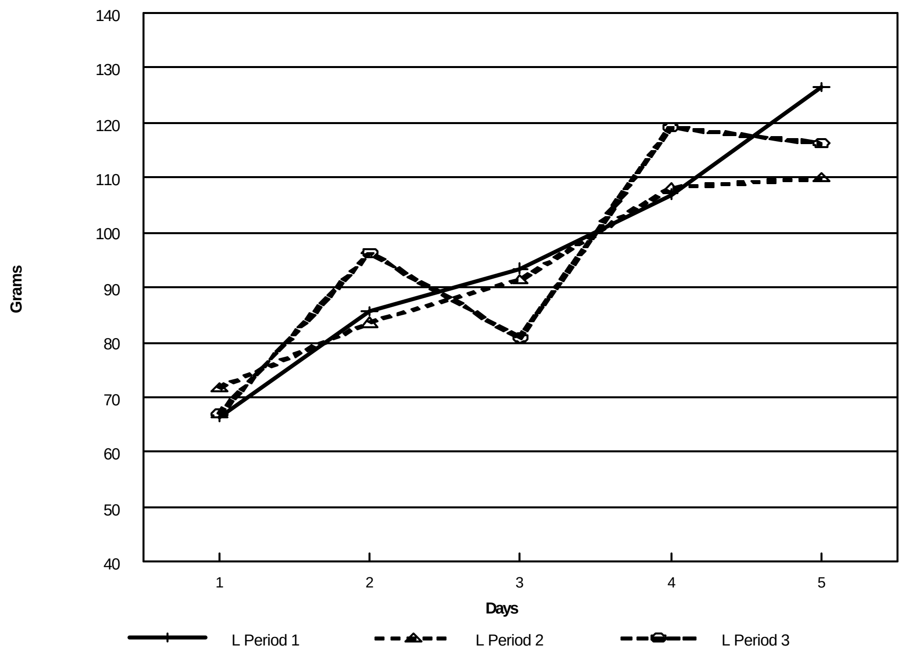


Figure 14: Average Plate Waste at Junior High School 4

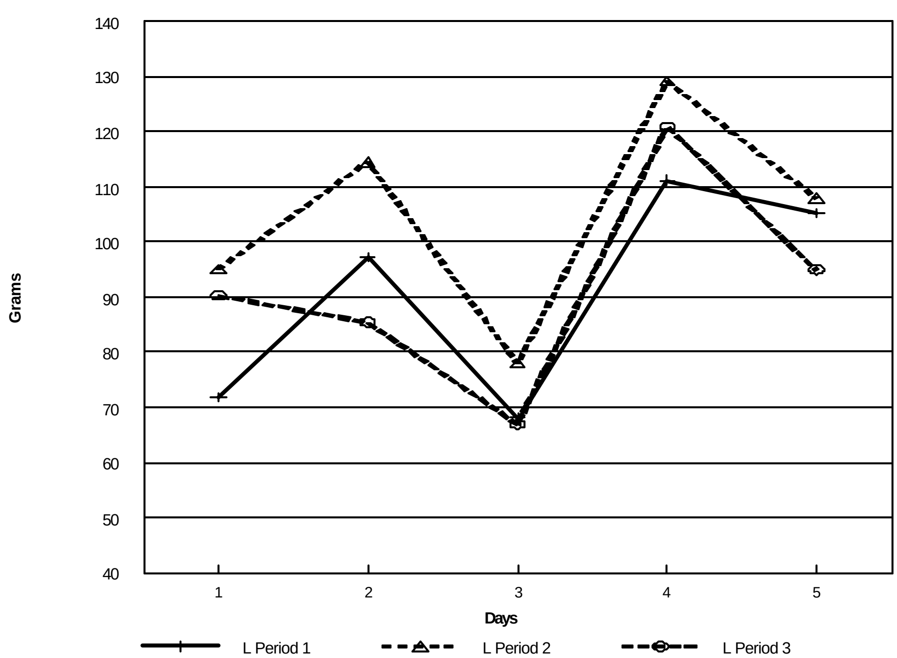
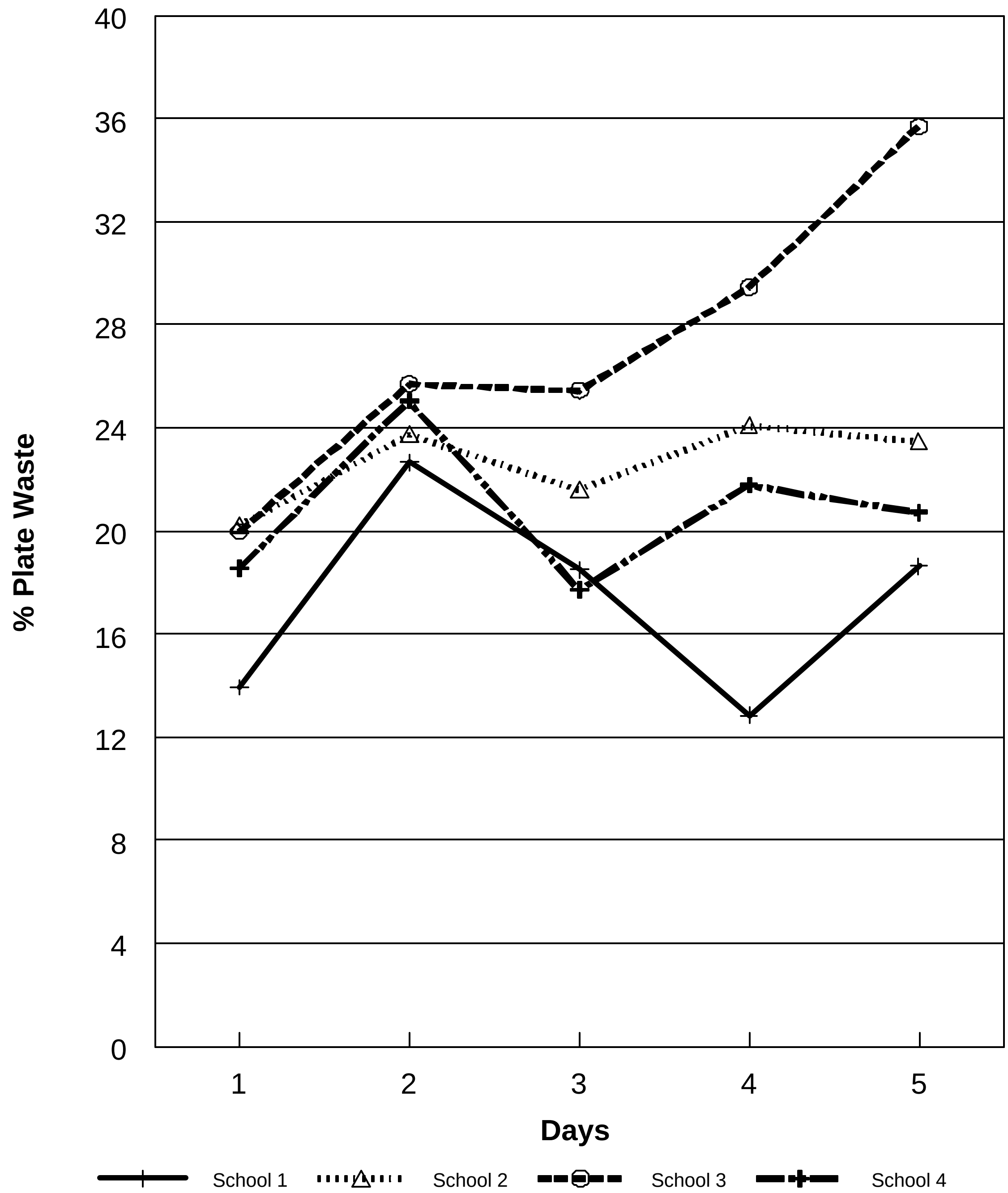


Figure 15: Plate Waste Percentage in Junior High Schools



Student perception surveys

Several statements were given to the students with a Likert scale for the answers: 1= strongly agree, 2=agree, 3= neutral, 4= disagree, 5=strongly disagree. Regarding the statement **I like the decorations of the cafeteria** the students' answers were very similar ($F(3,1517) = 1.31$, $p = .2695$) they tended to not particularly like the decorations (M = 3.13, SD = 1.32). Researchers did not ask specifics regarding what students found displeasing about the aesthetics of the cafeteria environment. However, it is fair to assume that students had no real basis to judge decorations because "decorations" amounted at most to be Styrofoam initials of the school affixed to cafeteria walls.

Students' responses to the statement **The physical condition of the cafeteria is very good** differed by school ($F(3,1517) = 29.13$, $p < .0001$). Students of the newest cafeteria liked it the most (M = 2.39, SD = 1.14) and students of School 3 liked it the least (M = 3.03, SD = 1.03). As conditions of cafeterias at Schools 2 and 3 were similar, the fact that students did not like their cafeteria at School 3 can be related to the strict control during lunch.

Students' responses to the statement **There is too much noise in the cafeteria during lunch time** differed by school, ($F(3,1517) = 5.49$, $p = .0009$) but in general students tended to disagree with the statement concerning the noise level being too high. Students at School 3 were the ones who disagreed the most (M = 3.47, SD = 1.20), and the students at School 4 were the ones who disagreed the least (M = 3.15, SD = 1.38). The statement **The noise level during lunch allows me to talk and listen to my friends** had different answers by school ($F(3,1517) = 7.38$, $p < .0001$), but all responses were in the 2.18 to 2.66 range.

Students' opinions of **The lighting in the cafeteria during lunch time is very good** differed by school ($F(3,1517) = 12.91$, $p < .0001$). They tended to agree with the statement, and the school that agreed the most with the statement was School 4 (M = 2.26, SD = 1.13). School 4 was the school with most window area. School 1, the school with the smaller window area where blinds obstructed the pass of light, disagreed the most (M = 2.83, SD = 1.13).

The statement **The temperature in the cafeteria during lunch time is very pleasant** had different answers according to school ($F(3,1517) = 5.86$, $p = .0006$). All agreed that in the temperature was pleasant; but it was interesting to see that the students at the newest school were the ones who agreed the most (M = 2.39, SD = 1.15), and the ones who agreed the least were from School 3 (M = 2.67, SD = 1.08).

The statement **I like the seating arrangements of the cafeteria** had different responses ($F(3, 1517) = 287.74$, $p < .0001$). This was an interesting case where Schools 1 2, and 4 (M = 2.32, SD = 1.26) agreed that they liked the seating arrangements and School 3 disagreed with that opinion (M = 4.31, SD = 1.09). School 3 is the school where the students were told where to sit according to when they exited the cashier line. In the other schools students had the choice of selecting their seating place.

The statement **The physical condition of the cafeteria is very good** had different answers ($F(3,1517) = 29.13$, $p < .0001$). The school where students agreed the most was School 4 (M = 2.39, SD = 1.14) and the school where the students agreed the least was School 3 (M = 3.03, SD = 1.03). One should expect more difference between the answers from the newest school and the others, but that was not the case.

Students responded to the statement **The cafeteria is too crowded during lunch time** with similar answers from the schools, almost all having a neutral opinion ($F(3,1517) = 0.16$, $p = .9201$). Here the answers were very close, ranging from 2.84 to 2.90. Significantly different scores were expected from the schools with less square foot per student, but that did not happen.

This is an example where students' perceptions differed from the physical evidence as suggested by Robbins (2001).

The statement **Usually I am hungry before lunch time** had different answers according to schools (F(3,1517) = 4.16, *p* = .0061). In general, all of them agreed that they are hungry before lunch; the ones who strongly agreed were from School 2 (M = 1.86, SD = 1.26), and the ones who agreed the least were from School 1 (M = 2.23, SD = 1.38). There is no way to link this answer with the amount of plate waste since the participation of the students on the survey was voluntary. Although a student might be hungry, that does not mean the student will eat vegetables or dessert he or she does not like. Peer pressure may also be a factor which prevents students from eating as mentioned by Meyer et al. (2000).

Responses to the statement **I eat my lunch in ten minutes or less** varied by school, (F(3, 1517) = 4.88, *p* = .0022) but were close to a neutral answer. School 3 results were the closest to disagreeing (M = 3.15, SD = 1.20), and School 1 respondents agreed more (M = 2.87, SD = 1.33). This result is consistent with the measurements of OTE times in all schools. There were no differences noted in average eating times with 75 percent of schools providing 17-24 minutes for lunch periods.

Conclusions and Recommendations

The only positive correlation between environmental conditions and plate waste was humidity. A regression analysis corroborated the finding that when the relative humidity was higher, the amount of plate waste also increased. Relative humidity varied by school and was within the limits recommended by ASHRAE at all the sites. This relationship makes sense on an intuitive level, as discussed earlier, and could bear further study. However, a causal relationship between cafeteria humidity levels and plate waste could not be established.

In West Texas, with more than 300 days of sunshine each year, the kind of weather that would correspond to higher levels of humidity (i.e., overcast or rainy days) tends to have an adverse effect on the moods of students and teachers, as evidenced by the increase in discipline problems. Perhaps this negative change in mood is responsible in part for a decrease in appetite and a resulting increase in plate waste.

Crowdedness or student density in the cafeteria indicated that there were different conditions at the schools. However, the surveys indicated no differences in student perceptions of crowdedness.

Average plate waste varied from lunch period to lunch period daily at the same school. Within the same school, overall average plate waste varied on a daily basis. However, when averaging the plate waste by days, no significant differences were noted among schools.

On perception surveys, students responded that they were hungry before lunchtime. However, that does not explain the large plate waste. According to opinions expressed by students, the plate waste was in part due to having non-popular menu items for lunch. Another possible reason was that in order to be considered as a reimbursable meal, the student had to take at least a minimum number of food choices. Frequently, the non-popular menu items are not touched by the students and went directly to the waste container.

A small positive correlation was found between noise and illumination levels. Noise levels during lunchtime were higher in cafeterias with the highest density (number of students per square foot of cafeteria space). Therefore, the researcher observed that as illumination increased, noise also increased. The perception of students, as indicated by the student surveys, was that noise levels were acceptable.

Illumination levels differed from school to school, and a weak positive correlation was found between illumination levels and temperature. Therefore, the researcher observed that as illumination increased, temperature also increased. Illumination levels, according to the surveys, were acceptable.

Temperatures were found to be higher in the cafeterias with a larger student density. Temperature levels were within ASHRAE recommendations, and the surveys indicated that students found dining room temperatures acceptable.

With the preponderance of research indicating that human behavior is undeniably affected by factors in the physical environment—amount and quality of light, noise, air quality, temperature—it would seem obvious that the physical aspects of the dining room setting would affect the appetites of school children and the effect should be measurable by the amount of plate waste. However, only a small and highly suspect influence was revealed by this study.

Some factors beyond the scope of the study may have contributed to the occurrence and amount of plate waste. For example, events that took place before lunch may have had an influence over the mood of the students, which in turn may have influenced their appetites.

The 30 minutes of the lunch period makes up about 3 percent of a student's 16 or so waking hours. In the other 97 percent of their time, students are interacting with parents, peers, and authority figures. During this time they are also dreaming about the future, worrying about tests and exams, and thinking about extracurricular activities. All of these concerns affect their moods which, in turn, affect their appetites. Thus, the snapshot taken by measuring plate waste is like a frame from a movie—it has a context that is much longer than the immediately preceding 30 minutes and much broader than the walls of the cafeteria.

Some factors that may have influenced plate waste were beyond the control of researchers. For instance, school menu items did not match up between schools on respective days of data collection. Also, the environment could not be manipulated over time to determine the influence of changes in light, noise, temperature, or other variables.

According to the survey results, student acceptance of menu items varied. Therefore, it is recommended that in future studies menu items be controlled; that is, studies in different schools need to be conducted in such a way that the same menu choices are being offered in all schools studied. Also, popular menus and not-so-popular menus should be included in the study. Another possibility of study is to let the student decide on the number of food items to take, while still considering it as a reimbursable meal.

The positive correlation of relative humidity to plate waste indicates some influence of the physical environment on the amount of plate waste. If, in future studies, humidity levels could be controlled, or if this influence could be examined in regions with different levels of average relative humidity, this relationship could be more fully explored.

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APPENDIX
Data Collection Forms

Texas Tech University

Plate Waste Research

School_________________________________ **Date**_________

Research Assistant_____________________

Food Items-Average Weight (grams)

Food Item	**1**	**2**	**3**	**4**	**5**	**Average**
Nacho grande						
Hamburger						
Cheeseburger						
Pepperoni pizza						
French fries						
Hamburger fixings						
Tossed salad						
Pinto beans						
Assorted fresh fruit						
Vanilla pudding						
Milk –variety						

Texas Tech University

School Foodservice Plate Waste Study

School____ **Date**________________________

Student Assistant____

Lunch Period ☐ 11:45-12:15 ☐12:15-12:45 ☐12:45-1:15

Elapsed Time Until Student is Seated

Set stopwatch to ZERO when lunch period starts.
Do not record 100ths of a second.

Student	Time						
	MIN:SEC	26.		52.		78.	
1.		27.		53.		79.	
2.		28.		54.		80.	
3.		29.		55.		81.	
4.		30.		56.		82.	
5.		31.		57.		83.	
6.		32.		58.		84.	
7.		33.		59.		85.	
8.		34.		60.		86.	
9.		35.		61.		87.	
10.		36.		62.		88.	
11.		37.		63.		89.	
12.		38.		64.		90.	
13.		39.		65.		91.	
14.		40.		66.		92.	
15.		41.		67.		93.	
16.		42.		68.		94.	
17.		43.		69.		95.	
18.		44.		70.		96.	
19.		45.		71.		97.	
20.		46.		72.		98.	
21.		47.		73.		99.	
22.		48.		74.		100	
23.		49.		75.		101	
24.		50.		76.		102	
25.		51.		77.		103	

Texas Tech University
School Foodservice Plate Waste Study

School____ **Date**_________________________
Student
Assistant_______________________________________
Lunch Period ☐ 11:45-12:15 ☐12:15-12:45 ☐12:45-1:15

Cafeteria Illumination Level

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Texas Tech University
School Foodservice Plate Waste Study

School____ **Date**________________________
Student Assistant_____________________________________
Lunch Period ☐ 11:45-12:15 ☐12:15-12:45 ☐12:45-1:15

Cafeteria Noise Level

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Texas Tech University
School Foodservice Plate Waste Study

School____ **Date**________________________
Student Assistant______________________________________
Lunch Period ☐ 11:45-12:15 ☐12:15-12:45 ☐12:45-1:15

Cafeteria Temperature/Humidity

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location w here reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Time:

Mark location where reading was taken with an 'X'

Student Survey

You are being asked to participate in a study exploring the effects of the physical dining environment on plate waste by responding to the following questionnaire regarding your behavior related to school lunch. You should also understand that the responses will be held in confidence, and that there is **no way your name or this school can be linked to your responses after the session.** The questionnaire will be handled only by Dr. Alfonso Sánchez from Texas Tech University.

Your responses are very important, so please answer all questions TRUTHFULLY.

1. Where did you get your lunch **today**? (Choose all that apply.)

____ vending machine

____ snack bar

____ lunch menu line

____ á la carte line

Continue on back

Please pick a number from the scale to show how much you agree or disagree which each statement and circle it in the corresponding space.

Scale

1. **Strongly agree**
2. **Agree**
3. **Neutral**
4. **Disagree**
5. **Strongly disagree**

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
2. There is too much noise in the cafeteria during lunch time	1	2	3	4	5
3. The lighting in the cafeteria during lunch time is very good	1	2	3	4	5
4. The temperature in the cafeteria during lunch time is very pleasant	1	2	3	4	5
5. The appearance of the cafeteria is very good	1	2	3	4	5
6. The cafeteria is very clean	1	2	3	4	5
7. I like the decorations in the cafeteria	1	2	3	4	5
8. I like the appearance of the serving line	1	2	3	4	5
9. I like the seating arrangements of the cafeteria	1	2	3	4	5
10. The physical condition of the cafeteria is very good	1	2	3	4	5
11. The noise level during lunch allows me talk and listen to my friends	1	2	3	4	5
12. The food that I eat during lunch at school is nutritious	1	2	3	4	5
13. The flavor of the food that I eat at school lunch is good	1	2	3	4	5
14. Considering the price, the amount of food, and quality, the school lunch is a good value	1	2	3	4	5
15. The portion size of the ham & cheese/ pizza/ cheeseburger is about right	1	2	3	4	5
16. The portion size of the tossed salad is too small	1	2	3	4	5
17. The portion size of the french fries/tater tots is too large	1	2	3	4	5
18. The portion size of the chilled fruit is too large	1	2	3	4	5
19. I do not spent too much time waiting in the food serving line	1	2	3	4	5
20. I eat my lunch in ten minutes or less	1	2	3	4	5
21. The cafeteria is too crowded during lunch time	1	2	3	4	5
22. The teachers/lunch monitors help to maintain discipline during lunch time	1	2	3	4	5
23. Usually I am hungry before lunch time	1	2	3	4	5

Individual Plate Waste

Research Assistant__________________________ Cavazos Junior High School November 8, 2001

		Grms.		Grms.		Grms.		Grms.		Grms.		Grms.		Grms.		Grms.
1	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
2	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
3	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
4	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
5	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
6	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
7	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
8	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
9	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
10	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
11	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
12	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
13	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
14	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
15	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
16	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	
17	Lasagna ? Pizza ? Cheeseburger ?		Corn? Potato rounds?		Italian salad ? Hamb. Fixings ?		Chef salad ? T salad ?		Chilled fruit		Apple ? Orange ?		Cake		Milk	