Increasing School Children's Whole Grain Intake: A School-Based Study

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Reaching this goal of obtaining my PhD has closed one chapter in my life and opens another. So begins the next chapter.....

This dissertation is dedicated to my children: Brianna and Tony.

Abstract

Whole grain intake is associated with reduced risk for various chronic diseases, such as coronary heart disease (CHD), type 2 diabetes, and overweight/obesity. However, current consumption by children is only about one-third of the recommended level. The 2005 Dietary Guidelines and My Pyramid recommend that half of all the grains consumed should be whole grains [1, 2]. Despite this recommendation, several attributes of whole grain foods that may deter liking by children include the dark color, bitter taste, and tough texture compared to refined grain foods.

In recent years, school nutrition programs have actively sought to increase the availability of whole grain products served as part of school breakfast and lunch in an effort to follow the recommendations of the 2005 Dietary Guidelines for Americans. However, little research has been conducted to examine effective approaches to increase children's whole grain consumption through school meals. The research described in this dissertation consists of three diverse and interrelated studies which include both quantitative and qualitative research methods: Study I reported results based on a gradual incorporation of red and white whole wheat flour into bread products served for lunch in elementary schools (Fall 2005-Spring 2006); Study II included the development and testing of psychosocial variables that might be associated with whole grain intake by elementary school children (Spring 2006); and Study III involved the development of an innovative method to observe whole grain consumption during school lunches by videotaping followed with focus group interviews (Spring 2007 and Fall 2007).

Study I tested the feasibility of an innovative approach whereby the whole wheat content of bread products in school lunches was gradually increased to enhance whole

grain intake by children. A convenience sample included children in K-6th grade from two elementary schools in a Midwestern city. Whole red and white wheat flour content of buns and rolls served twice weekly was increased from 0% to 91% in 16 and 7 incremental levels, respectively over the school year. Red wheat products were served in one school and white wheat products in the other. Plate waste methods were used on a whole school basis to estimate consumption. Mean consumption of whole grain (g/child) increased as the level of red and white whole wheat flour increased in modified bread products. Consumption of modified bread products did not differ statistically from baseline (0% whole grain flour) until the 72% level for red and 67.5% level for white wheat was served. Consumption of buns and rolls varied with type of accompanying menu items regardless of wheat type or level. A gradual increase in whole wheat content in menu items resulted in favorable whole grain consumption by children.

In study II, an instrument to measure the influence of psychosocial variables on children's whole grain consumption was developed and tested. Ninety-eight children in grades 4th - 6th in one elementary school participated in one 24 hour dietary recall interview and completed a questionnaire measuring self-efficacy, outcome expectations, preferences and knowledge on two occasions (approximately 14 days apart). Seventy-six parents completed a supplemental home inventory checklist to assess the availability of whole grain foods in the home. Mean total grain intake was 7.7 servings (SD 3.2) per day while mean intake of products containing whole grain (whole grain + some whole grain) was slightly over 2 servings/day. Internal consistency for psychosocial scales was modest or acceptable (α = .55 - .70). Test-retest correlation coefficients were acceptable (r =0.55 - 0.63) for the three psychosocial scales but not for a knowledge item. Total scores on the

home inventory checklist ranged from 1 to 38 for whole grain items with a mean of 15 (SD 7). Reported home availability and refined grain intake were significantly related to whole grain intake while psychosocial variables were not. Availability in the home may be a more important variable associated with whole grain intake than preferences, self-efficacy and outcome expectations. Intake of whole grain foods was based on only one 24-hour recall interview which may not be representative of a usual intake and therefore represents a limitation regarding the interpretation of the results.

The final study III further investigated children's eating behaviors related to whole grain products using an innovative technique of video recording cafeteria lunches in a local school district. Approximately 90 children were taped on several occasions (range = 1 to 18 times / child) while eating a variety of grain foods including whole grain products served in a typical elementary school lunch. Focus groups (n~30) were used to collect in-depth information regarding students' response to new product introductions. Video analysis was based on a modified Dyadic Interaction Nomenclature for Eating (DINE). DINE is a valid behavioral coding system developed to assess parent–child mealtime interactions in young children [3, 4]. DINE is comprised of three categories of behaviors: parent behaviors, child behaviors, and child eating behaviors. The modified DINE was renamed Student Lunch Observation Nomenclature Eating (SLONE) to investigate eating patterns and behaviors of children during a school lunch. This study specifically used SLONE to investigate how whole grain products were consumed by children in a typical school environment. Results indicate that at higher grade levels children decreased the number of food items selected and time spent eating. Desserts made with grains, such as cookies and cakes, were taken by twice as many children when

offered with a pizza meal compared to when fruits were served as a dessert. Differences in consumption of the main entrée approached significance when consumed with desserts made with grains compared to fruit desserts. Although the frequency of bites and sips varied among children, general eating patterns were categorized as “typical”, “nibblers”, and “cyclic” eaters. This baseline data provides a foundation for further exploring the use and acceptability of foods in school meals at the elementary school level. This information can be helpful in facilitating whole grain product development and introduction in an interactive and realistic cafeteria environment for children.

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CHAPTER I

LITERATURE REVIEW

Background:

What are whole grains?

Whole grains may be defined at three distinct stages as they pass through the supply chain from farm to consumer. Prior to the milling process the intact whole grain kernel naturally contains all three edible portions including the bran, germ and endosperm. During the milling process, the kernel may be directly milled into a whole grain ingredient that contains all three original components. Alternatively, the kernel may be separated into each of its own components and recombined back into a whole grain flour containing the bran, germ and endosperm in the relative proportions naturally occurring in that particular grain. In either case, as the intact kernel or processed whole grain ingredient (e.g. flour) the American Association of Cereal Chemists' International (AACCI) defines both entities as a whole grain ingredient [5]. A whole grain food definition becomes much more complex as a whole grain ingredient(s) is typically incorporated at some level into a specific formula or recipe. Currently, a universal definition does not exist for either a whole grain ingredient or whole grain food. This has made it difficult for industry, government and academics to develop useful whole grain definitions for product development, regulatory guidelines and effective communication with consumers.

Whole grain ingredient definitions

In 1999 the AACCI issued a definition for whole grains ingredients "as the intact, ground, cracked, or flaked caryopsis, whose principal anatomical components—the starchy endosperm, germ, and bran—are present in the same relative proportions as they

exist in the intact caryopsis" [6, 7]. Although this definition is technically sound, it is not consumer friendly. In 2004, a more consumer friendly definition was established through a joint effort of the AACCI and the Whole Grains Council affiliated with the Oldways Preservation Trust. This new definition states, "Whole grains or foods made from them contain all the essential parts and naturally occurring nutrients of the entire grain seed. If the grain has been processed (e.g., cracked, crushed, rolled, extruded, lightly pearled, and/or cooked), the food product should deliver approximately the same rich balance of nutrients that are found in the original grain seed" [6, 8]. Particle size is not dealt with in either definition but may be needed to be addressed in the future. Examples of consumer accepted whole grain foods and flours are the following: amaranth, barley, buckwheat, bulgur (cracked wheat), corn (including whole cornmeal and popcorn), millet, oats (including oatmeal), quinoa, rice (both brown rice and colored rice), rye, spelt, sorghum (also called milo), teff, triticale, wheat including varieties such as spelt, emmer, einkorn, farro, kamut®, durum and wheat berries and wild rice [8, 9].

Whole grain food definitions

The U.S. Department of Agriculture and Agricultural Research Service, 1997 has determined that one serving of a whole grain food contains 16 grams of whole grain flour, based on Pyramid Servings data. In addition the Food and Drug Administration (FDA) requires foods that bear the whole grain health claim to contain 51 percent or more whole grain ingredients by weight per reference amount and be low or moderate in fat (up to 6.5 g fat per reference amount) [10-13]. The whole grain health claim was allowed by the FDA in July 1999. This claim stated that "Diets rich in whole grain foods

and other plant foods and low in total fat, saturated fat, and cholesterol, may help reduce the risk of heart disease and certain cancers." This claim was modified in 2003 to the following: “Diets rich in whole grain foods and other plant foods, and low in saturated fat and cholesterol, may help reduce the risk of heart disease”. The whole grain health claim provides numerous benefits to consumers, government, industry and academia by 1) reinforcement of dietary and health goals established by government which potentially reduce chronic disease risk, 2) contribution to whole grain identification, health benefits and consumption, 3) development and promotion of new whole grain products, and 4) an increase in whole grain research [14]. Despite much progress in establishing whole grain definitions, consumers and even professionals remain confused in identifying whole grain foods in the marketplace [15].

Whole grain stamp program

To aid in the identification of whole grain products, the Whole Grains Council launched the Whole Grain Stamp program in early 2005 (Phase I). This voluntary program initially categorized whole grains into three categories: good source, excellent source, and 100% whole grain source. A good source provided at least 8 grams of whole grain per serving and was equal to a half-serving of whole grain while the excellent source provided at least 16 grams of whole grain per serving and was equal to a full serving of whole grain. The 100% whole grain source provides a full serving of whole grain with at least 16 grams of whole grain per serving without any refined grain. This approach was based on the May 2004 General Mills petition to FDA requesting the use of three levels of whole grain content on food packages that consumers might understand

(made with; good source; excellent source). However, this petition was not supported by the FDA. An updated whole grain stamp was launched that categorized whole grain products into two levels based on government guidelines: the 100% and basic stamp. The 100% stamp identifies a product as having all the grain ingredients as whole grains with a minimum 16 g of whole grain per labeled serving. The basic stamp identifies a product having at least 8 g or a half-serving of whole grain. The basic stamp will even be used on products that contain large amounts of whole grain (23g, 37g, 41g, etc.), if the high whole grain content of the products is due to extra bran or germ [16]. Whole grain products have been increasing dramatically in the marketplace since 2000. According to the Mintel Global New Products Database, new whole grain products have increased at an average of about 50% per year with an overall increase of 1344% from 2000 to 2007 [17].

Whole grain foods in the marketplace

Food companies are changing the face of the marketplace in response to growing awareness of the health benefits of whole grains by reformulating existing or introducing new products [12]. Recent whole grain product innovation by major manufacturers includes numerous products such as breads, cereals, wraps and snacks with some level of whole grain flour incorporation. In a one-year period (2006 to 2007), new whole grain products on the market increased by 50% with a total of 2,368 new whole grain introductions in 2007 and sales of whole grain products jumped by 18% [17]. Despite an increase in whole grain introductions and sales, overall whole grain products on grocery store shelves remains low at approximately 10% of all available grain products [18].

Dietary recommendations relative to whole grain consumption

Current dietary recommendations

The U.S. government has been advising Americans regarding what to eat for over a century. This advice has changed to keep pace with both the new findings as well as changing patterns in food consumption and physical activity [19]. The Healthy People 2010 Goals for Americans included the objective of "increasing the proportion of persons aged two and older who consume at least six daily servings of grain products, with at least three being from whole grains" [20]. Although the 2000 Dietary Guidelines suggested adding whole grains to the diet [21] an actual quantitative recommendation for whole grains was not added until the 2005 Dietary Guidelines and MyPyramid which states that "at least one-half of all the grains eaten should be whole grain" [1]. A whole grain serving or ounce equivalent, as defined by the USDA, refers to any food containing 16 grams of whole grain ingredients per serving. Some examples of whole grain servings include 1/3 cup cooked whole wheat pasta or brown rice, 2 cups of popcorn (popped), 1 slice of whole wheat bread, and 1/2 cup of oatmeal. For consumers to meet this whole grain recommendation it will require a significant shift in the food selection and habits of most Americans.

Dietary intake of whole grain foods

Currently in the U.S. few individuals are meeting the recommendation for whole grain intake. Data from the USDA 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) indicated a preference for and over-consumption of refined grains while whole grain intake only met one-third of the recommendation [22-

25]. Data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) indicated little change from the previous data. The NHANES data suggested that a majority of people over 12 years of age met the recommendation for grains daily, but only 11% of the total grains consumed consisted of whole grains [26]. U.S. children and adolescents (ages 6 - 19), also had a low intake with a mean average of 0.8 to 1 servings of whole grains on a daily basis [27].

Consumer surveys suggest that the availability of whole grain products is more limited in the food service setting than at home. In 1994–1996 and 1998, about two thirds of total grain and non-whole-grain servings were obtained from “at home” sources, while fewer than 15% of whole-grain servings were obtained “away from home”[24, 25]. In addition, restaurants and fast food establishments, which accounted for about one-third of total food energy, were also the source of only 6% of total whole-grain servings or about 0.29 ounces per 1000 calories [24, 25]. As food availability outside the home increased, the availability of whole grain products in food service facilities became progressively more important. Based on these data, breakfast cereal, grain-based snacks, and yeast breads were the most common contributors to whole grain foods. This may be pertinent information for the grain industry as they consider strategies for new product development related to whole grains and to contribute to enhanced whole grain consumption. Overall, the average consumer was older, more educated, from a higher socioeconomic class, and tended to have other positive lifestyle traits, such as being a non-smoker, participation in regular physical activity, and increased fruit and vegetable intake [22, 23, 25, 28].

Harnack et al.[27] further analyzed the CSFII data to characterize the types of whole grain foods consumed by children and adolescents aged two to 18 years. Average whole grain intake ranged from 0.8 servings to 1.0 serving per day. In addition, ready-to-eat cereals (30.9%), corn and other chips (21.7%), and yeast breads (18.1%) accounted for the major food sources of whole grains in children and adolescents. Consumption of whole grain intake for college students was similar with an average of 0.7 servings/day with the main source being ready-to-eat cereals and wheat bread (70%) while grain based snacks, popcorn and hot cereals comprised the remainder of the whole grain intake [29]. Kantor et al. [24] reported that schools account for 1.3 servings of whole grains per day, but the products that contributed to this amount was undisclosed. Wechsler et al.[30] examined availability of foods and beverages based on questionnaire data representing a national sample of schools. Some states and districts had requirements about specific foods offered to students. Of the schools that returned surveys 12% of state and 50% of school districts indicated requirements to offer five or more products that contain whole grain per week. Eighty-four percent of schools were yielding to this mandate. However, the type of food or level of whole grain content in these foods was not reported. Despite these findings, whole grain consumption for children needs to increase from the current $\leq$ 1 serving per day to the recommendation of at least three or one-half of all grains consumed as whole grain.

Whole grain intake and chronic disease

Overview

Significant scientific evidence indicates that whole grains reduce the risk of various chronic diseases. Epidemiological studies indicate an association between intakes of whole grains and a reduced risk for heart disease [31-39], type 2 diabetes [40-52] and obesity or weight loss [29, 47, 49, 53-59]. In addition clinical studies suggest beneficial effects of whole grain on risk factors related to heart disease [60-63], type 2 diabetes [64-66], and on weight gain or obesity [61, 67]. Given the relatively large volume of previous research on whole grains, particularly epidemiological studies, this section will only highlight the more recent findings on the relationship with chronic disease.

Coronary Heart Disease

Strong epidemiological evidence has linked consumption of whole grains to a reduced risk for coronary heart disease (CHD) in both men and women. In the Nurse's Health Study, a large, prospective study of U.S. adult women followed for 10 years, a strong inverse association was found between whole grain intake and risk of CHD. Women in the top quintile of whole-grain consumption experienced a >30% lower risk of CHD than women in the lowest quintile. Women in the highest total dietary fiber quintile had an age-adjusted relative risk of 0.57 ($p=0.001$) compared to women in the lowest quintile [32]. Similarly the Iowa Women's Health Study, a prospective cohort of postmenopausal women followed over a 9-year period, showed a 30% reduction in ischemic heart disease (IHD) deaths for those eating $\geq$1 serving of a whole-grain product each day, compared with those who reported rarely eating any whole-grain products [31].

Jensen et al. [34] reported that men in the highest quintile of whole grain consumption had an age-adjusted relative risk of 0.64 ($p<0.0001$) for overall CHD compared to men in the lowest quintile for whole grain consumption. Pereira et al. [35] conducted a pooled analysis of cohort studies on dietary fiber and risk of coronary heart disease and found that consumption of total dietary fiber including cereal fiber deceased coronary risk by 10% to 30% for each 10g/d increase in fiber.

Djousse and Gaziano [37] examined cereal consumption among 21,376 participants in the Physicians' Health Study I using a semi-quantitative food frequency questionnaire. The incidence of heart failure was ascertained after an average of 19.6 years. The results indicated that after adjustment for age, smoking, alcohol consumption, vegetable intake, use of multivitamins, exercise, and history of atrial fibrillation, valvular heart disease, and left ventricular hypertrophy variables the hazard ratios (95% confidence intervals) for heart failure related to cereal consumption servings of 0 servings, 1 or fewer, 2 to 6, and 7 or more, were 1 (reference), 0.92 (0.78-1.09), 0.79 (0.67-0.93), and 0.71 (0.60-0.85), respectively ($P<.001$ for trend). This association was limited to whole grain cereal intake ($P<.001$ for trend) but not for refined cereals ($P=.70$ for trend).

In addition to large population-based studies a smaller nested cohort study demonstrated that whole grain intake was inversely associated with cardiovascular disease (CVD) [36]. This study included postmenopausal women (n = 229) with established coronary artery disease (CAD). Women who consumed more than six servings of whole grains per week had a smaller decline in minimum coronary artery diameter. After adjustment for other CAD risk factors, the rate of atherosclerosis

progression was slower in women whose cereal fiber intake was 4.0 g per 1000 kcal compared to those with half the fiber intake (2.0 g per 1000 kcal). This was the first study to directly assess the association between fiber intake and CAD progression in postmenopausal women. The results suggest that intakes of cereal fiber, particularly whole-grain products, are inversely associated with progression of atherosclerosis in postmenopausal women with established CAD.

Mellen et al. [38] investigated the association of whole-grain intake with carotid intimal medial thickness (IMT) and IMT progression in the Insulin Resistance Atherosclerosis Study. A median whole grain intake of <1 serving/day resulted in an inverse association with carotid IMT and IMT progression independent of individual risk intermediates, single nutrient constituents, or dietary patterns. Wang et al [39] also determined that a higher whole grain intake was associated with a reduced risk of hypertension in middle and older aged women. Despite the evidence, the epidemiological studies only suggests that the incidence of heart disease is inversely associated with whole grain consumption. Large clinical trails are needed to explore the cause and effect relationship between whole grain intake and heart disease risk. However, a few smaller clinical trials have investigated the effect of whole grain intake on heart disease.

A study by Behall et al. [62] with twenty-five non-hypertensive men and women (pre and post menopausal), indicated that substituting about 20% of kcalories in a Step I diet with whole wheat/brown rice, barley, or half wheat-rice/half barley reduced systolic, diastolic and mean arterial pressures. Katcher et al. [63] investigated a hypocaloric diet containing either refined or whole grain products on weight loss and CVD risk factors. Results indicated that both diets were effective in decreasing CVD risk factors. However,

whole grain consumers had a significantly greater decrease in C-reactive protein CRP and body fat in the abdominal region compared to refined grain consumers.

Although the previous clinical studies show a positive association with whole grain consumption, all research has not been as supportive in the results related to reducing CVD risk factors [68, 69]. In fact some research has been contradictive in results.

Andersson et al. [68] evaluated the effects of a whole grain diet compared to a refined grain on insulin sensitivity and markers of lipid peroxidation and inflammation. A randomized crossover study including 22 women and 8 men (BMI 28 +/- 2) were given either whole-grain or refined-grain products (3 bread slices, 2 crisp bread slices, 1 portion muesli, and 1 portion pasta) to include in their habitual daily diet for two 6-wk periods. With respect to the lipid peroxidation and inflammation results only, whole-grain consumption did not affect 8-iso-PGF (2alpha) in urine, IL-6 and C-reactive protein in plasma, blood pressure, or serum lipid concentrations. In conclusion, substitution of whole-grains for refined-grain products in the habitual daily diet of healthy moderately overweight adults for 6-wk did not affect markers of lipid peroxidation and inflammation.

Biorklund et al. [69] investigated whether a daily intake of a ready meal containing oat beta-glucan lowed total cholesterol (T-C) and low-density-lipoprotein cholesterol (LDL-C) in hyperlipidemic subjects and effects on postprandial glucose and insulin concentrations. Subjects included 43 healthy men and women with elevated serum cholesterol levels who partook in a parallel, placebo-controlled trial consisting of a 3-week run-in period (all subjects consumed ready-meal soup without beta-glucan) and 5-week intervention period (subjects were randomly assigned to either continue

consumption of the control soup or an equal soup supplemented with beta-glucan).With respect to CVD risk factors only the serum lipid results are reported. Despite initial results of decreased serum lipids with the LDL-C concentrations during the run-in period (0.24 ± 0.41 mmol/l in the beta-glucan group; 0.25 ± 0.39 mmol/l in the control group), both group LDL-C concentrations leveled off during the subsequent 5-week intervention period where the control was not significantly different from the intervention group (0.05 ± 0.27 mmol/l and 0.16 ± 0.36 mmol/l, respectively). There were no significant difference between groups regarding reductions in total-cholesterol during the intervention period (0.18 ± 0.38 mmol/l beta-glucan; 0.09 ± 0.34 mmol/l control). HDL-C tended to decrease slightly in both groups during run-in and intervention periods, but the changes were not significantly different between groups. Additionally apolipoprotein B and H-CRP changed during the intervention (reduction and increase, respectively) for both groups but were not significantly different from each other. Although these results proved inconclusive, Queenan et al. [70] concluded that oat β-glucan can significantly reduce total and LDL cholesterol in subjects with elevated cholesterol with LDL cholesterol being significantly different from control.

Despite considerable research efforts, the mechanism(s) in addition to the components of whole grains that might contribute to health benefits have not been clearly identified and are poorly understood [71]. In fact whole grains are derived from various species and consumed in different forms. Therefore, it is likely that there will be no single mechanism that will account for the health benefits [71].

However, there are studies that suggest potential mechanisms that contribute to the inverse relationship between whole grain intake and heart disease. Blood cholesterol

levels may be reduced via soluble fiber found in oats [70, 72, 73] by increasing intestinal viscosity [74, 75], and bile acid production [74, 76, 77]. Daily consumption of whole grain wheat exerted a pronounced prebiotic effect on the human gut microbiota composition which may contribute to the beneficial physiological effects [78]. Additionally beta-glucan in barley [79] and oats [69] has been shown to reduce serum cholesterol concentrations and visceral fat.

Whole grains also contain numerous phytochemicals which may inhibit oxidative stress that cause inflammation. Numerous epidemiological studies have shown an inverse association between whole grain consumption and inflammatory markers [63, 80] and inflammation-related death [81].

As previously stated, whole grains are a rich source of energy, fiber, vitamins, minerals, antinutrients, anti-oxidants, hormonally active compounds, non-nutrient compounds, and unusual fatty acids. These biologically active compounds found within the whole grain may work individually, in combination or synergistically to reduce disease risk [82, 83]. Therefore additional studies are needed to investigate whole grain effects on various types of inflammation, insulin sensitivity and blood glucose response.

Type 2 Diabetes

Several major prospective epidemiological studies have shown an inverse relationship between whole grain intake and risk of developing type 2 diabetes [40, 42-46, 48, 52, 84-88]. These studies document up to a 30% lower risk for developing type 2 diabetes with higher whole grain intake. In the Iowa Women's Health Study, Meyer et al. [41] showed an inverse relationship between whole grain intake and risk of type 2

diabetes. The relative risk for diabetes was 0.79 (P=0.0089 for trend) in the highest quintile for whole grain intake compared to the lowest quintile. Therefore, women who consumed an average of 21 servings of whole grains weekly were 21% less likely to develop diabetes than women who consumed only one serving weekly. Fung et al. [42] also reported an inverse association between whole grain consumption and type 2 diabetes risk in the Health Professionals Follow-Up Study. The relative risk for diabetes was 0.70 (P=0.0006). Therefore, men who consumed an average of 22 servings of whole grains weekly (which corresponds to an average of 3 servings per day) were 30% less likely to develop diabetes than men who consumed only 2.8 servings per week. Similarly McKeown et al [89] investigated the association between consumption of whole grains and refined grains and risk factors for developing diabetes or cardiovascular disease in the Framingham Offspring Study. Results indicated that a favorable association existed between whole-grain intake and waist to hip ratio, total cholesterol, LDL-cholesterol, and fasting insulin concentrations. In contrast, refined-grain intake was not related to any of these metabolic risk factors.

A recent review examined pooled data from six cohort studies indicating that an increment of two servings per day in whole grain consumption decreased risk of type 2 diabetes by 21% (95% CI; 13% -28%) [50]. However, the authors concluded that the evidence from the prospective cohort trials is too weak to draw a definite conclusion that whole grains have a protective effect on the development of type 2 diabetes [52]. Large clinical trails are needed to explore the cause and effect relationship between whole grain intake and type 2 diabetes. However, a few recent smaller clinical trials have

demonstrated that various components in whole grains may elicit positive effects on insulin response.

Ostman et al. [64] conducted a randomized crossover designed study with 7 women with a history of gestational diabetes and impaired glucose to investigate the feasibility of improving blood lipids, glucose tolerance and insulin sensitivity by modifying the glycemic index (GI) and dietary fiber (DF) content of their bread. Subjects were given either low GI/high DF or high GI/low DF bread products during two consecutive 3-week periods, separated by a 3-week washout period. Results indicated that lowering the GI and increasing DF improved serum insulin area under the curve (AUC) on average by 35% within the first hour for all women. However, fasting glucose levels, insulin, HDL-cholesterol or triglycerides did not change. Thus, the authors concluded that a combination of low GI and a high content of cereal DF has a beneficial effect on insulin in young women at risk for developing type 2 diabetes [64].

In another study, Weickert et al.[65] investigated the effect of purified insoluble oat fiber on insulin sensitivity among overweight or obese subjects with normal glucose metabolism. Seventeen subjects were required to consume fiber-enriched bread (white bread enriched with 31.2 g insoluble fiber/day) or control (white bread) over 72 hours. Results indicated that glucose disposal was improved after fiber consumption. However plasma lipids, serum magnesium, ghrelin, and adiponectin concentrations, as well as substrate utilization and body weight, were not significantly changed by fiber intake. The authors concluded that an increased insoluble dietary fiber intake for 3 days significantly improved insulin sensitivity.

A 10-week randomized two-way crossover design was used to examine the effect of a whole grain product with reduced starch versus a nutrient-dense meal replacement product, in combination with a hypo-energetic diet on body weight, fasting blood glucose, insulin resistance and lipids [66]. Thirty-one subjects (BMI 33.9 kg/m2, fasting blood glucose 6.3 mmol/l) replaced at least two meals daily with the whole grain and nutrient-dense meal replacement product consuming approximately 200 g of either product per day. Both groups decreased body weight, fasting blood glucose, total cholesterol, triaclyglycerol (TAG), and homeostasis model assessment (HOMA) scores with no significant differences between groups. However, after statistical adjustment for the amount of body weight lost, comparison between fasting serum insulin ($P = 0.031$) and HOMA insulin resistance score ($P = 0.049$) improved better with the whole grain versus the control diet. The authors concluded that during the hypo-energetic diet, whole grains favorably influenced metabolic risk factors for type 2 diabetes independent of body weight loss [66].

Poppitt et al. [75] investigated the postprandial effects of a barley β-glucan product on blood glucose, insulin and lipids. Subjects included 18 lean healthy men who consumed a 10g dose of barley β-glucan supplement in 4 treatments: 1) high-carbohydrate $_{\text{food control}}$; 2) high-carbohydrate $_{\text{food+fiber}}$; 3) high-carbohydrate $_{\text{beverage control}}$; and 4) high-carbohydrate $_{\text{beverage+fiber}}$. The addition of the β-glucan supplement significantly reduced the glycemic and insulinemic responses when used in a food form but not when served in a drink. The authors concluded that the β-glucan supplement can improve glucose control when served in a high-carbohydrate food due to the increased

gastro-intestinal viscosity; however, this mechanism may be hindered by the rapid absorption of high-carbohydrate beverages.

The previous research suggests that consumption of whole grains improves insulin sensitivity. However not all research has not shown a significant improvement with insulin sensitivity. Andersson et al. [68] results indicated that peripheral insulin sensitivity did not improve or differ within or between groups when subjects consumed whole-grain products (6.8 +/- 3.0 at baseline and 6.5 +/- 2.7 after 6 wk) or refined products (6.4 +/- 2.9 and 6.9 +/- 3.2, respectively). While Biorklund et al. [69] results also indicated that neither postprandial glucose nor insulin concentrations were significantly different from the control after a beta-glucan supplementation. It maybe that certain characteristics of various grains or grain products may elicit improved glucose metabolism and the potential for delayed onset or progression of diabetes. The physical properties and structural characteristics of whole grains include: particle size, grain structure, viscosity and solubility [90]. Still other components of whole grains include dietary fiber [91-93] magnesium [94, 95], phenolic compounds, along with other anti-oxidants such as phytic acid [96], vitamin E and selenium [97] which are thought to influence diabetes outcome variables. Further investigation is warranted to examine the influence of these and other grain components on potential mechanisms for diabetes risk. In addition, research is needed to determine whether these components might work individually, additively and or synergistically to reduce disease risk and improve health.

Obesity and body weight regulation

A number of epidemiological studies have examined the relationship between changes in the consumption of grain foods and weight gain [29, 53, 54, 57, 59, 98, 99]. These studies demonstrated that increased intake of whole grains was inversely related to weight gain. Among women, higher whole grain intake was associated with less weight gain (mean weight gain 1.52 kg in 2-4 y in the lowest quintile; and 1.23 kg in the highest quintile; *P* for trend < 0.0001). In contrast, higher intake of refined grains was related to greater weight gain (from 0.99 kg to 1.65 kg; *P* for trend < 0.0001) [53]. Additionally, women consuming at least one serving of whole grain had a significantly lower mean body mass index (BMI) and waist circumference than women with no whole grain consumption [59]. Similarly, increased consumption of whole grains over an 8-year follow-up period was inversely associated with weight gain in men [54]. Because whole grains were classified based on their respective whole grain and non-whole grain ingredients, the authors estimated that for every 40g daily increment in whole grain intake long-term weight gain was reduced by 0.49 kg. These findings support the results of several studies that reported that high whole grain diets are associated with lower body weight [29, 32, 53, 99, 100]. Although most of the research supports the results that whole grain diets are associated with lower body weight, a resent article examined the associations of whole-grain intake with body weight and adiposity in two nationally representative samples of British adults [101]. A 1986-1987 survey indicated whole-grain intake was inversely associated with percentage of men using BMI as obese however, intake was not associated

with body weight or prevalence of overweight. Additionally, no corresponding associations were observed among women. The 2000-2001 survey results indicated whole-grain intake was not associated with body weight, BMI or waist circumference. Conclusions indicate that two national surveys of British adults provide little evidence of an association of whole-grain intake with body weight or measures of adiposity.

In addition to epidemiological studies, some clinical studies have provided preliminary evidence regarding the beneficial effects of whole grain consumption during weight loss programs. Melanson et al. [67] conducted a two phased 12-week randomized clinical study which assessed diet quality on three different weight-management programs (exercise only-control; hypocaloric diet plus exercise; or hypocaloric diet with fiber-rich whole grain cereals plus exercise). Subjects that completed the study included 134 sedentary overweight and obese adults. Data indicated that the hypocaloric diet with fiber-rich whole grain cereals plus exercise decreased energy intake more than exercise only (1,488±88 versus 1,708±97, respectively (P=0.032)). Total fat intake decreased significantly more and was sustained in the hypocaloric diet for the fiber-rich whole-grain cereal group compared to the exercise only group. Additionally, the group on the hypocaloric diet with fiber-rich whole grain cereals plus exercise significantly increased intake of total fiber, insoluble fiber, magnesium, and vitamin B-6 more than the other regimens.

Katcher et al. [63] also investigated consumption of whole grains in a hypocaloric diet (reduced by 500 kcal/day) and compared weight loss and cardiovascular disease risk factors among obese adults with metabolic syndrome. Results indicated that although

hypocaloric diets with either whole grains or refined grain were an effective means of improving cardiovascular disease risk factors with moderate weight loss, there were significantly greater decreases in C-reactive protein and percentage body fat in the abdominal region in subjects in the whole grain group. Dietary fiber and magnesium intake increased in the whole grain but not the refined-grain group [63]. This evidence suggests that whole grain cereal consumed in a hypocaloric diet increases the diet quality and decreases various risk factors associated with disease during weight loss. Despite this evidence longer term studies examining the direct effect of whole grain intake and body weight are warranted.

Since weight reduction is an important component of the previous diseases (e.g., CVD and diabetes) many of the mechanisms related to weight regulation with whole grains are similar. These components include effects of whole grain on hormonal factors, satiety (longer duration between meals) and satiation (lower meal energy content) [102]. A systemic review by Harland and Garton [99] analyzed observational studies and evidence relating to the consumption of whole-grain as a marker of healthy body weight and adiposity. Fifteen trials were identified which included data from 119,829 male and female subjects aged 13 years and over. A higher intake of whole grains (about three servings per day) was associated with lower BMI (0.630 kg/ m^2; $p < 0.0001$), reduced central adiposity measured as waist circumference or waist:hip ratio (-2.7 cm, $p = 0.03$; 0.023, $p < 0.0001$ respectively), increased dietary fiber intake (9g, $p < 0.01$) and decreased total and saturated fat (11g and 3.9g respectively). In addition, those who consumed more whole grains were likely to have a healthier lifestyle [99]. However, this can lead to considerable confounding in epidemiological studies as the influence of other

lifestyle factors associated with whole grain intake limits the ability to clearly elucidate the relationship between whole grain intake and chronic disease risk.

Protective effects of whole grain intake: Implications for children

In summary, current scientific evidence suggests that consumption of whole grains, cereal fiber, and total fiber decreases the risk of many chronic diseases. Based on this evidence increased whole grain intake in childhood has implications for overall health and quality of life extending into adulthood. However, development of healthy eating behaviors and preferences for specific foods begins early in life and shows a high degree of variability among individuals [103].

In just two decades, the prevalence of overweight doubled for U.S. children ages 6 to 11 and tripled for American teenagers [104]. Obesity associated diseases such as insulin-resistant type 2 diabetes [105], dyslipidemia, and hypertension continue to rise among youth [106]. Although the etiology is multifaceted, it appears that obesity is directly associated with the increasing availability of energy dense, high-calorie foods and drinks through away-from-home eating situations, including schools. Among other issues, changes in the family, particularly an increase in dual-career or single-parent working families, may also have increased demand for food away from home or pre-prepared foods [104].

Predictive Factors and Food Preferences of Children

Factors that predict eating behavior of children

An understanding of eating behavior in children is necessary to design nutrition education and public health interventions to positively influence food intake behaviors. Among collective socio-environmental factors, food availability and accessibility, parental and household factors, cultural factors, and economic determinants such as income/socio-economic status, food pricing, and education can have significant influences on healthy eating [107, 108]. Personal factors include knowledge, attitudes, food preferences, self-efficacy, familiarity, and outcome expectancy [107, 109, 110]. Although many factors have been identified as possible determinants of healthy eating, not all have a predictive relationship with consumption. The lack of consistency in previous studies may be attributed to numerous issues including conceptualization, research design, measurement, and analysis.

In a review of literature regarding models predicting food intake, including psychosocial variables predicting fruit & vegetable and fat consumption, Baranowski et al. [111] found a low overall level of predictiveness. At best, less than 30% of the variability in dietary behavior of adults was explained. The authors suggested that influences vary by foods, due to the increasing R^2 values with narrow food categories. Additionally, the narrowed food categories demonstrated higher predictiveness due to specific scales with more homogeneous foods.

Various models to predict children's intake of fruits and vegetables have been previously studied. Resnicow et al. [109] assessed self-efficacy, outcome expectations, preferences, social norms and knowledge of third grade children regarding fruit and

vegetable consumption. Preferences and outcome expectancies were significant predictors of fruit and vegetable consumption accounting for 10-11% of the variance in intake. Blanchette and Brug [112] reviewed intervention studies and determined that in addition to taste preference, availability and accessibility were the strongest determinants for increased consumption of fruits and vegetables in children 6 to 12 years. Neumark-Sztainer et al. [113] found similar results in adolescents. Additionally, parental behavior, feeding practices, food access and preparation, knowledge of recommendations, and asking skills had a positive association with intakes of fruit and vegetables. Whereas television viewing, exposure to television advertisements, and having a school snack bar were associated with lower fruit and vegetable intake. Knowledge, although beneficial, did not have a significant impact on behavior [109, 114, 115]. Currently limited studies exist that have examined factors that may be related to whole grain consumption by children or used as the basis for interventions to increase consumption of whole grain foods by children [116, 117].

Factors that influence whole grain intake

Factors that influence the overall quality and acceptability of whole grain products include production, delivery and service: shelf-life and stability of flour products; mixing, dough preparation, and baking; freezing, shipping and thawing; and the time period that whole grain foods sit in the open air before consumption (freshness). Other barriers that may influence consumption include children's eating habits or food preferences, insufficient time to eat, lack of support from administration, teachers and principals, and availability of vending machines in schools [118].

Children's food preferences and dietary choices are primarily driven by taste. Thus, the type and/or level of whole grain flour, sugar, fat and salt in the product can directly determine children's food preferences. Relative to adults, children show an exaggerated avoidance response to bitter taste and an elevated liking of intensely-sweet foods [119]. As measured by taste, texture, flavor, aroma, and appearance, these attributes will be the driving force behind the successful introduction of any whole grain products in the school cafeteria. Research to identify significant determinants of whole grain consumption by children is lacking. However, focus groups with children indicated that familiarity, appearance and the taste of new foods were important factors that influenced acceptability [120]. Therefore, taste as well as appearance and familiarity may strongly affect children's preferences for breads, cereals and other grain-based foods.

Most bread products, particularly yeast breads are made with red whole wheat. These products are generally dark in color, have a bitter taste, and have a tough texture compared to refined grain foods. These attributes tend to be less well liked than the characteristics of refined grain foods. This bitter taste and the genetic variation in sensitivity to the bitterness of 6-n-propylthiouracil (PROP) may play a role in whole grain acceptance as it is believed to influence the acceptance and rejection of bitter-tasting vegetables [121, 122]. Berg et al. [123] conducted a study where 181 Swedish school children, ages 11-15, described their usual breakfast and their idea of a tasty and healthy breakfast. About 68% of the bread items included in the tasty breakfasts were refined, whereas only 32% were high-fiber breads (whole-wheat or rye breads), which supports the idea that children prefer the taste of refined bread. Since repeated exposure

helps build acceptance of foods by children [119], whole grain foods may need to be offered several times over an extended period of time.

Introducing whole grain foods to children

Research suggests infants and children need at least 8 and as many as 15 taste exposures to a food before preferences for that item increases [124-126]. This suggests that the type and level of whole grain flour used in products will allow students to become more accustomed to whole grain foods. It is not desirable to risk the introduction of new foods that may exceed an acceptable sensory level and potentially hinder students from wanting to try a new whole grain food again.

Several studies have investigated preferences for red whole wheat products compared to white whole wheat products. Lukow et al. [127] used sensory tests to examine preference for breads made with white whole wheat flour compared to red whole wheat flour. They found that the ratio of children that preferred the pan bread made with lighter colored 100% white whole wheat flour for appearance was two and one-half times higher compared to the bread made with darker traditional 100% red whole wheat flour. Twice as many children also preferred the taste of bread made with white whole wheat flour as opposed to bread made with red whole wheat flour. Camire et al.[128] also used sensory tests to evaluate the acceptance of products made with different types of flour based primarily on color with adults. Four types of flour were used to bake mini muffins; traditional (red) whole wheat, white whole wheat, all-purpose (refined), and caramel-colored all-purpose (refined). There were no differences found in acceptability of any attribute among muffin types based on color, appearance, flavor,

texture, and overall quality. However, after subjects were informed about the type of flour used in the muffin subjects were once again asked to rate each of the products for overall acceptability and healthiness. The second rating resulted in the red whole wheat muffins having the highest ratings followed by the white whole wheat flour, colored all-purpose and all-purpose, respectively. Overall acceptability decreased significantly for the all-purpose flour, while healthy ratings for the white wheat flour increased the most. This suggests that color did not have a significant impact on consumption with adults until after they were informed of flour content. Children may have a rudimental approach when it comes to food preferences in bread and use color as a factor as seen previously. However, if health messages were included in studies such as Camire et al. [128] , it is not known if the results would have changed. Future sensory studies should examine health messages related to color and food preferences of whole grain foods in children.

Preliminary studies have examined the influence of using various types and levels of whole grain flour in a variety of grain-based foods in elementary schools in the Minneapolis / St. Paul area. Pizza is an ideal food to deliver whole grains as the cheese and sauce mask most characteristics in whole grains that may make the food unacceptable to children. One slice of pizza made with a 50:50 blend of white whole wheat to refined wheat flour can provide about one-serving of whole grain. Chan et al. [129] showed no difference in liking for pizza crust made with refined flour compared to the pizza crust made with the 50:50 blend white whole wheat flour with elementary children (grades 1^{st} through 6^{th}).

In another study by Schroeder et al. (submitted) cheese pizza and French bread were also made with a 50:50 blend of red or white whole wheat flour and 50% refined

wheat flour. Results showed that pizza crust made with whole red or whole white wheat flour was consumed at similar levels (around 70% consumption per plate waste). However, overall consumption of French bread made with a 50:50 blend of red whole wheat or white whole wheat and refined wheat flour was consumed at a relatively low level (~45%) at two different schools. Therefore, in order to successfully increase whole grain consumption in elementary school children, it may be necessary to select a familiar and popular food, and adjust the product ingredients to include a certain type and level of whole grain flour content.

Adaptation approach to change food preferences in children

An adaptation approach would implement a series of undetectable steps resulting in a desired product change that would enhance the liking for the new product (possibly predisposing one to a preference for the new product) without adversely affecting consumption. The current literature does not document any adaptation approaches related to whole grain consumption in any population. However, there is some evidence that food companies have used gradual approaches to secretly change food products. Coca-Cola® apparently used a step-wise approach in the 1960s to reduce the amount of caffeine in Coke [130]. There is also speculation that food products were reformulated gradually to improve their nutritional profiles when the FDA started requiring manufacturers to list fat and sodium on food labels. Dubow and Childs [130] mentioned that this gradual approach was used by one major canned goods and one salty chip manufacturer in response to the new labeling requirements. This is the only mention of a gradual approach reported on a population-wide basis.

Previous research has investigated approaches to increase consumption of non-preferred food items in small samples in special populations by serving [131] and blending [132] or fading [133] nonpreferred foods with preferred foods. Piazza et al [131] compared the difference between two food presentations; simultaneous and sequential, to increase consumption of nonpreferred foods for three children with food selectivity. Mueller et al. [132], on the other hand, examined a blending treatment consisting of mixing nonpreferred food into preferred foods in various ratios (e.g., 10% nonpreferred/90% preferred, 20% nonpreferred/80% preferred) for 2 participants with sever food refusal. Patel et al. [133] experimented with a fading procedure to increase caloric-dense fluid consumed by a 6-year-old child with feeding problems. The fading procedure consisted of adding Carnation Instant Breakfast and then milk to water, a fluid the child would drink. Although increased consumption was reported for the nonpreferred foods, these studies were limited to individual cases and special populations. However, these cases suggest that nonpreferred foods may be increased in combination with preferred foods and may serve as an approach to increase nonpreferred foods in the general population.

Flavor-Flavor Conditioning

The Pavlovian flavor-flavor associative learning or flavor-flavor theory is one explanation for the development of food likes and dislikes [134]. Flavor-flavor learning occurs when a nonpreferred flavor is paired with a naturally preferred flavor in the hope that the preferred flavor will transfer to the disliked food. The naturally preferred flavors are called unconditioned stimuli, while the new flavor is a conditioned stimulus. The

effectiveness of this strategy has been demonstrated by Zellner et al. [135] who found that liking for tea could be increased by adding sugar. In addition, the liking for tea was maintained even when served without sugar. The same effect has been observed with the addition of sugar to vegetables. For example, Havermans & Jansen [136] reported a positive shift in preference for vegetable taste being paired with the sweet taste of dextrose among preschool children even after the dextrose was removed from the vegetables. Therefore, flavor-flavor learning may potentially contribute to children's liking of foods that are otherwise less accepted, such as foods with high levels of whole wheat flour.

A gradual introduction of whole grain foods

The incorporation of low levels of whole wheat flour into a variety of grain-based foods may serve as a tool to develop products that meet consumer taste profiles and yet provide a meaningful (significant) level of whole grain in the U.S. diet. Marquart et al.[137] used a theoretical model to speculate on the possible increase of whole grain in a diet based on a gradual incorporation of whole grain flour into grain-based products. Using previous data from the Iowa Women's Health Study, the incorporation of whole grain flour into a variety of grain products, having indiscernible effects on taste and texture, would increase servings from 2.0 to 3.3 (~60% increase). In other groups that currently eat more refined grain foods, the effect of adding small amounts of whole grain flour to many grain foods would be even larger on a percentage basis. Although whole grain consumption for refined grain eaters would increase, this level would most likely be lower than three servings of whole grain a day. However, small incremental changes may

be one approach to increase the liking for the nonpreferred flavors associated with whole wheat products.

More recent data from the USDA's summary for School Nutrition Dietary Assessment study III (SNDA-III) still indicated minimal exposure of whole grain foods with only about 5% of school lunch menus offering foods made from whole grains [138]. In addition to the minimal exposure to whole grains in the school, other internal and external factors may be affecting the consumption of whole grains in the school meal.

Factors affecting food intake at eating occasions

Factors affecting eating behavior

In today's world the amount eaten in any given eating episode may depend less on internal needs and more on environmental contextual factors (ambience). It is thought that the process of satiation can easily be disrupted by variety effect (different foods introduced in a meal), social context (presence and number of companions), and distractions (competing tasks) [139]. This ambience, which is underestimated, may have a major influence on eating behavior and should be included and emphasized in more nutrition-related research in the real-world context [140].

The Analysis Grid for Environments Linked to Obesity (ANGELO)[141] was developed for the investigation of obesogenic environments. ANGELO has two axes. The first includes a micro and macro environment. The second axis distinguishes four "types" of environments: physical, economic, political, and sociocultural. The sociocultural environment refers to the subjective and descriptive norms and other social influences such as social support for the adoption of healthy behavior and social pressure

to engage in unhealthy habits. These attitudes, beliefs, and values related to food and physical activity can be influenced by gender, age, ethnicity, traditions, religion, and sub group affiliations which can also have a powerful effect on the behavior of individual members in the community group. These environmental factors all contribute to the overall cultural norms and individual experiences during eating occasions.

Until recently research investigating food preferences in diverse populations has dedicated inadequate attention to cultural factors [142]. However, a few studies have investigated differences in cultural eating practices between countries, such as France and the U. S. Rozin et al[143] investigated potential reasons as to why the French are leaner than Americans. Three methods were used to examine cultural differences between the cities of Paris and Philadelphia: on-site observations with comparable or identical restaurants with similar neighborhoods; prices and foods, portion sizes in restaurant guides; and portion sizes in cookbooks. Results indicated that for all three methods American food portions were approximately 25% larger than French portions. In addition, the French spend more time eating. Mean time spent eating and sitting at McDonald's was 22.2 (±9.6) min in France compared to 14.4 (±6.3) min in the United States. Although the French eat less than Americans, they seem to eat for a longer period of time, and hence have more food experience. This illustrates the French can have their cake and eat it too. Wansink et al. [144] investigated whether people who use internal cues to determine satiation when eating a meal are likely to weigh less than people who instead rely on external cues. Subjects included 133 adults from Paris and 145 adults from Chicago who completed a brief survey on meal cessation that asked the extent to which they agreed with statements associated with internal cessation cues and external

cessation cues. Results indicated that overweight individuals were more likely to use external cues compared to normal weight individuals (5.8 vs. 5.3; $p < 0.043$) to determine when they were finished with a meal and less likely to use internal cues (3.7 vs. 4.3; $p < 0.005$). On the other hand, the French were more likely to report food behaviors that suggested that they used internal cues of meal cessation rather than external cues of meal cessation (6.6 vs. 4.9; $p < 0.001$). Therefore to truly understand eating behaviors in America a novel concept is to embrace theories which include the chaos and complex adaptive system [145, 146] in addition to the established cognitive theories.

Health behavior change theories, including nutrition and physical activity behavior, have been rooted in a cognitive-rational paradigm, where a linear relationship has been assumed between psychosocial predictors and behavior. However a model such as this fails to account for non-linear, quantum influences on human thought and action. An alternative view is that decisions to initiate and possibly maintain behavior change are not linear events but quantum which can be defined as two types: epiphanies and insightful [147]. Based on this perspective, behavior change can be understood through the lens of Chaos Theory and Complex Dynamic Systems. Four principles from these theories relevant to understanding health behavior change include: “1) Chaotic systems can be mathematically modeled, usually in non-linear terms, but are nearly impossible to predict; 2) Chaotic systems are sensitive to initial conditions (usually involve a quantum event); 3) Complex Systems involve multiple component parts that interact in a nonlinear fashion; and 4) The results of Complex Systems are often greater than the sum of their parts” [145, 146]. A combination of the linear progression theories and chaotic theories may act in a complementary manner in the goal to understand behavior change, since the

linear paradigm "error" may represent the chaotic component. Therefore the linear and chaotic paradigms may not be mutually exclusive and behavior change may include both chaotic and cognitive processes. Therefore nonlinear concepts should be incorporated into research design and embraced. Resnicow & Page reported established qualitative and quantitative research methodologies can be applied to examine the extent to which chaotic and quantum process influence health behavior changes [145].

For that reason conducting direct observation in “chaotic” environments along with psychosocial variables and focus groups are warranted to elicit an enhanced understanding of the complex interaction of the various factors including cultural parameters that may influence eating behavior.

Meal observations

Many techniques including 24-hour recalls, food records, food frequency questionnaires, and direct observations have been used to assess dietary intake of school-aged children [148, 149]. Direct meal observations are considered preeminent compared to other dietary assessment methodology because the method is valid, practical, capable of quantifying intake, and avoids recall bias by subjects [148-150]. Challenges inherent to this method include adequate consistency among multiple recorders, cost, recording intake of children who do not eat the school meal and limitations to the number of children that can be observed simultaneously [149, 150]. In addition the direct observation method requires the use of a standardized protocol and extensive training prior to data collection to assure a high-degree of accuracy [151]. Sources of error may include lack of attention by research staff while observing children and inaccurate

recording of the types and/or amounts of foods consumed [151]. To alleviate error between observers, Simons-Morton and Baranowski [151] recommend the use of interobserver agreement assessments (IOR) defined as “two simultaneous observations on identification of foods or amounts of each food eaten by a subject.” Adequate level of agreement for IOR have been established at > 85% [152, 153]. With the advancement in audio/visual technology researchers are investigating alternative methods to examine meal intake.

Two recent methods to more carefully observe and analyze meal situations include digital photography and video recording of meals. Digital photography was studied in elementary [154] and college[155] cafeterias. Results indicated that digital photography of meals can be a practical, highly accurate, and cost-effective way to measure actual meal consumption [154, 155]. Video recordings, a technique similar to direct observation, have also been used to reliably distinguish patterns of interaction in children [3, 4, 156-159]. However these studies have been limited to comparing children with chronic illnesses to healthy controls but in a controlled family meal setting.

Stark et al. [159] investigated calorie intake, behavioral eating styles, and parent perception of eating behaviors with school-aged children with cystic fibrosis (CF) compared with healthy peers. Subjects included 28 families with CF preschool children (ages 6-12 years) and 28 families with healthy peers matched for age and socioeconomic status. Family meals were video recorded during 3 dinners. Additionally parents kept a weighed 3-day food record for the child(ren) and filled out an Eyberg Child Behavior Inventory following the dinner recordings. Heights and weights were also measured. Dinner meals were scored for meal duration, number of bites per minute, calories per bite,

and percent of intervals with bites. Results indicated that CF children spent more time eating (24.56 min vs 17.34 min) and consumed more daily calories (2175 cal vs. 1875 cal) than the control children. Despite the longer eating time, CF children had a significantly slower pace of eating (43.27% of 10-second intervals with bites) compared to control children (51.29% of 10-second intervals with bites). Responses regarding problem behaviors indicated that parents of children with CF rated mealtime problems more intensely than parents of control children. Stark found similar results in preschool children [158]. The authors concluded that increased calories were not without cost because the CF children spent an additional 7 minutes eating and ate at a slower pace than the healthy individuals. Additionally, there appeared to be higher intensity ratings of mealtime behaviors and parent perception of CF children's eating behaviors that contribute to CF children's failure to meet their higher dietary recommendations by parents with CF children compared to parents of healthy control children. The authors concluded that individualized assessment of energy needs for children with CF and comprehensive programs that teach parents behavioral strategies to motivate their children to meet these higher energy requirements in an adaptive manner are warranted [158, 159].

Stark et al. [4] then investigated mealtime behaviors in families of children with CF. Subjects included 32 families with CF children (age range 2 to 6 years) and matched 29 control families. Family meals were recorded 3 to 6 times until 3 representative meals were achieved. The DINE was utilized which consists of 3 categories of behavior: parent behavior, child behavior and child eating. Results indicated children with CF engaged in more behaviors that deterred eating than control children. Parents of both children with

and without CF showed a significant increase in parental behaviors in the second half of the meal compared with the first half. Additionally children with CF and control children showed an increase in behaviors not-compatible with eating during the second half of the meal compared with the first half. Faster eaters were compared with slower eaters. Results indicated that faster eaters consumed more energy and tended to be at higher weight percentiles for age and sex regardless of group (CF or control) than slower eaters. The authors concluded there were no differences between groups among parents or children in the rate of behaviors exhibited or types of strategies used to encourage eating. However, children with CF and their parents engage in these behaviors more frequently. Additional support in the form of child behavior management training may be necessary to assist parents in meeting the child's caloric requirements.

Patton et al. [156] conducted a similar study with 26 families of pre-school children with type 1 diabetes and 26 families with age-matched healthy controls. Each family was video recorded 3 times in their home which was then coded using DINE. Results indicated no difference in parental or child behaviors at mealtimes between families with a type 1 diabetic child versus controls. Similar to previous research, children ate less (fewer bites) and engaged in more behaviors incompatible with eating during the second half of the meal compared to the first half. Independent of group, children who took more time to eat (> 20 min) were less likely to reject food but played more during the meal than children who ate their meal within 19 minutes. Additionally children in both groups took more bites and sips during fast meals compared to slow meals. Authors concluded that although parental concerns increase with pre-school children with type 1 diabetes, there were no differences between mealtime behaviors of

children with type1 diabetes compared to apparently healthy controls. However, interventions to teach effective strategies for managing problematic behavior to alleviate parental concerns may be necessary to improve diet adherence.

Patton et al. further investigated the relationship between parent-child mealtime interactions and dietary adherence and glycemic control in young children with type 1 diabetes [157]. Subjects included 35 families of children (ages 2.2 to 7.9 years) with type 1 diabetes. Families had at least 3 meals videotaped in their home and analyzed using the DINE. Results indicated that a positive correlation existed between disruptive child behaviors and the number of carbohydrates not consumed. Children who were disruptive during meals had poorer average daily blood glucose levels. Furthermore parent behaviors revealed significant positive correlations between parents' use of ineffective/coercive parenting strategies and children's dietary deviations and glycemic control. The authors concluded that mealtime problems could be improved by behavioral interventions.

Although some research has been conducted to investigate behavioral patterns exhibited during a family meal with chronically ill children; to date we are not aware of any research that has used video recording of behavioral patterns during school meals with healthy children. However, it seems prudent that many of these strategies related to eating and behaviors using DINE can be extrapolated into new environments to investigate innovative approaches for currently existing and new products.

Summary and specific aims:

Rationale

Based on this review of literature, whole grains are consumed by children far below the recommended levels established by U.S. dietary guidance. Research suggests that a higher consumption of whole grains may reduce risk for certain chronic diseases. Therefore it would be beneficial to increase whole grain intake among children in the U.S. However, some innate attributes of whole grains may be potential barriers for children. Many studies have investigated methods to increase consumption of nonpreferred foods, psychosocial factors that affect intake of various foods, and valid techniques to assess dietary intake. However, to date, few studies have investigated these approaches and techniques regarding whole grain consumption among healthy school-aged children. Therefore the proposed studies will seek to further our understanding in the area of whole grain foods, by investigating the acceptability and dietary assessment of whole grain intake among children in a school environment through various innovative procedures.

Research Objectives and Hypothesis

The entire project entailed three studies which included both qualitative and quantitative research. The purpose of the first study was to examine the feasibility of gradually introducing whole grain foods into a school lunch program. The purpose of the second study was to investigate psychosocial variables associated with whole grain intake of pre-adolescents. Finally the third study used an innovate method involving video recordings to investigate children's eating behaviors associated with the consumption of

whole grain foods during a typical school lunch to identify relationships or patterns in the consumption of various whole grain items.

The specific study objectives and hypothesis for each project are listed below:

Study I: Gradual incorporation of whole wheat flour into bread products for elementary school children (August 2005 to June 2006)

Objective 1:

To gradually increase the levels of red and white whole wheat flour in bread products over the course of a school year to determine if consumption by school children differed by whole grain content, bread type, and menu category based on accompanying foods.

Hypothesis 1:

Consumption may be affected by the whole grain content, bread type, and menu category over the course of a school year.

Study II: Association between whole grain intake and psychosocial variables among elementary children. (January 2006 to May 2006)

Objective 1

To develop a questionnaire to assess potential psychosocial variables that may be associated with whole grain intake by children.

Objective 2

To determine associations between whole grain intake and potential psychosocial variables.

Hypothesis 1:

Based on the psychosocial questionnaire, children with a higher consumption of whole grains assessed by 24-hour recalls will have a higher preference for whole grain products, more positive outcome expectancies related to whole grains and more confidence in their ability to consume whole grain foods in difficult situations.

Hypothesis 2:

Based on the psychosocial questionnaire, children with more access to whole grain products assessed with a parent home inventory form will have higher preference for whole grain products, more positive outcome variables related to whole grain and more confidence in consuming whole grain foods in difficult situations.

Hypothesis 3:

Based on the psychosocial questionnaire, children with higher preference for whole grain products will have more whole grain products in their homes as evaluated by the parent inventory.

Study III: Video observations of elementary school meals-Implications for whole grain eating behaviors.

Objective 1

Determine behavioral patterns associated with eating whole grain foods such as frequency of bites, frequency of sips and overall consumption.

Objective 2

To examine children's acceptance of whole grain products served during school lunch through the use of focus groups.

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Chapter II: Gradual incorporation of whole wheat flour into bread products for elementary school children improves whole grain intake

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Abstract

Purpose: Whole grain intake is associated with health benefits but current consumption by children is only about one-third of the recommended level. The purpose of this study was to test the feasibility of an innovative approach whereby the whole wheat content of bread products in school lunches was gradually increased to increase whole grain intake by children.

Methods: A convenience sample included children in K-6th grade from two elementary schools in a Midwestern city. Whole red and white wheat flour content of buns and rolls served twice weekly was increased from 0% to 91% in 16 and 7 incremental levels, respectively over the school year. Red wheat products were served in one school and white wheat products in the other. Plate waste methods were used on a whole school basis to estimate consumption. ANOVA procedures were used to determine whether whole grain and modified bread product intake differed by level of whole wheat flour and menu entrée category.

Results: Mean consumption of whole grain (g/child) increased as the level of red and white whole wheat flour increased in modified bread products. Consumption of modified bread products did not differ statistically from baseline (0% whole grain flour) until the 72% level for red and 67.5% level for white wheat was served. Consumption of buns and rolls varied with type of accompanying menu items regardless of wheat type or level.

Application to Child Nutrition Professionals: A gradual increase in whole wheat content in menu items resulted in favorable whole grain consumption by children. This approach may allow school foodservice directors to gradually introduce acceptable whole grain products into school menus.

Introduction

Recent reviews of scientific evidence indicate that whole grain intake reduces the risk of various chronic diseases such as coronary heart disease (Flight & Clifton, 2006; Jacobs & Gallaher, 2004; Mellen, Walsh, & Herrington, 2008; Seal, 2006) and type 2 diabetes (Kaline, 2007; Priebe, van Binsbergen, de Vos, & Vonk, 2008; Qi & Hu, 2007). Recent U.S. national dietary intake data, Continuing Survey of Food Intake by Individuals (CSFII) 1994-1996, showed that children and adolescents 6-19 years of age consumed 0.8-1.0 mean servings of whole grain products per day (Harnack, Walters, & Jacobs, 2003). These levels are only about one-third of the amount recommended by U.S. Dietary Guidelines for Americans, 2005 (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2005).

School nutrition services can play an important role in facilitating an improved intake of whole grain foods by offering children more whole grain bread products through school meals. However, some attributes of whole grain products present challenges in increasing intake of whole grain foods by children. Most whole grain bread products, particularly yeast breads are made with red whole wheat flour which generally produces a darker colored product and a bitter taste compared to refined grain foods (Atwell, 2002). Focus group results with children indicated that familiarity, appearance and the taste of new foods such as whole grain foods were important factors that influenced acceptability (Burgess-Champoux, Marquart, Vickers, & Reicks, 2006). The genetic variation in sensitivity to bitterness is thought to play a role in the acceptance and rejection of bitter-tasting vegetables (Bell & Tepper, 2006; Cowart, 1981) and may play a

role in whole grain acceptance as well based on the bitter taste of some whole grain products (Atwell, 2002).

To address the potential issue of bitterness and appearance of whole wheat foods, wheat products made with white whole wheat have recently been introduced. The lack of darker pigment in the bran portion of white whole wheat flour is mainly responsible for the lighter color of these grain products (Atwell, 2001). While the color may differ, red and white whole wheat flours have similar macro- and micronutrient content (Syms & Cogswell, 1991). Similar to red wheat, white wheat has a high protein content, strong gluten and high water absorption which makes it a good choice for breads and related products (Atwell, 2001). Children preferred bread made with 100% white whole wheat flour two and one-half times more for appearance and two times more for taste compared to bread made with 100% red whole wheat flour (Lukow, Guinard, & Adams, 2004). Preliminary studies by Chan, Burgess-Champoux, Vickers, Reicks, and Marquart (2008) showed that serving school children pizza crust made with a 50:50 blend of white whole wheat and refined flour resulted in consumption levels similar to those observed when pizza crust made with 100% refined wheat flour was served. Limited studies have evaluated the acceptance of products made with red and white wheat. Further studies are needed to incorporate grain products made with red and white whole wheat into the school meal setting.

Gradual modifications in product formulations have been made successfully by food companies over time (Dubow & Childs, 1998). This gradualist approach to improving nutritional quality of food products has been referred to as “stealth nutrition” (Spittler, 2007) and represents an approach that parents and school foodservice personnel

may find acceptable to improve diet quality of children. Examples include a step-wise approach in the 1960s to reduce the amount of caffeine in Coke and gradual reductions in sodium and fat in canned goods and savory snack products (Dubow & Childs, 1998). No reports in the literature document the effectiveness of a systematic approach to gradually incorporate higher levels of whole grain into products to allow consumers to adapt to the variations in taste, texture and appearance.

The objective of this study was to test the feasibility of incrementally increasing the levels of red and white whole grain flour in bread products over the course of a school year to determine if whole grain intake increased as red or white whole wheat flour content increased, and differed by menu category based on accompanying foods.

Methodology

Subjects

Participants were Kindergarten through 6th grade children from two suburban elementary schools (selected by the district food service administration) having a total student population of approximately 600 students each in a large Midwestern metropolitan area. The schools had fairly equal numbers of boys and girls. In both schools, about one-fifth were minority children and one-fifth were eligible for free or reduced price school meals. The school district research committee and the University of Minnesota Institutional Review Board approved the study.

Procedures

Modified red whole wheat products were served in one school and modified white whole wheat products in the other. A preliminary study used difference threshold testing

to establish the concentrations (levels) of red and white whole wheat flour as a percentage of the total flour content used to prepare the bread products (Delk & Vickers, 2007). Trained adult panelists (n=25) made judgments through ascending forced-choice tests; where the threshold step level was determined when 50% of the subjects could detect a difference based on the color, texture and taste of the sample rolls. Test results established 15 levels between 0 and 91% for products made with red whole wheat flour and 7 levels between 0 and 90% for products made with white whole wheat flour. Because participants could more easily detect differences in levels for products make with increasing concentrations of red whole wheat flour (possibly due to the color), there were more levels for these products than for those made with white whole wheat flour.

Bread products (buns-2 oz and dinner rolls-1.5 oz) were prepared by a local bakery (Great Northern Bakery, Minneapolis, MN) based on a method adapted from Finney (Finney, 1984) and a recipe provided by the bakery. Quantities of whole wheat flour used to make bread products to the specified levels were measured to the nearest 0.001 grams on scales calibrated weekly. The level of refined flour decreased and the amount of water increased as the level of red or white whole wheat flour was increased as a percentage of the total flour content of the products. The concentrations of all other ingredients were held constant except that gluten was increased as the levels of whole wheat flour increased. To maintain optimal quality, hamburger buns were baked, sliced, and frozen about two weeks prior to delivery to the school on the day they were served. Rolls were prepared as frozen shaped dough pieces, then thawed, proofed and baked at the school on the day they were served.

For the first two weeks of the 2005-2006 school-year, a baseline level of consumption was established by serving buns and rolls made with 100% refined wheat flour as a percentage of the total flour content of the product. Bread products prepared at each subsequent level of red and white whole wheat flour were served an average of 3.8 times and 7.6 times, respectively. Based on the school district menus, modified bread products were substituted when rolls or hamburger buns were already being served. Buns were typically served as part of the main dish for a meal while research staff placed the roll on the child's tray to make sure that children were exposed to these products. Acceptance was monitored throughout the study by examining consumption (based on plate waste) at each level. Products made with the next incremental level of whole grain flour were served if overall consumption did not fall below 75% of values observed at baseline when products containing no whole wheat flour were served.

Each time the bread products were served over the course of the school year, the weight of the product served was calculated by multiplying the mean weight of 10 conveniently selected product samples by the total number served to children. Trained observers were present in the school cafeteria to help children discard uneaten bread product waste at the end of the meal. The amount consumed was calculated as a percentage of the difference between the amount discarded and the amount served based on an actual count of the buns or rolls served daily (Comstock & Symington, 1982). The amount consumed was corrected to account for the weight of residue such as condiments and sandwich fillings remaining on the buns. Intake of whole grain (g/child) from the modified bread products was determined based on calculations using Nutrition Data System for Research software (Nutrition Coordinating Center, University of Minnesota,

2006) to determine whole grain content of bread products. Together with bread product consumption data derived from plate waste data, grams of whole grain consumed per child were calculated.

Data analysis

Consumption data were analyzed as grams of whole grain consumed per student and as percentage of modified bread products consumed based on the difference between the amount served and the amount collected as waste on a school wide basis. Prior to data analysis, consumption data were tested for normality and found to be normally distributed. One-way ANOVA (Statistical Analysis System, SAS Institute, Cary, NC, Version 9.1, 2002-2003) was used to determine if mean whole grain consumption (g/child) differed according to the level of whole wheat flour in the products. ANOVA was also used to compare differences in consumption of bread and rolls on a school wide basis according to level of whole wheat flour in the bread products. Observations from lower levels were collapsed into one value (pairs) to increase the number of observations per level. Differences in consumption were also examined by bread type (bun or roll) and 5 menu entrée categories based on characteristics of the entrée. These categories included: 1) bun served with a meat patty; 2) bun served with a meat mixture; 3) roll served with a meat or cheese/pasta dish; 4) roll served with a breaded piece(s) of meat or fish; and 5) roll served with a plain meat item and gravy. The level of significance was set at $p<0.05$.

Results and Discussion

As the content of whole wheat flour was gradually increased in bread products over the course of the school year, the mean grams of whole grain consumed per child

increased from 0 to 12.9 grams and 10.7 grams for red and white wheat products respectively (Table 1). These results indicated that whole grain consumption per child met almost one full serving of whole grain according to the school food service requirement (14.75 grams) (U.S. Department of Agriculture-Food and Nutrition Services, 2001).

Mean consumption of buns and rolls at the baseline for both schools (0% whole wheat) was ~75% (Table 2). Intake of bread products did not differ significantly from the baseline level up to the 59% level of red whole wheat and 45% level of the white whole wheat. The consumption of products made with 72% and 91% for the red whole wheat flour and the 67.5% and 90% levels for white whole wheat flour was significantly lower than intake at the baseline level (Table 2). The range of consumption for dinner rolls made with red whole wheat flour was 57% to 77% while white whole wheat flour was 50% to 78% (Table 2). Buns were not served enough times at each level to compare bun consumption to the baseline level. However, the range of consumption for buns throughout the school year for red whole wheat was 51% to 67% and 54% to 67% for white whole wheat (data not shown).

Consumption of the bread products was also compared based on 5 entrée categories. Mean consumption of all bread products containing red and white whole wheat flour when served in the 5 menu entrée categories ranged from ~56% to 74% and 55% to 69% (respectively) (Table 3). Buns served with a patty (such as hamburger or chicken), rolls served with pasta/sauce, and rolls served with sliced meats/gravy were consumed in amounts significantly higher than buns served with mixed meat (such as sloppy Joes and BBQ pork) and rolls with breaded meat (such as chicken nuggets and

shrimp poppers). It is possible that the flavor of whole wheat was masked by bun fillings and condiments while rolls were generally consumed plain. In support of this concept, others have shown that for a trained panel, a combination of tomato sauce and soy protein caused a suppression of the bitter, harsh and astringent tomato flavors and that the soy protein flavor was less distinguishable (McDaniel & Chan, 1988). Stevens (1996) quantified the conditions for taste masking based on the strength of one taste (masker) and the concentration of the masking target. While it doesn't appear that this quantification has been done for masking the bitter taste of whole grain with other flavors, it may be important to complete these studies to assist in menu planning in schools. Another factor that could have contributed to acceptance of the modified bun product was that it was always served as part of the entrée and the entrée food group has been shown to be consumed at a high level by children in school meals in the past (Getlinger, Laughlin, Bell, Akre, & Arjmandi, 1996).

Previous research has applied Pavlovian flavor-flavor associative learning or flavor-flavor theory to explain changes in liking for specific foods (Rozin & Zellner, 1985). Flavor-flavor learning occurs when a nonpreferred flavor is paired with a naturally preferred flavor to enhance liking for the nonpreferred flavor. The effectiveness of this strategy has been observed in several studies based on serving a preferred food with a nonpreferred food (Piazza et al., 2002); blending a preferred food with a nonpreferred food in various ratios (Mueller, Piazza, Patel, Kelley, & Pruett, 2004); or fading which is a varaition of blending with more than one food (Patel, Piazza, Kelly, Ochsner, & Santana, 2001). Although these studies were limited to one to two children with extreme eating disorders, extrapolating from these cases would indicate that blending of

nonpreferred flavor (whole grain flour) with preferred flavor (refined flour) may be a potential approach to increase consumption of whole grain foods in the general population.

The manner in which preferences for foods are developed in children and modulated is thought to be based on long-term repeated exposure (Liem & de Graaf, 2004). In the current study, repeated exposure to bread products at each level of red whole wheat flour was minimal (ranging from 3-4 exposures) but the long-term exposure to products containing whole wheat flour was extensive (9 months). This long term repeated exposure through school meals may have been helpful in facilitating increased whole grain intake.

With repeated exposure, the modified bread products may have become more familiar to children. A recent study by Cooke, Carnell, and Wardle (2006) showed no association between intake of bread rolls by 4-5 year old children and scores on a food neophobia scale indicating that bread rolls are considered familiar foods that children are not reluctant to taste. According to U.S. CSFII data (1994-1996), one of the major food sources of whole grains for children and adolescents were yeast breads accounting for about 20% of intake (Harnack et al., 2003). These promising aspects related to bread intake by children provide support for a better understanding of factors that might affect intake of whole grain bread within a school meal. In the current study, rolls served with breaded meats were consumed at lower levels compared to buns and rolls served with other menu items. This raises the possibility that the moisture content of the accompanying food may affect intake of bread products consumed as part of a school

meal. However, research focusing on the moisture content of one food and its effect on consumption of other school meal components has not been reported in the literature.

The limitations of this study include a small convenience sample from two elementary schools in a Midwestern suburban area thus limiting the potential to generalize to other students in a broader geographic area. Data from this study indicated that a gradual incorporation approach was feasible to increase whole grain intake by children and therefore additional replication studies are needed with a more rigorous controlled experimental design. Although having adults establish the difference threshold levels could be considered a limitation, adults can more accurately detect difference in products based on color, texture and taste.

Conclusions and Application

A gradual increase in the red and white whole wheat flour content of bun and roll products served in a school lunch program increased whole grain consumption by school-aged children over the course of a school year. However, based on the results of this study, whole grain bread products for school meals may be more acceptable with a total whole grain flour content approaching 75%. This may be a more feasible approach than serving bread products made with whole wheat flour as 100% of the flour content.

The incremental levels of whole wheat flour used in the current study were based on difference threshold testing by trained adult panelists regarding the color, texture and flavor of sample rolls (Delk & Vickers, 2007). It was thought that making the transition between levels as transparent as possible would enhance acceptability at each incremental level. The ability to discriminate between levels based on color, texture and flavor

differences was greater for the red whole wheat products compared to the white whole wheat products in part because of the larger bran particle size and darker color resulting in a greater number of incremental levels. Sensory panelists in a previous study rated bread crust as smoother and texture as less gritty when the bread was made with bran of a finer particle size (Zhang & Moore, 1999). Bread made with white wheat bran was also rated as having better flavor and mouthfeel compared to bread made with red wheat bran. These findings are important as they indicate that replication studies in school feeding programs should be designed to optimize liking of bread products for children based on color, texture and flavor.

School food service professionals are encouraged to implement guidance from the Dietary Guidelines for Americans, 2005 regarding whole grain intake in school meal programs. To address this guidance, the amount and variety of whole grain products offered to students should be increased within the limitations of cost and group feeding situations. The gradual introduction of either red or white whole wheat flour into familiar grain products represents a novel, feasible approach to increase the amount and variety of whole grain containing products in school meals.

Additional research is needed to assess the influence of taste masking by accompanying food items, flavor-flavor learning based on the ratio of refined and whole wheat flour, effects of repeated exposure and transparency of the transition between levels according to type and particle size of whole wheat. Because intake by children is largely driven by food preferences, it will be important that the quality and acceptability of whole wheat products meet the expectations of students so whole grain consumption is increased in schools. From a management and economic perspective, it may not be

feasible to allow for a transparent transition between levels in many schools. A more practical approach may need to be implemented with fewer levels (25%, 50% and 75% whole wheat flour) over the course of a school year. This may allow school foodservice directors to gradually introduce acceptable whole grain products into school menus and more closely meet student taste profiles. During menu planning, it may be important to consider how the overall meal taste/texture/moistness and quality is affected by the combination of whole grain and other accompanying foods.

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Table 1. Mean whole grain consumption - grams per child[1]

Level of red whole wheat flour (% of total flour content)	Mean whole grain consumption - g per child (times served)		Level or white whole wheat flour (% of total flour content)	Mean whole grain consumption - g per child (times served)
0	0 [a] (5)		0	0 [a] (7)
1	0.2 [ab] (3)		11	1.5 [b] (7)
2	0.3 [ab] (4)		23	3.5 [c] (8)
5	0.8 [ab] (4)		32	4.1 [c] (5)
7	1.1 [ab] (3)		45	6.2 [d] (7)
10	1.5 [ab] (4)		67.5	7.7 [e] (12)
14	2.2 [bc] (3)		90	10.7 [f] (7)
21	3.6 [cd] (4)			
26	4.2 [de] (4)			
32	5.6 [e] (5)			
38	5.7 [de] (4)			
47	5.8 [e] (4)			
59	8.6 [f] (5)			
72	10.0 [f] (5)			
91	12.9 [g] (8)			

[1]Values not sharing the same superscript letters are significantly different ($p<0.05$ according to GLM procedure).

Table 2. Percent consumption of bread products made with whole red and white wheat [1]

Level of red whole wheat flour (% of total flour content)	Consumption[2] (%) for all products (times served)	Consumption[2] (%) for rolls (times served)		Level of white whole wheat flour (% of total flour content)	Consumption[2] (%) for all products (times served)	Consumption[2] (%) for rolls (times served)
0	73 ± 7^{a} (5)	76 ± 5^{ab} (4)		0	74 ± 8^{a} (7)	78 ± 6^{a} (5)
1-2	64 ± 17^{ab} (6)	77 ± 10^{a} (3)		11	66 ± 14^{ab} (7)	78 ± 5^{a} (1)
5-7	71 ± 11^{ab} (6)	75 ±12^{ab} (4)		23	66 ± 6^{ab} (8)	68 ± 6^{a} (3)
10-14	70 ± 10^{ab} (6)	75 ± 9^{ab} (4)		32	66 ± 13^{ab} (5)	74 ± 3^{a} (3)
21-26	70 ± 10^{ab} (7)	73 ± 10^{ab} (5)		45	68 ± 5^{ab} (7)	68 ± 6^{a} (3)
32-38	69 ± 8^{ab} (7)	71 ± 7^{abc} (4)		67.5	57 ± 9^{b} (12)	51 ± 5^{b}(5)
47-59	65 ± 6^{ab} (7)	64 ± 7^{abc} (5)		90	59 ± 10^{b} (7)	50 ± 5^{b} (3)
72	60 ± 10^{b} (6)	62 ± 11^{bc} (4)				
91	59 ± 7^{b} (8)	57 ± 8^{c} (5)				
p-value	0.12	0.02		p-value	0.009	<0.001

[1]Values with different superscript letters in the same column are significantly different ($p<0.05$).

[2]Consumption was calculated by taking the total weight of product served and subtracting plate waste. Total weight served was determined by multiplying the number of served products by the mean weight (based on 10 conveniently selected products).

Table 3. Percent consumption by menu entrée category [1]

Category	Total percent consumption red wheat (times served)	Total percent consumption white wheat (times served)
1- Buns with patty (chicken or hamburger)	67 ± 6[a] (9)	69 ± 3[a] (8)
2- Buns with mixed meat (sloppy joe or BBQ pork)	55 ± 7[b] (10)	55 ± 9[b] (9)
3- Rolls with pasta (spaghetti with sauce, lasagna)	69 ± 9[a] (15)	65 ± 9[a] (12)
4- Rolls with breaded meat (chicken or shrimp poppers)	59 ± 11[b] (7)	55 ± 10[b] (7)
5- Rolls with whole meat (Salisbury steak/gravy or turkey/gravy)	74 ± 9[a] (12)	65 ± 11[a] (10)
p-value	<0.0001	0.002

[1]Values with different superscript letters in the same column are significantly different ($p<0.05$).

Chapter III: Association between whole grain intake and psychosocial variables among elementary children.

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Abstract

Valid and reliable instruments to measure psychosocial determinants related to whole grain (WG) consumption in children are limited. The purpose of this study was to develop scales based on psychosocial variables and test for associations with whole grain intake by elementary school children. Ninety-eight children in grades 4^{th} - 6^{th} participated in one 24 hour recall interview and completed a questionnaire measuring self-efficacy, outcome expectations, preferences and knowledge on two occasions (approximately 14 days apart). Seventy-six parents completed a supplemental home inventory checklist to assess the availability of whole grain foods in the home. Mean total grain intake was 7.7 servings (SD 3.2) per day while mean intake of products containing whole grain (WG + some whole grain (SWG)) was slightly over 2 servings/day. Internal consistency for psychosocial scales was modest or acceptable (α = .55 - .70). Test-retest correlation coefficients were acceptable (r=0.55- 0.63) for the three psychosocial scales but not for a knowledge item. Total scores on the home inventory checklist ranged from 1 to 38 for whole grain items with a mean of 15 (SD 7). Reported home availability and refined grain intake were significantly related to WG intake while psychosocial variables were not. Multiple regression analyses showed that only parent age was a significant predictor of WG + SWG intake. Availability in the home may be a more important variable associated with whole grain intake than preferences, self-efficacy and outcome expectations.

Introduction

Significant scientific evidence indicates that increased consumption of whole grain reduces the risk of chronic diseases such as coronary heart disease, type 2 diabetes, and some cancers [1]. Based on this evidence, national dietary guidance has changed over the past 10 years to more prominently focus on increased intake of whole grains [2, 3]. The 2005 Dietary Guidelines for Americans now recommend that "At all calorie levels, all age groups should consume at least half the grains as whole grains."[4]. Previous estimates of whole grain intake indicated that few Americans were meeting the recommended intake of whole grains. Data from the USDA 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CFSII) indicated a preference for and over-consumption of refined grains while consumption of whole grains was only at one-third of the recommendation [5-7]. These data also showed that children and adolescents (ages 6 - 19) consumed 0.8 to 1.0 mean servings of whole grains on a daily basis [8]. More recent national dietary intake data (U.S. National Health and Nutrition Examination Survey 1999-2002) indicated that only 3.4% of children and adolescents (12-18 yrs) met the whole grain recommendation [9]. Between 30-40% of individuals over 12 years of age met the daily recommendation for grains while only 11% of the total grains consumed consisted of whole grains [9].

An understanding of eating behavior in children is necessary to design effective nutrition education and public health interventions to positively influence this behavior. According to Social Cognitive Theory (SCT), dietary intake can be influenced by three factors (behavioral, personal, and environmental) which operate in an interactive fashion as reciprocal determinants of each other [10, 11]. Several studies have examined the

relationship between food group intake and psychosocial variables based on SCT that affect intake by children [12-18] and showed that within selected theoretical frameworks, they could predict about 30% of the variability in intake [19]. Various constructs from SCT were predictive of children's intake of fruits and vegetables. Resnicow et al. [20] showed that preferences and outcome expectancies were significant predictors of fruit and vegetable consumption accounting for 10-11% of the variance in intake. Blanchette and Brug [21] reviewed intervention studies and determined that in addition to taste preference, availability and accessibility were the strongest determinants for increased consumption of fruits and vegetables in children 6 to 12 years. Among adolescents, the strongest correlates of fruit and vegetable intake were home availability and taste preferences [22]. A recent review of studies with children and adolescents indicated that gender, age, socio-economic status, preferences, parental intake and home availability/accessibility most consistently supported consumption of fruits and vegetables [23]. While many studies have investigated predictors of fruit and vegetable intake in children and adolescents, limited studies [24] to date examined constructs related to intake of whole grain foods.

A pilot multi-component intervention to improve whole grain intake was recently conducted with school-aged children and their parents involving classroom, cafeteria and family components. Evaluation tools for both parents and children were developed to measure intervention effects regarding several psychosocial variables [24]. For children, these included knowledge, availability in the home, self-efficacy and intention to choose whole grain foods. Results indicated that children were fairly confident in their ability to

choose, eat, and ask parents for whole grain foods; however, associations between these variables and actual whole grain intake were not examined.

The purpose of this study was to further develop subscales based on psychosocial variables thought to predict dietary intake and assess their relationship to whole grain intake in children. The results may be useful in determining how to intervene to change variables associated with the dietary intake of whole grain foods.

Methods

Sample

This study was conducted as part of a larger intervention project where the whole grain content of rolls and buns served in the school cafeteria was gradually increased over the course of the school year [25]. At the end of the school year (spring 2006), children in the fourth, fifth and sixth grades were enrolled in this study and asked to complete a questionnaire on two occasions and participate in a 24-hour dietary recall interview. Children were recruited through an announcement in a school newsletter and informational fliers sent home to parents. Children who returned consent forms signed by parents and who gave assent participated in the study. The University of Minnesota Institutional Review Board, Human Subjects Protection Committee and the school district research committee approved the study. Children were given a $25 gift card in return for their participation while parents who returned an availability tool were sent a $10 gift card.

Procedures

Overview. A 24-hour record-assisted dietary recall procedure was used with children to estimate whole grain intake. Children also completed a questionnaire on two

occasions to assess whole grain food preferences, self-efficacy regarding the selection of whole grain foods, outcome expectations, and knowledge about current whole grain intake recommendations. Parents completed a home inventory checklist to assess the availability of whole grain foods in the home and a short questionnaire regarding demographic characteristics.

Data Collection. Children were given a packet the day before the scheduled 24-hour dietary recall interview containing a food record form, instructions, and the parent whole grain home inventory form. Children were instructed to complete the food record form for the 24 hours before the interview and return it and the completed parent home inventory form to school for use during the interview.

Individual interviews (n=98 children) were conducted in a conference room by two research assistants trained in the use of NDS-R (Nutrition Data System for Research, Nutrition Coordinating Center (NCC), University of Minnesota, version 2006) interview software. The interviews were conducted over a four-week period with 23 children on Mondays, 21 on Wednesdays, 27 on Thursdays, and 27 on Fridays to balance recalls on weekend and weekdays. To help improve the accuracy of the recall, children were shown 1) cups, bowls, plates, and measuring utensils of varying sizes, 2) Food Portion Visual™ labels (2D pictures that accompany the NDS-R software based on foods in the NCC Food and Nutrient Database which have a volume option), and 3) packages and labels from whole grain food items available at local grocery stores including breads, cereals, rice, pasta, and snack foods. Whole grain servings were calculated using NCC's food group serving count system which was based on the 2005 Dietary Guidelines for Americans [4] and the USDA MyPyramid [26]. Three subgroup categories were used to classify grain

and grain-based products as whole grain (WG), some whole grain (SWG) and refined grain (RG). WG was defined as a food product where the first ingredient on the label was whole grain; SWG included foods containing a whole-grain ingredient appearing anywhere else on the label; and RG included foods with no whole-grain ingredients on the label. Grain foods listed on the food record by children were verified as whole or refined grain items with the assistance of the whole grain home inventory. For example, if a child indicated that a food item was whole grain, such as whole wheat bread for a sandwich, the home inventory was checked to verify that a whole grain product was marked by the parent as being available in the home. The inventory was also used to assess whole grain availability in the home.

A questionnaire to assess whole grain preferences, outcome expectations, knowledge and self-efficacy were administered after the child completed the 24 hour recall on two occasions, approximately 14 to 17 days apart (time 1 and time 2). Prior to completing the questionnaire, children were provided with written information showing ways to identify whole grain foods based on examples. While children were completing the preferences section of the questionnaire, additional examples of whole grain food product packages were shown to students by the research assistant.

Instruments

Food Record Form (FR) The FR contained separate lines for recording food and beverage items consumed over the past 24 hours. Each line had three columns to indicate the following: when the item was consumed (breakfast, lunch, dinner or snack), the location where the food/beverage was consumed, and a description of the food/beverage item.

Child Questionnaire Whole grain questionnaire items were constructed based on SCT constructs that were most predictive of fruit and vegetable intake by children [27-30]. Self-efficacy items (n=9) were modified from an existing scale related to whole grain intake previously used in a school-based intervention in the same school district [24] and assessed with three response options: I'm not sure I can = 1, I'm a little bit sure I can = 2, or I know I can = 3. Items addressed whole grain food choices at various venues (home, restaurants, or a friend's house) and included difficult situations to choose whole grain foods, for example, "My friends don't eat whole grains" and "I don't know which foods are whole grain". A scale that measured preferences or liking of whole grain foods included 14 items with response options: never tried it = missing data , I hate it = 1, I don't like it = 2, It's OK = 3, I like it = 4, or I love it = 5. These items included breads, cereals, pastas, and snacks. Missing data accounted for a small proportion of all preference ratings (12%). An outcome expectations measure for whole grain foods included 10 items with five response options: strongly disagree = 1, disagree = 2, neither disagree nor agree =3, agree = 4 or strongly agree = 5. Items included general benefits of whole grains (good for me, healthy heart, grow strong) while negative outcomes were related to gaining weight and upsetting one's stomach. Negative outcome expectations items were reverse coded. One question assessed knowledge of the number of recommended daily whole grain servings needed by children with response options of I don't know = 1, none = 2, one third of all the grain foods I eat = 3, half of all the grain foods I eat = 4, all of the grain foods I eat = 5.

Prior to completing the questionnaire at time 1, all children were provided with an explanation regarding how to identify whole grain foods and shown common examples of

these foods. Researchers were careful not to provide information about the healthfulness or daily requirements of these foods.

Whole Grain Home Inventory Form for Parents A whole grain inventory tool was developed based on existing instruments regarding availability of fruits, fruit juices and vegetables [31, 32]. Several months prior to the child interviews, a market basket survey was conducted by research staff in grocery stores in the school catchment area to assess the availability of whole grain products. A total of 112 food items were organized under 16 broad categories including pasta/grains, rice, taco/tortilla shells, waffles, pizza, entrées, bagels, granola bars, cookies, cooked cereals, dry cereals, breads, frozen dough, snacks, flours and flour mixes, and crackers. Under each broad category, food items were listed by name brand and type of product. The whole grain inventory was tested and modified several times with the research staff and intervention school staff for simplicity and clarity before distribution. The final whole grain inventory tool included grain items available which contained a whole grain ingredient within the first three ingredients of the ingredient list. Parents were instructed to check items that were currently in the home at the time of the survey. Additionally, under each category, parents were asked to specify other foods not listed.

Statistical Analyses

Data were analyzed using SAS (Statistical Analysis System, Version 9.1, copyright 2002-2003, Cary, NC). Whole grain consumption was tested for normality. Non normally distributed data for WG and SWG intake were transformed using square root transformation prior to analysis, however, non-transformed data are reported. Point values were assigned to responses for each item on the child questionnaire based on

response options. Scale scores were calculated by summing points on each item across the scales. Internal consistency of each scale was assessed based on Cronbach alpha coefficients. Spearman correlation analysis was completed to determine test-retest reliability between each mean scale score at two different times. Each food item selected on the whole grain inventory form was assigned 1 point for a possible total score of 112. Spearman correlation and multiple regression analysis were used to assess correlations between mean whole grain intake of children and their mean scores on the whole grain preferences, outcome expectations, and self efficacy scale scores, the mean knowledge score, and the parent home inventory score.

Results

Children in the fourth (n=20), fifth (n=54) and sixth (n=24) grades completed the dietary recall interview (n=98), the questionnaire at time 1 (n=96) and time 2 (n=92). Two children who completed the dietary recall interview did not complete the questionnaire (1 dropped out of the study, another was not asked to complete the questionnaire because he/she reported unrealistic intake data (energy intake > 5000 kcalories)). Several children did not complete the questionnaire at time 2 because they were either absent from school or declined to participate when the questionnaire was administered the second time. Children ranged in age from 9 to 12 years (mean age = 10.7 years (±0.85). About half were female (54%) and 64% were non-Hispanic white. Mean consumption of total grain foods per child averaged about 8 servings (7.7 ± 3.2) per day. Of the total grain servings, the mean intake of refined grain foods was 5.4 ± 3.2

while the mean ± SD intake of whole grains (including some whole grain products) was 2.4 ± 2.3 servings/day.

The overall mean preferences score for whole grain foods was fairly high (mean = 3.8 ± 0.5 on a scale of 1-5) (Table 1). Foods most liked by children included snack foods (popcorn and chips) and familiar foods such as ready-to-eat cereals and bread. Less familiar foods such as whole wheat tortillas and whole wheat pasta were not rated as highly as more the familiar foods. Children also had fairly high outcome expectations scores (mean ± SD = 3.7 ± 0.4 on a scale of 1-5) (Table 2) based on beliefs that whole grain foods were generally good for them, helped them be strong, provided energy, kept their heart healthy, and pleased their parents. The overall level of self efficacy was moderate with a mean of 2.1 on a scale of 1-3 (Table 3). Children were most confident in their abilities to eat whole grain foods at restaurants and when they had many other food choices available.

Internal consistency for two of the three scales (whole grain preferences and self-efficacy) at time 1 was fairly acceptable (α = .62 and .70 respectively), whereas internal consistency for the outcome expectations measure was only modest (α = .55) (Table 4) [33]. Test-retest correlation coefficients for preferences, outcome expectations, and self-efficacy scale scores were acceptable (r=0.65, r=0.63 and 0.55, respectively). The correlation between the mean response on the knowledge item at the two time points was low (r= 0.33) (Table 4).

The whole grain home inventory was completed and returned by 76 parents (78%). The age range of parents was 26 to 59 years (mean age = 41.6 years ±6). The majority were female (81%), had attended or graduated from college (90%), were

employed either part or full time (73%), and were non-Hispanic white (84%). Total scores on the home inventory ranged from 1 to 38 for whole grain items with a mean ± SD of 15 ± 7 (Table 5). The most commonly available products in the home were cereals, snack products, pastas and grains, and bread. Results indicated that a wide range of whole grain products were available in the home with twelve of the sixteen categories having at least one item marked within the category. Fewer parents reported having whole grain flour, other various breads (bagels, pizza, waffles and dough), snacks (granola bars and cookies) and entrées in the home. Only a small proportion of parent respondents (<12%) specified other whole grain foods not listed on the inventory as being available in their home, however, most responses were vague and not verifiable, therefore these data were not included in the analysis.

Correlation analysis showed that refined grain intake was inversely associated ($p<0.001$) with WG intake (WG + SWG $r_s = -0.322$ and WG $r_s = -0.347$) (Table 6). There was a positive association between WG + SWG and WG intake for the WG availability score ($r_s = 0.257$, $p<0.05$ and $r_s = 0.293$, $p<0.01$ respectively). Preferences, outcome expectations and self efficacy were not significantly correlated with WG + SWG intake or WG intake but were significantly related to each other. In particular, self efficacy and preferences were moderately correlated ($r_s =0.463$, $p<0.001$).

Using multiple regression analyses, WG + SWG intake were regressed on the linear combination of preferences, outcome expectations, self-efficacy, knowledge, availability score, child gender and age, and parent age, education level, and employment status (Table 7). The equation containing these 10 variables accounted for approximately

21% of the observed variance in WG + SWG intake (F (10, 63) = 1.70, p =0.10, adjusted $R^2 = 0.09$).

Beta weights and uniqueness indices were reviewed to assess the relative importance of the ten variables in the prediction of WG + SWG (Table 7). A uniqueness index represents the "percentage of variance in a criterion that is accounted for by a given variable above and beyond the variance accounted for by the other predictor variables in the equation."[34] The results indicated that only parent age showed significant beta weight values.

When demographic variables were taken out of the regression model, the equation containing the five variables (preferences, outcome expectations, self-efficacy, knowledge, and availability score) accounted for 8% of the observed variance in WG + SWG intake (F (5, 69) = 1.2, p = .31, adjusted $R^2 = 0.01$). Similar to the bivariate results, only the availability score displayed significance with a beta weight of 0.24 ($p < 0.05$) and uniqueness index of 4.46 ($p < 0.05$) (results not shown).

Discussion

This study extends previous research based on psychosocial determinants related to fruit and vegetable intake [12, 20, 23, 35] along with measures to assess effectiveness of intervention activities related to improving whole grain consumption for children and parents [12, 20, 24, 36]. In the current study, whole grain intake by children was related to availability of whole grain foods in the home but not to preferences, outcome expectations and self-efficacy. Possible explanations for these findings are discussed

given that they are contrary to results regarding predictors of intake of others foods by children.

Most children in the current study met the recommendation for total daily grain intake, but not for whole grain intake. Whole grain intake (mean = 2.3 ± 2.0) was slightly higher than the national average for children [8] which may be explained in part because the children were eating school lunches which contained whole grain bread products about twice weekly as part of a larger intervention study[25]. If recall days occurred when these products were offered, whole grain intake could have been increased by at least one serving/day. Additionally, whole grain intake (WG + SWG) was calculated based on consumption of products with a whole grain ingredient appearing first on the ingredient list (WG) and products with a whole grain ingredient somewhere in the ingredient list (SWG). This may have contributed to a slight overestimation of whole grain intake (WG + SWG) with servings of SWG foods adding approximately 0.5 servings/day.

Knowledge of intake recommendations is thought to be important in enabling dietary change as part of the construct known as behavioral capability [35]. However, relatively few children in this pilot study were able to accurately select the number of daily whole grain servings recommended and most provided different responses at both time points indicating a general lack of knowledge about recommended intake. Recent research related to intake of fruits and vegetables by children indicated that knowledge scores also had poor test-retest reliability with an ICC < 0.4 [37]. It may be that construction of nutrition knowledge items for early adolescent children needs more

attention or in the case of whole grain recommendations, more instruction regarding identification of products may be required.

In the current study, preferences were not positively correlated with whole grain intake of children which is in contrast to other studies where preferences regarding fruits and vegetables were important predictors of fruit and vegetable intake [20-22]. Whole grain items are commonly served as part of mixed dishes (e.g. sandwiches, pizza, pasta dishes) while fruits and vegetables could more easily be recognized by children as individual items. Therefore, children may have had a difficult time separating the taste preferences for whole grain products from other components in mixed dishes. In addition, children were asked to indicate liking for single products such as oatmeal and brown rice and also for categories of foods such as whole grain cereal and whole grain crackers. It may be that children liked some whole grain foods in one category more than others (e.g., cereals) and were unclear as to how to rate the whole category. This represents a methodological issue that may affect the validity of an overall preference scale score and therefore also the validity of correlations with intake. However, given the large variety of whole grain foods and brands, it would be difficult to avoid categorizing foods into groups for the purpose of rating liking.

The other psychosocial variables tested in this study (self efficacy and outcome expectations) were also not positively correlated with whole grain intake. Again, this is contrary to previous research regarding predictors of fruit and vegetable intake by children [17, 22, 23]. An important issue that may help explain this discrepancy is the general sense that consumers are confused by what constitutes a whole grain product and have difficulty distinguishing these products from refined grain products [5, 24].

Availability tools have been used previously to investigate availability and accessibility of fruits and vegetables in the home [31, 38-40]. To our knowledge this is the first availability tool that assessed home availability of whole grain foods. A positive attribute of the inventory was that it listed specific items first by category, followed by name brands and lastly type of food. This allowed for fewer problems with identification of products as whole or refined grain by parents. In addition, the list was based on a recent market basket survey of supermarkets in the area to ensure that probable items/brands and types were included. The average household had about 15 whole grain foods from a wide range of categories with the most common items being cereals, snack products, pastas and grains, and breads. These are common dietary sources of whole grain foods for adults and children according to national dietary intake data [7-9] supporting the validity of the instrument. This level of whole grain foods in the home also supports the estimate of whole grain intake for children in this study based on a 24-hour dietary recall interview. However, a negative attribute of the inventory is that it needs constant updating given the changing number of whole grain products becoming available on the market [41] and that the distribution of products/brands and extensions may differ by region.

This study had several limitations. All data were self-reported by children and parents and therefore potential errors may have occurred based on estimation of portion sizes. The lack of ability to correctly identify whole grain products may also be seen as a limitation despite education regarding labeling and identification issues prior to administration of the instruments. Additionally, grouping whole grains into categories may have affected the score related to liking. Using only one 24-hour recall interview to

assess whole grain intake may not be representative of a usual intake representing a limitation regarding the interpretation of the results. In addition, participants were from one school in one district in a large suburban metropolitan area limiting generalizability to a broader group of parents and children.

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Table 1. Preferences scores[1] for selected whole grain foods among school aged children

	Mean	Standard Deviation (SD)	Scale r^2
Overall preferences score	3.8	0.5	1.00
Popcorn	4.5	0.9	0.09
Corn chips (like Doritos, Fritos, or Sun chips)	4.5	1.0	0.34
WG cereal (like Mini Wheats, Total, Cheerios)	3.6	1.2	0.39
WG bread (like whole wheat bread or rolls)	3.5	1.4	0.37
WG crackers (like Triscuits, "Whole grain" wheat thins)	3.5	1.4	0.49
WG pancakes, waffles, or French toast	3.5	1.9	0.43
Hard taco shell	3.4	1.4	0.46
WG bagels or English muffins	3.2	1.6	0.35
Oatmeal	3.1	1.4	0.40
Pizza with WG crust	2.8	1.9	0.40
Corn tortilla	2.7	1.9	0.29
Brown rice	2.6	1.8	0.40
WG noodles like spaghetti	2.6	2.1	0.21
Whole wheat tortilla	2.3	2.0	0.37

[1]Never tried it = missing, I hate it = 1, I don't like it = 2, It's OK = 3, I like it = 4, or I love it = 5.
[2]Correlation between the score for each individual item and the total preferences scale score.
WG = whole grain

Table 2. Outcome expectations score[1] for selected variables related to health among school aged children.

	Mean	Standard Deviation (SD)	Scale r^2
Overall outcome expectations scale	3.8	0.4	1.00
WG foods are good for me	4.2	0.92	0.54
WG foods keep my heart healthy	4.1	0.85	0.52
WG foods help me grow strong	3.7	1.01	0.52
Eating more WG foods pleases my parents	3.7	1.18	0.42
WG foods give me energy to run and play	3.6	0.91	0.53
WG foods keep me from being hungry between meals	3.1	0.86	0.37
WG foods help me think better at school	3.1	1.08	0.41
WG foods make me gain weight	2.2	0.94	0.39
WG foods upset my stomach and give me gas	1.9	1.08	0.34
WG foods make me constipated	1.9	1.1	0.49

[1]Strongly disagree = 1, disagree = 2, neither disagree nor agree =3, agree = 4 or strongly agree = 5. The last 3 items were reverse coded prior to analysis.
[2]Correlation between the score for each individual item and the total preferences scale score.

Table 3. Self efficacy score[1] for choosing whole grains in various situations among school aged children.

I can eat whole grain foods when....	Mean	Standard Deviation (SD)	Scale r[2]
Overall self efficacy scale score	2.1	0.5	1.00
I eat at restaurants	2.5	0.7	0.55
I have many other food choices	2.3	0.9	0.59
My friends don't eat WG foods	2.2	0.9	0.60
I don't know which foods are whole grains	2.1	0.8	0.39
I want half of the grain foods I eat to be whole grain	2.1	0.8	0.68
I don't like WG foods	2.0	0.8	0.58
I don't have time to make WG snacks	2.0	0.8	0.46
I would rather eat other grain foods instead	2.0	0.8	0.64
There are no WG foods I like available	2.0	0.8	0.50

[1]Children were asked to respond according to three options: I'm not sure I can = 1, I'm a little bit sure I can = 2, or I know I can = 3 regarding their ability to eat WG foods in these situations (: I can eat whole grain foods when…)

[2]Correlation between the score for each individual item and the total preferences scale score.

Table 4. Psychometric properties of variables for children

Child scales and single item regarding knowledge	# of items	Range of possible scores	Time 1 N	Mean ± SD[a]	Cronbach α	Time 2 N[b]	Test-retest reliability[c]
Preferences	14	1-5	96	3.8 ± 0.5	.62	92	.65
Outcome expectations	10	1-5	94	3.7 ± 0.4	.55	86	.63
Self-efficacy	9	1-3	96	2.2 ± 0.4	.70	89	.55
Knowledge	1	0-1	96	0.3 ± 0.5	Not applicable	90	.33

[a]Time 1 data SD = standard deviation
[b]Time 2 response rate = 92%
[c]Refers to the correlation between each scale score at different times under the same conditions

Table 5. Availability of whole grain foods in the home according to parent home inventory report

Category	Maximum # of items	Mean ± SD	Total score = 0 (%)[1]	Total score = 1 (%)[1]	Total score >1 (%)[1]
Dry cereal	38	4.1 ± 2.7	5	10	85
Cooked cereal	6	1.7 ± 1.3	24	63	13
Snacks	9	1.7 ± 1.2	15	32	53
Crackers	5	1.6 ± 1.8	42	36	22
Pastas and grains	11	1.5 ± 1.5	35	19	46
Rice	6	1.5 ± 1.2	19	35	46
Bread	11	1.2 ± 1.1	30	44	26
Taco/tortilla shells	6	0.9 ± 0.9	36	41	23
Whole grain flour	2	0.5 ± 0.6	58	37	5
Granola bars	2	0.5 ± 0.6	60	33	7
Bagels	3	0.2 ± 0.6	83	14	4
Pizza	4	0.2 ± 0.4	86	13	1
Dough	2	0.09 ± 0.3	91	9	0
Cookies	3	0.09 ± 0.3	91	9	0
Entrée	2	0.06 ± 0.2	94	6	0
Waffles	2	0.03 ± 0.2	98	2	0
Overall mean score	112	15.0 ± 7.0			

[1]Percent of parents who marked 0, 1, or more than 1 food item

Table 6. Whole grain intake and associations with psychosocial and availability variables

	Mean	SD	1	2	3	4	5	6
1. WG Intake (WG +SWG)	1.26	0.82						
2. WG intake (WG)	1.09	0.75	0.83***					
3. Refined Grain Intake	5.43	3.25	-0.39***	-.0353***				
4. Preferences	3.82	0.46	0.089	0.004	0.051			
5. Outcome Expectations	3.76	0.42	0.139	0.042	-0.15	0.224***		
6. Self Efficacy	2.14	048	0.014	-0.043	-0.086	0.477***	0.43***	
7. Availability Score	13.67	6.86	0.257*	0.293**	-0.171	-0.074	-0.036	-0.05

*p<0.05, **p<0.01, ***p<0.001, n=94 except for the availability score where n=76

Table 7. Multiple regression analyses predicting whole grain intake of school aged children

Predictor	B[1]	SE B[2]	β[3]	t value	Uniqueness index
Preferences	0.30	0.23	0.17	1.29	1.76
Outcome expectations	0.34	0.24	0.16	1.41	2.10
Self efficacy	-0.01	0.25	-0.01	-0.04	0
Knowledge	-0.13	0.21	-0.08	-0.65	0.40
Availability score	0.02	0.01	0.20	1.69	3.04
Child gender	-0.06	0.20	-0.03	-.29	0.09
Child age	0.23	0.11	0.24	1.99	4.19
Parent age	0.04	0.02	0.2	2.44*	6.29*
Parent education	-0.18	0.15	-0.15	-1.16	1.43
Parent employment	0.01	0.08	0.01	0.08	0.01

* $p < .05$

[1] Nonstandardized multiple regression coefficient

[2] Standard error of the nonstandardized multiple regression coefficient

[3] Beta weight or standardized multiple regression coefficient

Chapter IV: Video observations of elementary school meals-Implications for whole grain eating behaviors.

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Abstract

More than 29 million children participate in the National School Lunch Program (NSLP), which provides an excellent opportunity to introduce children to whole grain foods. Recent plate waste studies indicate that grain-based foods made with varying levels of whole grain content are accepted as well as their refined counterparts. To further investigate children's eating behaviors of whole grain products, cafeteria lunches were video recorded in a local school district. Approximately 90 children were observed ~10 times (range 1-10 times) eating a variety of grain foods including whole grain products served in a typical elementary school lunch. Focus groups (n~30) were used to collect in-depth examination of students' response to product introduction. Video analysis used a modified Dyadic Interaction Nomenclature for Eating (DINE) renamed Student Lunch Observation Nomenclature for Eating (SLONE) to investigate eating patterns and behaviors of whole grain products. Results indicate that at higher grade levels children selected fewer food items from the cafeteria line and spent less time eating. Desserts made with grains, such as cookies and cakes, were taken by twice as many children when offered compared to when fruits were served as a dessert. Main entrée and waste for the main entrée approached significance when desserts made with grains were consumed as compared to fruit desserts. Although the frequency of bites and sips vary and are not significantly different among children, general eating patterns can be categorized as "typical", "nibblers", and "cyclic" eaters. This baseline data provides a foundation for further exploring the use and acceptability of foods in school meals at the elementary level. This information can be helpful in facilitating product development and

introduction of school foods, such as whole grains with children in an interactive and realistic cafeteria environment.

Introduction

Significant scientific evidence indicates that increased consumption of whole grain foods reduce the risk of chronic diseases such as coronary heart disease, type 2 diabetes, and some cancers [1]. The 2005 Dietary Guidelines for Americans recommend that "At all calorie levels, all age groups should consume at least half the grains as whole grains."[2].However, data from the USDA 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CFSII) indicated that children and adolescents (ages 6 - 19) consumed 0.8 to 1.0 mean servings of whole grains daily [3]. More recent data from the U.S. National Health and Nutrition Examination Survey (1999-2002) suggests that only 3.4% of children and adolescents (12-18 yrs) met the whole grain recommendation [4]. In order for Children to achieve the government recommended daily servings of whole grains a significant shift will need to occur in the availability of consumer friendly whole grain products that meet taste expectations, particularly for school-aged children. Several approaches are being explored to more effectively introduce whole grain foods into school cafeterias by gradually increasing the level of whole grain flour content [5] using white whole wheat flour [6], and multi-component interventions [7]. In addition, current evidence suggests that accompanying foods appearing on the same lunch tray, along with the moisture content may promote or potentially serve as a barrier to the consumption of whole grain foods. It is not known how the characteristics of accompanying foods either promote or inhibit consumption of whole wheat products by school children.

To our knowledge there are no observational reports in the literature documenting children's eating behaviors or factors affecting the consumption of whole grain foods in schools using advanced technology equipment. Digital photography has been used in school applications resulting in a practical, highly accurate, and cost-effective means to measure actual meal consumption [8, 9]. Video recordings, a similar technique to direct observation, have been used to investigate patterns of behavior and dietary interactions in children. However, these studies have been limited to comparing children with chronic illnesses to healthy controls, and in a controlled family meal setting [10-15]. However, many of these strategies related to eating and behaviors may be extrapolated into new environments investigating innovative approaches and products and behavioral patterns during a school lunch with healthy children.

The purpose of the present study was to investigate behavioral patterns associated with eating whole grain foods during an elementary school lunch. Focus groups were also conducted with 4^{th} -6^{th} graders about whole grain foods served during elementary school lunches.

Methods

School / Subjects

The lead researcher contacted the foodservice director from the Roseville School district to identify one elementary school to participate in the study. Once a school was identified, a meeting was convened with the district nutrition coordinator and school principal to discuss the research protocol, timeline, description of food products, school menus and product substitution, along with the set up for video recording and focus group interviews. The Roseville area schools included predominantly white children,

accounting for ~68% of the total enrollment (total Roseville enrollment) and about one-third were minorities (~32%). The intervention school Brimhall elementary (K-6th), had a higher percentage of minority enrollment with ~44%. The number of males and females were 53% and 47%, respectively. Brimhall served approximately 400 lunch meals per day. This project was approved by the Roseville School District and the Institutional Review Board of the University of Minnesota.

Food Categories

The foods recorded during lunch included typical grain products served at school. Accompanying foods were defined as items part of the school lunch (other than the entrée) that were taken for lunch by the children. Foods were categorized into four groups: main entrée, dessert, beverage, and competition foods. Main entrée was defined as one of the two choices available for lunch. Dessert was defined as two categories based on what was severed; fruit or grain based. On days when grain based desserts were served fruit may have also been available. On these days if a child took both the grain based dessert and fruit, the fruit was defined as a competition food. Competition foods were defined as foods offered to accompany the entrée such as vegetables or another grain product that were optional for the child to take.

To minimize variability in children's choices, grams of food were calculated for group categories. All food grams were collected using manufacture data or food information from the USDA Nutrient Data Laboratory [16]. Grams for each category (dessert, main entrée, and competition food) were calculated using an average gram weight of all items served in that category for all taping sessions. Waste grams for each category were also calculated. Additionally a total food category was calculated for both

grams and waste grams. Beverages were not used for analysis due to the inability to determine exact amounts consumed.

Video Recording

Eighty-nine children were enrolled in the study during the spring 2007 and fall 2007-2008 school-years. Children were recruited through informational fliers sent home to parents. Children who returned consent forms signed by parents and who gave assent were enrolled in the study. Children were mailed a $5 gift card after the last taping session in return for their participation.

Focus Groups

Thirty-two children participated in focus groups conducted during their lunch and recess periods. Children were recruited through informational fliers sent home to parents. Those children who returned consent forms signed by parents and who gave assent participated in the focus groups. The University of Minnesota Institutional Review Board and the school district approved the study. Children were mailed a $10 gift card after participating in their focus group.

Procedures

Video Recording

Children participating in the study were asked to sit at a particular table in the school cafeteria to be video recorded on ~10-15 occasions. Only those meals that included a whole grain product of interest were video recorded. The first set of recording sessions was conducted during May 2006-2007 for 12 days and the second set during November / December, 2007-2008 for 18 days. A JVC video camera (Everio Hard Disk Drive 30 GB model GZ-MG77U) set up on a tripod was used to record children's

lunches. The camera was set up at the end of a designated table and started at the beginning of the lunch period running continuously throughout the lunch until the last child left the table. Total lunch time was approximately sixty-five minutes with groups recorded by grade level (K-6th) for about 15 minutes per grade (Table 1). Due to the logistics of a school lunch, having overlapping lunch times, all children were not equally video recorded. The children were informed before the first video taping session to sit at the table during the designated recording days if room allowed. If the table was full they could sit elsewhere and would have an opportunity to participate next time.

Focus groups

A three-member research team conducted the interviews, transcribed, and analyzed the data. Questions were developed and designed for use in a semi-structured format. Focus groups were conducted by the same moderator in the school in an open room adjacent to the library set up with tables and chairs. Groups were conducted by grade level of about six children per session, with a total of seven focus group sessions lasting about forty-five minutes. Children were served whole grain lunch entrée that were designated as the main topic of discussion. Children were asked to choose 2 of the 3 main entrees [maxi sticks (rectangular shape), pepperoni pizza (triangle shape), and a double stuffed cheese pizza (rectangle shape)]. In addition, all children were given a whole grain dessert. The moderator asked the same open ended questions based on accepted methodology and protocol [17] to all the children, except for the last group. The last group was asked additional questions at the end of the session about the designated whole grain items. Transcripts of the interviews were coded independently by two coders and

differences were reconciled. Data were analyzed using a frequency and intensity of response format [17].

School Lunch Observation Nomenclature for Eating (SLONE)

The SLONE was developed by modifying the Dyadic Interaction Nomenclature for Eating (DINE) [12, 15]. DINE consists of three categories: parent behaviors, child behavior and child eating. SLONE consist of only the first two categories with the parent component eliminated. Child behaviors included several distractions from eating (such as talking, playing with food, and preoccupation with something else going on in the cafeteria), preparing food, moving away from the table or tray, cleaning up and obstructive view. Eating behaviors are defined as bites, sip, spit-up, segment/remove inside, combine, wipe/dunk, licking utensils and licking food. All behaviors were coded and recorded on a 10-second interval in score sheets developed by the research team. The codes and operational definitions are available upon request. Videotape recordings of school lunch meals were scored for meal duration, number of bites per minute, number of sips, amount of food consumed, and behaviors by the child that occurred during the lunch period. Bites were summed at 1-minute intervals to arrive at bites per minute.

Coding and Reliability

Each video recorded lunch was viewed approximately 2 times by trained observers. Child eating was coded during the first viewing and child behaviors were coded during the second viewing. Amounts eaten were also observed and recorded during the child eating. Servings consumed were scored as none (0%), taste (12.5%), little bit (25%), half (50%), most (25%), and all (100%). Reliability was assessed on 30% of the

video recordings by having two observers score the recordings independently. Kappa coefficients of 0.60 are considered acceptable[18, 19]. Kappa were calculated on the exact agreement on the number of bites/sips and behaviors within each 10 second interval. The average kappa across all video recordings was 0.88 (range 0.46 to 1.00). However, the bite/sips kappa was on a much higher agreement level at 0.95 than for behaviors 0.64. Kappa was highly acceptable on the exact agreement of scored consumption (0.90).

Statistical Analyses

Video recording

Data were analyzed using SAS (Statistical Analysis System, Version 9.1, copyright 2002-2003, Cary, NC). One-way ANOVA was used to determine if number of items taken, total time eating and number of bites and sips (per category) differed by grade and whole grain items. ANOVA was also used to determine if mean bites and sips differed according to pizza products. A t-test was used to compare variable difference between the dessert groups (fruit dessert or grain based dessert). The level of significance was set at $p<0.05$.

Focus groups

Audio recordings were transcribed verbatim by two members of our research team. Coding of the transcripts was conducted independently by three team members. The investigators used qualitative data analysis procedures to generate common themes [17, 20]. Data was organized around nine distinct topics based on the questions asked during the focus groups. Each category identified had themes generated and a summary statement written to illustrate ideas the children discussed. Throughout the analysis

process, cross checking was used to provide a measure of how well the data were indexed. Differences in coding were resolved through discussion, and inter-coder comparison was found to be high. The research team then met as a group to discuss the major themes and reached a consensus; all major saturated themes were identified across coders and representative quotes were identified.

Results

Participants

During the two data collection periods, 89 children participated in video recording in the following grades: first (n=14), second (n=9), third (n=14), fourth (n=25), fifth (n=14) and sixth (n=13). About half of the children were female (47%) and male (53%). Focus group participants included children in the 4^{th} (n=9), 5^{th} (n=14), and 6^{th} (n=9) graders and exactly half of the children were female and male. Demographic characteristics (age, race, and ethnicity) were not collected for any of the child participants.

Meal Observation

The mean time spent eating lunch decreased as grade level increased. The average time for first, second, third, fourth, fifth, and sixth graders to eat lunch was 14.5(±2.5), 10.5(±2.5), 8.8(±2.4), 9.9(±1.9), 6.9(±1.6), and 5.5(±2.2) respectively ($F = 24.46$; $p<0.0001$) (Figure 1.). The number of food items selected and placed on their tray during a whole grain pizza meal varied by grade. The average number of items taken by first, second, third, fourth, fifth, and sixth graders was 3.8(±0.8), 2.7(±0.5), 3.9(±0.9), 3.3(±0.8), 3.4(±0.5), and 2.8(±0.9) respectively ($F = 4.01$; $p = 0.0031$) (no figure shown). However, when grades were combined in pairs of first and second (3.5 ± 0.9), third and

fourth (3.4 ± 0.8), and fifth and sixth (3.0 ± 0.8); the average number of items were approaching significance ($F = 1.62$; $p < 0.20$) (Figure 2.). When comparing desserts taken by students, overall twice as many children took a grain based dessert when served versus when the fruit dessert was served (Figure 3).

To minimize variability in food selection children, the following categories were identified: main entrée, dessert, competitive foods, and beverage. Bites and sips were calculated by food category and were not significantly different by grade for any of the categories (Table 2.). Regardless of the bites and sips by food category, three patterns of eating were identified as typical, cyclic, and nibblers. A typical pattern was defined as having no discernable pattern where bites and sips of all products were taken at varying times throughout the lunch. A nibbler pattern was defined as spending most bites with one food (greater than 85% of bites with one item) with no cyclic pattern identified. A cyclic eater was defined one of two ways: either eating an entire food before moving on to the next food or taking bites of each food in a cyclic pattern. Of the three identified patterns observed, and recorded 66% were typical ($n = 42$), 13% cyclic ($n = 13$) and 14% nibblers ($n = 9$).

When comparing dessert groups to the following variables: grade, dessert (grams), dessert waste (grams), main entrée (grams), main entrée waste (grams), competition food (grams), competition food waste (grams), total food (grams), and total food waste (grams), t-test between fruit dessert group and grain dessert group reported significance for total food (290 ± 48 fruit dessert and 207 ± 45 grain dessert; $p < .0001$) and nearing significance for main entrée (98 ± 45 fruit dessert and 74 ± 36 grain dessert;

p = 0.057) and main entrée waste (34 ± 45 fruit dessert and 58 ± 36 grain dessert; p = 0.057).

Focus Groups

Children were asked a series of questions regarding various whole grain pizzas and a whole grain dessert served during school lunch, including how to decide what to eat for lunch, how the products were similar, what they liked or disliked about each product and how they would change the products. Children stated that familiarity, hunger and mood were the most influential factors on "how to decide what to choose for school lunch". However, the name of the items played a role in food selection, such as choosing the food that sounds good and the food that sounds better if neither is liked. Accompanying items were influential-"the only reason kids ever choose the Deli Ham Stacker is to get the potato chips". Children also reported it only took one negative experience, even if the experience occurred in lower grades (e.g. 1st or 2nd), to decide the fate of a product served in school lunch.

The whole grain dessert received the most comments from children while fewer comments were given for the more familiar pizza items. In general pizza items were familiar and had similar attributes children liked such as crust, cheese, and sauce (table 3). The pasty item was less familiar but had positive feedback on looks and smell (table 3). Dislikes were less similar between products but in general were related to eating properties, appearance qualities and taste (table 4). The last focus group of sixth graders was asked additional questions specifically related to whole grain foods. Children

decided products were not whole grain based on appearance (color). Children were then asked if they would eat the products if whole grain. Responses for not eating whole grain products included taste and fear of change ("I like it how it is and if they changed it somehow I think it wouldn't taste good.")

Discussion

A modified technique, the Dyadic Interaction Nomenclature for Eating (DINE) [12-15] coding system was pilot-tested to investigate eating patterns of whole grain foods during an elementary school lunch. This study extends previous research related to whole grains and children which focused on the psychosocial determinants and whole grain intake in children [5, 6, 21]. To our knowledge this is the first school based pilot study that investigated the consumption of whole grains through video recordings with children during an elementary school lunch. The present study did not demonstrate any difference in bites and sips of children eating whole grain products served during school lunch. However, grain based desserts which may have also been served with fruit were selected by twice as many children over fruit being served as dessert during a pizza meal. The selection of a grain based versus a fruit dessert by students approached significance with comparison to entrée consumption during school lunch. Therefore, our pilot study suggests that if children are going to consume a grain-based dessert over the fruit, maybe alternative dessert/snack products should be offered by manufacturers with lower caloric density, sodium, fat and sugar. In addition, it may be possible to increase the nutritional content of these desserts by gradually increasing the whole wheat flour and fiber content of a cookie or cake with minimal impact on consumption [5, 22]. Thus these preliminary

findings may provide some evidence to encourage further research into the development of acceptable whole grain dessert items for school lunches.

The amount of food eaten in any given eating episode may depend less on internal needs and more on environmental contextual factors (ambience). It is thought that the process of satiation can easily be disrupted by variety effect (different foods introduced in a meal), social context (presence and number of others) [23-25], and distractions (competing tasks) [26]. This ambience, which is underestimated, may have a major influence on eating behavior and should be included and emphasized in more nutrition-related research in a real-world context [27].

Until recently articles investigating food preferences have dedicated inadequate attention to cultural factors [28]. A few studies have investigated differences in cultural eating practices between countries, such as France and the United States. Results indicated that American's spend less time eating food and consume portions 25% larger than the French [29]. Our pilot suggests that the school cultural factors may affect the amount of time spent eating lunch along with the number of items selected during the lunch period. These cultural factors may encourage meal cessation to rely more on external rather than internal cues which may influence a person to keep eating past an appropriate point contributing to the "obesity epidemic" [30]. Based on these preliminary results further investigation is warranted.

Aside from personal factors that influence children's consumption of whole grain foods, schools may be limited as to the availability of whole grain foods for purchase. Chan et al [31] conducted focus groups with school foodservice personnel from randomly selected school districts in the Minneapolis / St. Paul area. Results indicated non-standard

definition, small packaging, limited distribution and availability, inconsistent quality, increased cost, and limited communication with vendors and industry were all barriers for schools in purchasing whole grain products. A direct quote includes: "The manufacturing side needs to make, nutritious, economical, acceptable, kid friendly products for kids made with whole grains" [23]. Further observational studies in school cafeterias will allow manufacturers to take into account environmental factors that might influence the successful development and marketing of whole grain foods for children.

This research has the potential to establish a new paradigm regarding the development, incorporation and acceptance of whole grain foods in school meals. In addition, the environmental aspect of school lunch such as logistics related to time, number of items served, and competition among items served on the cafeteria line require further study. The limitations of this study include a small convenience sample from a Midwestern suburban elementary school limiting the potential to generalize the results to other schools. Video recordings were done with one video camera at a downward angle. This may not have been the optimal height or angle for identification and measurement of foods. Menu variability also can be a limiting factor. Although menus have specific foods listed, menu changes can affect consumption and reduce the consistency of eating behavior between similar meals. Measuring height and weight of students would be helpful for future studies that aim to examine how calories correlate with bites and sips, time to consume lunch and number of items selected by students.

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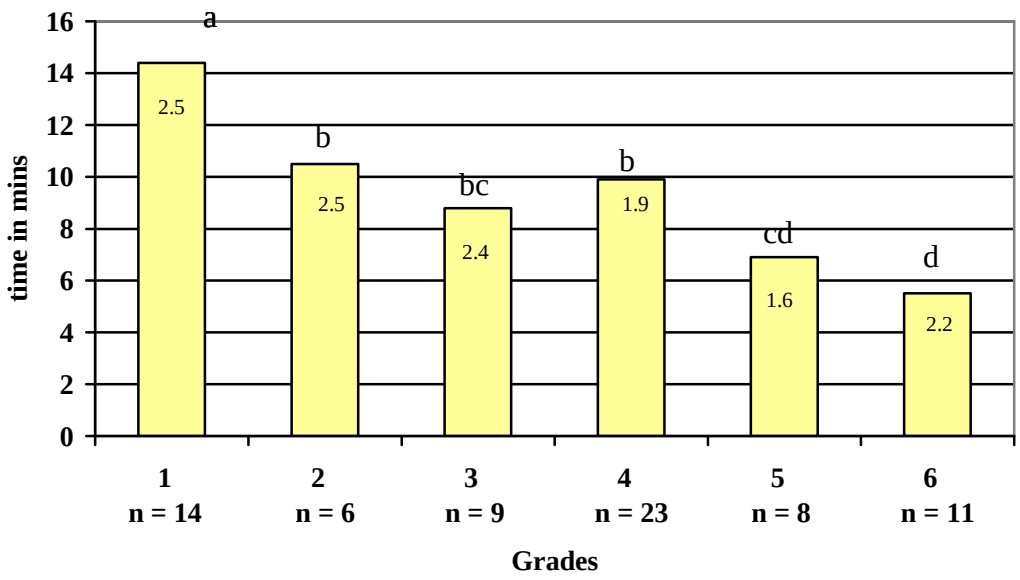
Table 1: Lunch schedule for elementary student

Grade	Enter lunch	Leave lunch
Kindergarten*	12:05	12:20
1st	11:35	11:50
2nd	11:50	12:05
3rd	11:55	12:10
4th	12:10	12:25
5th	12:20	12:35
6th	12:25	12:40

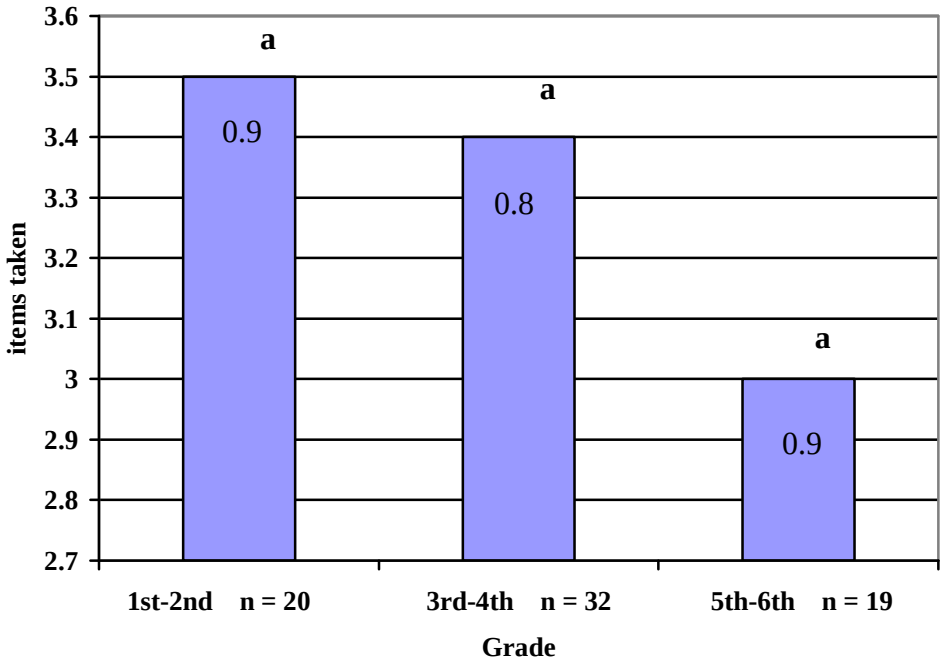
*Kindergarten child were not included in the video taping analysis but may have affected the children following their lunch time.

Figure 1. Average time spent eating a whole grain pizza lunch by grade



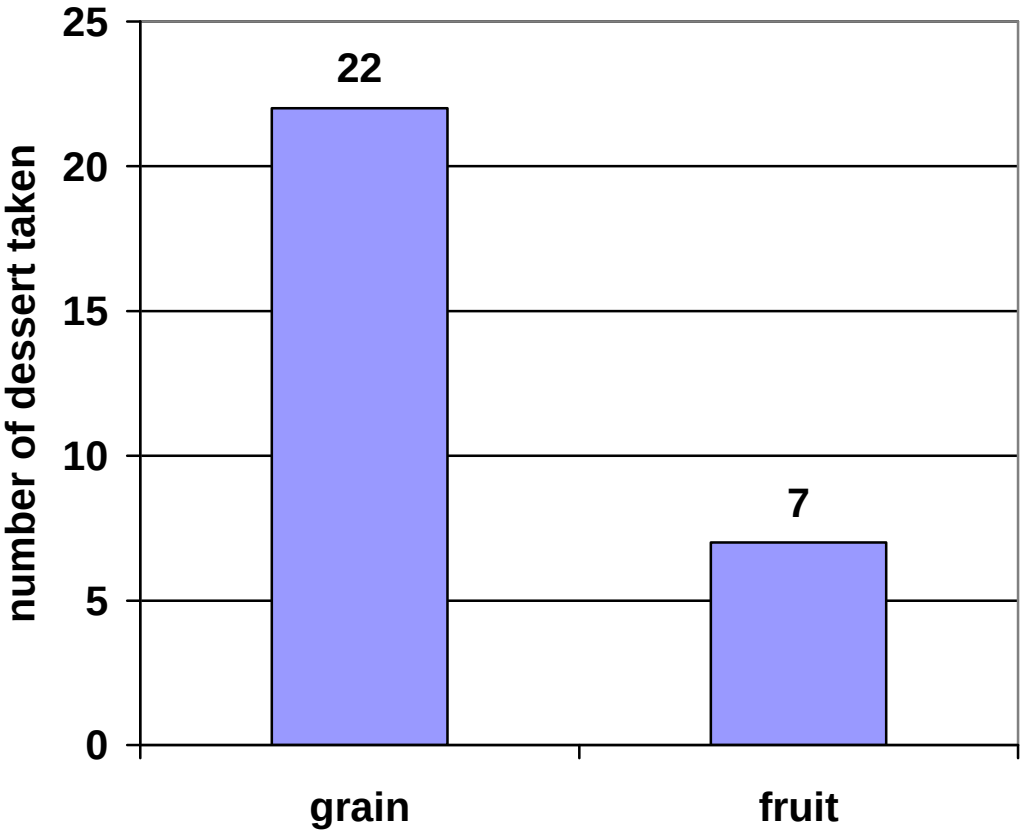
Values with different superscript letters in the same column are significantly different ($p<0.05$). Numbers within columns represent standard deviations.

Figure 2. Average items taken during a whole grain pizza lunch by grade



Values with different superscript letters in the same column are significantly different ($p<0.05$). Numbers within columns represent standard deviations.

Figure 3. Number of desserts taken by children during a pizza lunch



N = 23 and consists of match paired children.

Table 2: Comparison of the average bites and sips per category by grade[1]

Grade	Average sips or bites taken of					
	beverages	Entrée (pizza)	competition food	all desserts	fruit dessert	grain based dessert
1st	6.5 ± 5.2[a]	31.2 ± 20.6 [a]	9.4 ± 6.3[a]	13.1 ± 10.2[a]	14.3 ± 9.8[a]	0[a]
2nd	8.5 ± 9.0[a]	35.5 ± 13.0 [a]	8.0 ± 7.1[a]	N/A	N/A	N/A
3rd	5.9 ± 4.0[a]	35.1 ± 26.2 [a]	16.75 ± 17.1[a]	10.4 ± 10.7[a]	N/A	10.4 ± 10.7[a]
4th	8.1 ± 7.1[a]	25.8 ± 14.9 [a]	8.9 ± 7.0[a]	8.5 ± 6.6[a]	7.6 ± 6.7[a]	9.7 ± 6.9[a]
5th	8.9 ± 5.7[a]	23.7 ± 15.1 [a]	16.3 ± 3.4[a]	6.4 ± 4.0[a]	N/A	6.4 ± 4.0[a]
6th	7.7 ± 6.8[a]	21.5 ± 10.2 [a]	16.0 ± 7.5[a]	8.2 ± 5.4[a]	8.8 ± 6.1[a]	6.0[a]
p values	0.9282	0.5083	0.2782	0.5112	0.2144	0.7293

[1]Values with different superscript letters in the same column are significantly different ($p<0.05$).

Table 3: Factors influencing liking for whole grain products

Whole grain product	Themes	Description/quotes
Maxi sticks	Texture Flavors Appearance	❖ Soft crust, bumpy, chewy, crispy, ❖ Likes taste of cheese ❖ Likes stick shape ❖ Reminds of pizza without sauce
Double stuffed pizza	Appearance Flavors	❖ Similar to pizza- ▪ Different shape ❖ Better crust-cheese stuffed
Pizza	Flavors Appearance	❖ Likes shape ❖ Likes pepperoni ❖ Size- likes the larger quantity
Pastry	Texture Flavors Appearance Smells	❖ Resembles pie and streusel ❖ Serve as a dessert or a snack ▪ Size too big for a dessert ❖ Looks and smells good o "It looks very appetizing it makes you want to just grab right through the glass and be like GIVE IT." o "Makes you impatient with your other food. It's like ok I took a bite of it. It's done." o "I haven't tried mine yet, but just by looking at it I can tell I probably will like it because it has cinnamon on it and it's a dessert."

Table 4: Barriers and dislikes for whole grain products

Whole grain product	Themes	Description/quotes
Maxi sticks	Texture Flavors Appearance	❖ Bumpy texture-reminds of warts ❖ Crust has sweet and sour taste ❖ Too much cheese - makes look unhealthy
Double stuffed pizza	Flavors	❖ Too much sauce ▪ Drips out/messy
Pizza	Texture Appearance Flavors	❖ Toppings peel off ❖ Crust-too chewy, too flimsy, flat not fluffy like restaurants ❖ Oversaturation-served at home and school to often ❖ Crust has sour taste compared to store bought pizza
Pastry	Texture Flavors Appearance	❖ Crust is hard especially around edges o "You feel warm and soft and you hit this (referring to the edges). It's like your digging and you hit a rock." ❖ Too much jelly ▪ Drips out/messy ▪ Sticky ❖ Too much cinnamon ▪ Looks burnt ❖ Smells better than tastes ▪ Not sweet enough o "tastes like pizza crust with jelly" ❖ Too big for dessert o "it kinda suprising to me with the size of it and the looks of it, it almost looks like the size of a pepperoni hot pocket" o "it's as long as our bread sticks" o "it's as big as our meal"

Chapter V: Conclusions and Implications for Future Research

Conclusions

The primary objective of this research was to investigate various approaches and techniques to increase whole grain consumption among school-aged children. In Study I, the red and white whole wheat flour content of bread products served to elementary children was gradually increased. Study II identified and tested associations between psychosocial variables and whole grain intake by elementary school children. In study III, the knowledge that accompanying foods may affect the intake of whole grain foods was used as the basis for establishing an innovative method (video recordings) to examine eating behaviors during school lunch.

In study I, a gradual approach was applied to slowly increase the red and white whole wheat content of hamburger buns and dinner rolls over time. This study showed that mean consumption of whole grain (g/child) increased as the level of red and white whole wheat flour increased in modified bread products. The results demonstrated that consumption of modified bread products did not differ statistically from baseline (0% whole grain flour) until the 72% level for red and 67.5% level for white wheat was served. In addition, this study suggested that consumption of buns and rolls varied with type of accompanying menu items regardless of wheat type or level. Consumption data indicated rolls served with food items that contained less moisture content were consumed at lower levels compared to buns and rolls served with other menu items. This raised the possibility that the moisture content along with type of accompanying foods may affect intake of bread products consumed as part of a school meal. This gradual approach of whole wheat flour content in menu items resulted in favorable whole grain

consumption by children and may allow school foodservice directors to gradually introduce acceptable whole grain products into school menus.

Study II investigated the development of scales based on psychosocial variables thought to predict dietary intake and assess their relationship to whole grain intake in elementary school children. The variables of interest included self-efficacy, outcome expectations, preferences and knowledge. A home inventory checklist was developed and supplemented the 24-hour recall to assess whole grain home availability. Results indicated that mean total grain intake was 7.7 servings (SD 3.2) per day while mean intake of products containing whole grain (WG + some whole grain (SWG)) was slightly over two servings/day. Home availability and refined grain intake were significantly related to WG intake while psychosocial variables were not. Results indicated that availability in the home may be a more important variable associated with whole grain intake than preferences, self-efficacy and outcome expectations in pre-adolescent children.

The results from these two studies indicate that the consumption of whole grains in a school environment may be compromised by a combination of meal moisture content and accompanying foods appearing on the same lunch tray. It is not known how the characteristics of accompanying foods either promote or inhibit consumption of whole wheat products by school children. Therefore this finding presented an opportunity to develop a non-invasive innovative method to investigate behavioral patterns associated with the consumption of whole grain products served in an elementary school lunch.

The primary purpose of study III was to investigate behavioral patterns associated with eating whole grain foods during an elementary school lunch. Accompanying focus

groups were also conducted to examine responses to product introduction into school lunches. The results from this project suggested that the frequency of bites and sips did not significantly differ among children but general eating patterns were established and categorized as “typical”, “nibblers”, and “cyclic” eaters. Accompanying foods, especially grain-based desserts compared to fruit desserts, may have an effect on the consumption of a whole grain main entrée. Additionally environmental factors (e.g. time to eat and items taken) may affect overall eating habits of elementary school children.

Themes that emerged from the focus groups indicated that familiarity, hunger and mood were the most influential factors on “how to decide what to choose for school lunch”. However, the name of the items (e.g. choosing the food that sounds good or the food that sounds better if neither is liked) and accompanying items (e.g. chips served with ham sandwich) also influenced food selection. Children also reported it only took one negative experience, even if the experience occurred in lower grades (e.g. 1^{st} or 2^{nd}), to decide the fate of a product served in school lunch. Whole grain products were considered familiar and had positive feedback on appearance, taste, and smell. Dislikes were related more to eating (e.g. dripping sauce/filling) and appearance qualities rather than taste. Based on appearance (color) children did not think products tested were whole grain. Responses for not eating whole grain products included taste and fear of change (“I like it how it is and if they changed it somehow I think it wouldn’t taste good.”)

In summary, this research is important as it addresses various approaches to influence children’s whole grain consumption, and relevant information related to the development of new foods based on environmental and cultural factors that may affect whole grain consumption during school lunches. This research also adds another

dimension regarding factors that may affect school lunch consumption taking into account the spontaneity, peer influences, and other environmental factors such as time and eating behaviors. More importantly, this research contributes innovative and resourceful data to various organizations (e.g. government, industry and academia) interested in improving children's nutrition practices and intake through the school meals program.

There are several strengths and limitations that need to be addressed when interpreting the outcomes of this research. Strengths of these projects included the successful development and implementation of a multi-component, school based intervention to gradually increase and assess predictive variables related to whole grain intake in school-aged children. Additionally, the use of several approaches, including a plate waste method, video recordings and focus groups, allowed for a full investigation of children's behaviors and acceptability of whole grain products.

Limitations of the study included the use of a small convenience sample which limits the ability to generalize to students in a broader geographic area. All self-reported data obtained by children may be susceptible to social desirability bias or errors based on estimation of portion sizes. The lack of ability to correctly identify whole grain products may have increased the preference scale for children. Although the home-inventory listed specific items first by category, followed by name brands and lastly type of food, the defined catchment area may have limited the identification of all available whole grain products. Although meal observations are a reliable method for collecting dietary intakes, a video recording method has not yet been validated as a reliable method for collecting dietary intake and assessing behaviors. With a new method there may be observer error

that could have resulted in under- or over-estimation of child behaviors and whole grain consumption.

Implications for future research

This research project contributes to a better understanding of innovative methods for incorporating whole grains into school meals. Based on these three studies, it was concluded that various approaches can be used to increase the intake of whole grain foods by children through increased exposure to familiar and appealing products. Additionally, the school lunch environment and cultural implications may be a potential area of investigation that plays an important role in the eating behaviors and consumption of whole grain foods.

This research provides several directions that could be beneficial in the incorporation of whole grains into the school meals program and increased consumption by children. A gradual approach may be beneficial in enhancing preferences for whole grains by children. However, a more practical approach with fewer levels (25%, 50%, and 75%) may be more appropriate to investigate the quality of whole wheat products acceptable to students.

The psychosocial variables assessed in pre-adolescents indicated that only availability of whole grain was related to whole grain intake; this may be due to the age of the child and dependent nature of the children upon the parents. Follow-up research should include an investigation into which psychosocial variables are predictive of whole grain intake with older children who are less dependent on parents.

The grain group from MyPyramid has grains that can be served as a whole food (e.g. rice, corn, oats, etc.) or separated into parts and altered beyond the original whole food and used as an ingredient (e.g. flours, bran, or germ, etc.). Unique to the grain group are two types of grain - whole grains and refined grains. Grains are commonly served as part of mixed dishes as whole foods or ingredients (e.g. sandwiches, pizza, pasta dishes, corn tortilla, rice). However, because of the two grain groups and advancement in manufacturing it may be more difficult for individuals to identify whole grain products on appearance and taste compared to identifying other groups such as fruits and vegetables. Therefore research needs to develop and validate measurement tools that can accurately measure the amount of whole grain in foods regardless of whether they are served as an ingredient or as an isolated food item such as rice or bulger.

Focus group information indicates that additional research is needed related to the identification and perception of whole grains in school lunch products. Items introduced into the school system need to be cost-effective, high quality products that meet the cultural expectations of school children. For the school lunch environment, it may be important to consider how the overall meal taste/texture/moistness and quality is affected by the combination of whole grain and other accompanying foods.

Ultimately, this research opens a unique opportunity for the food industry to collaborate with government and schools to help shape the availability and use of healthier, acceptable foods in the school environment in a cost-effective manner. Doing this poses the challenge of developing and delivering grain-based foods lower in calories, rich in whole grain / fiber while maintaining taste appeal with limited contributions from fat, sodium and sugar, all within the current USDA cost structure. Therefore research

using plate waste, focus groups, taste tests and video observations may be important. The synergy of research findings based on data collected using these techniques may help develop successful whole grain products for use in school meals and build open communication between key players (e.g. vendors, distributors and manufacturers) in all venues including government, industry and school foodservice.

Future studies also need to assess the influence of taste masking, accompanying food items, and flavor-flavor learning based on the ratio of refined to whole wheat flour, and effects of repeated exposure with whole grain foods (identified and not identified in a school lunch).

The video recording data are currently being analyzed and will address the following topics: differences in whole grain consumption related to on-task and off-task behaviors, difference in bites and sips in fast vs. slow eaters, and whether the frequency of bites and sips of fast vs. slow eaters is correlated with calories consumed in the meal and the source of the calories.

In conclusion, knowledge of the school lunch environment and cultural implications along with a gradual introduction of whole grain flour into familiar products can be an effective approach to increasing whole grain consumption by elementary school children. A dietary shift from refined to whole grains could result in long-term risk reductions for several chronic diseases and improved overall quality of life.

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APPENDICES: Study I

Appendix A: Whole Wheat Introduction Protocol

Gradual Incorporation of Whole Grain Study Time Line

Tanglen Elementary (White Whole Wheat flour)

Month	Ratio WG / RG flour	Exposures / month
September	0 / 100	7
October	11/89	7
November	23/77	9
December/ January	32/68	5
February/ March	45/55	7
March/April	67.5/32.5	12
May	90/10	7

Gatewood Elementary (Red Whole Wheat flour)

Month	Ratio WG / RG flour	Exposures / month
September	0 / 100	5
October	1/99 2/98	3 4
November	5/95 7/93	4 3
December	10/90 14/86	4 3
January	21/79 26/74	4 4
February	32/68 38/62	5 4
March	47/53 59/41	4 5
April	72	6
May	91	8

Specifications:

- Dinner rolls 1.5 oz/ Hamburger buns 2 oz each in weight
- Rolls delivered as frozen dough, proofed, baked on school premises
- Hamburger buns delivered as frozen baked products and held in freezer until day served.

September

- Dinner rolls / Hamburger buns will be made with refined white flour for both Gatewood and Tanglen Elementary Schools

October –May-

- Dinner rolls / Hamburger buns will be made with white whole wheat flour for Tanglen Elementary School at specified level for designated month
- Dinner rolls / Hamburger buns will be made with red whole wheat flour for Gatewood Elementary School at specified level for designated month

Appendix B: Plate Waste Protocol

PLATE WASTE PROTOCOL

Location: **Gatewood Elementary School**
Hopkins Public School District #270
14900 Gatewood Drive
Minnetonka, MN USA 55305

Kitchen Staff:
Kim- Cook
Diane- cashier
Beverly- server/dishwasher
Stacey-server/dishwasher

Lunch monitors in each room
Debra
Debra

Study Subjects: All children who purchase school lunch and have the item of interest (dinner rolls or hamburger buns).

Lunch Period: The schedule for collecting plate waste at Gatewood Elementary School will be approximately 12:15 PM to 2:15 PM. The following is a list of specific times and grades:

	Recess	SSR	Lunch
11:45	5th		
12:00 (Noon)	6th		
12:15	3rd	5th	
12:30	1st	6th	5th
12:45	2nd	3rd	6th
1:00	4th	1st	3rd
1:15		2nd	1st
1:30		4th	2nd
1:45			4th

SSR represent silent reading

Materials used during plate waste:

- One 33 gallon trash can with U of M sticker and label of roll and buns.
- Clean trash bags
- One hand counter
- One A and D digital scale (Model: SK-20KWP serial number:)
- Binder all pertinent information including data sheets, protocols, and all contact information (this will be on the cook's table)
- Several pairs of gloves

- Writing utensils: Pens, pencils, and marker

IF ANY SUPPLIES RUN LOW PLEASE CALL RENEE AT 952-451-6994 AND INFORM HER OF WHAT IS LOW AND NEEDS TO BE REPLENISHED.

Procedures:

Set-up

- **Locate the 33-gallon trash container** for collecting the bread item. This will be in the corner of the lunchroom.
- **Set up the 33-gallon trash container** next to the trash containers in front of the dish room closet to the entrance of the hallway (next to the red trash container). The only products collected will be dinner rolls or hamburger buns. Make sure that the correct label for the bread item being collected is facing the children.
- There will be **two 5 gallon buckets inside the large 33-gallon trash container**. If it is a hamburger bun day these buckets will be used. Set these buckets next to the 33-gallon trash container. On dinner roll days these extra buckets will not be used and should be stored under the table against the wall in the lunchroom.
- **The scale and all materials needed for the plate waste collection will be on a cart stored in the dry storage room of the Gatewood Elementary kitchen.** (This is the first door on your right when entering the service line). Bring these materials out into the lunchroom and use the table against the wall for set up.
- **1st line the trash containers**
  - Place a trash bag inside the 33-gallon trash container. This may be a large black bag or one of the recyclable trash bags. Both bags are available in the basket. Once a bag lines the trash container, secure the bag by snapping on the lid to prevent the trash bag from falling into the can during collection. NOTE: there is a hole cut in the top of the lid
  - If hamburger buns are being collected today line the two 5-gallon buckets with the smaller roll of black bags. One of the buckets will be used to collect salads that contain our dinner roll of the day. The other bucket will be used to scrap off the meat product on the hamburger bun before discarding the hamburger bun in the 33-gallon trash container.
- **Set- up the scale**. Use the front right corner of the table to set up the scale. In order to accurately weigh the bread items, the scale must be balanced. Using the levelling indicator on the left front side of the scale, adjust the legs of the scale until the bubble is directly in the middle of the circle.

- **Basic weighing procedure**:
  1. Make sure the scale was balanced.
  2. Turn on the scale by pressing the ON/OFF button. (The scale will automatically turn off to conserve batteries.)
  3. If the item of interest is going to be weighted on a plate or bag, place the plate or bag on the scale and press the TARE button. This will re-zero the scale.
  4. Place the item of interest on the scale.
  5. Record the weight.

- Once the scale is set up, ask the cook for 5 servings of the bread item of interest before lunch starts for the children.
    - Accurately weigh these and record on the **PLATE WASTE--ITEM WEIGHT** sheet. Specific instructions can be found on this sheet.
    - There are a couple of example sheets of the products being collected (rolls and sloppy joes) to assist in filling out the item weight sheet correctly.
    - Another 5 items will be weighed after the last children are served lunch. The cook usually brings the items out. If not go ask the cook for 5 more of the bread item of interest.

Counter/Server

- In order to accommodate the two different products being collected in plate waste (hamburger bun and dinner roll), two different counting techniques will be used so make sure the correct form is used depending on the product being served.
- When counting hamburger buns, the counter will be positioned at or by the cash register in order to keep track of the number of students buying the hamburger bun.
    - This person will also keep track of students buying additional servings of the food of interest (example two sloppy joes or a student went back and received seconds of the sloppy joe)
    - This person will also keep track of the number of salads being taken for the day and note if our roll is in the salad or another bread product.
    - **NO ADULTS WILL BE COUNTED IN THE MAIN COUNT BUT NEED TO BE TRACKED.**
    - There is a sheet in the binder **(PLATE WASTE COUNTER SHEET)** that will be used to record this data. Exact protocol sheet is located in front of the collection data sheets.
- On days when rolls are being served at Gatewood, there does not need to be a counter. However, this server will serve as the counter too.
- Any child may receive a dinner roll if purchasing a school lunch (This is the main meal, a salad or a sandwich). Children may also purchase a dinner roll Ala Carte.
- **Specific instruction on how to keep track of the number of rolls being served to the children will be on the PLATE WASTE—DINNER ROLL SERVER/COUNTER PROTOCOL.** Following the protocol is the plate waste-dinner roll server/counter sheet example and data collection sheets.

Collection

- Again make sure the sign indicating the food item being collected is facing the students in the cafeteria.
- One or two food collectors will help the students place the food of interest in the U of M trash can while making sure to avoid letting any non-collected food items goes into the U of M trash can (including beverages).
- These collectors will also monitor to make sure the food of interest does not get discarded into the organic or trash containers.
    - On days when hamburger buns are used, separate the hamburger bun from the meat item. Use one of the small 5 gallon buckets to throw the meat

in. The second five-gallon bucket can be used to collect any dinner rolls from the salads (if it is the correct product—this can be confirmed with the counter).

Measurements

- The total weight of plate waste will be recorded on the **PLATE WASTE-TOTAL WEIGHT AMOUNT** data sheet. An example plate waste-total weight amount data sheet is available.
- Due to the small size of the scale, several sets of weighing of the product may be necessary. Place one of the baskets on the scale (if you are using a bag to line the basket also include this to be weighed). Once this is on the scale, press the **TARE** button. This should reset your scale to zero. Weigh the products and record information on the **PLATE WASTE ---TOTAL WEIGHT AMOUNT** data sheet.
- Keep the weighed product under the table until all products have been weighed. **DO NOT** discard weighed rolls into the organic trash because the children may then see the rolls in the trash and discard the product of collection in the garbage instead of our trash container.

Clean-up

- When all rolls or product has been weighed, all food needs to be discarded.
- Because Gatewood is recycling, the rolls need to be placed in a special plastic bag and then taken to the organic trash bin.
- The special plastic bags are a light pink color. There should be some of these bags in the basket.
- Please wipe off all containers and items before storing away in original places.

THANK YOU FOR YOUR HELP

Appendix C: Plate Waste Item Weights

PLATE WASTE ---ITEM WEIGHT

Calculations for plate waste:

1. Record weight of item of interest in the following table
2. Write the item of interest (dinner roll or hamburger bun) in the sample item column. If it is a hamburger, record weight of bun in one sample item column and burger and toppings in the other sample item column.
3. Determine the weight of the item and record the weight in the adjacent column.
4. Calculate the sum and mean for item of interest.
5. Fill in bottom portion of the sheet.
6. Write down any observations that may help in the analysis in the Notes area. Example: Most of buns collected were crust only inner soft bread was taken out and eaten. Most of the buns were saturated with marinara sauce.

Sample item	Weight in kg	Sample item	Weight in kg
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	
7.		7.	
8.		8.	
9.		9.	
10.		10.	
Sum			
Mean			

Name of person recording weight of item of interest_____
Date_____
Time_____

Notes_____
_____
_____
_____
_____

Appendix D: Record Sheets

RECORD SHEET FOR BUN COUNT

Date	Number of buns received	Number of buns served	Number of buns thrown away	Notes	Initials

RECORD SHEET FOR ROLL COUNT (COOK)

Date	Number of rolls proofed	Number of rolls baked	Notes	Initials

RECORD SHEET FOR ROLL COUNT (SERVER)

Date	Number of rolls served (students getting collected food)	Number of students getting additional serving of collected food	Notes	Initials

PLATE WASTE ---Total weight amounts

1. Write in the provided columns the item being weighed and then the corresponding weight.

2. If more than one product is weighted please keep the items separate by item (look at example sheet if needed).

3. In the space below the chart, write down any observations that may be important during analysis of this data.

Item	Weight (kg)
TOTAL	
TOTAL	

Date_____
Person recording information_____

NOTES_____
_____
_____

Appendix E: Calculation for total plate waste

TOTAL PLATE WASTE CALCULATION FOR HAMBURGER BUNS

Information on sheets will be used for all calculations.

All information from recording forms were documented in excel (highlighted) where calculations were performed.

	May 1st					
TOTALS	Number served	Hamburger bun weight	meat weight	meat + bun weight	waste weight (kg)	waste weight (kg)
cheeseburger	379	0.06	0.06	0.12	meat	6.76
cheeseburger		0.06	0.06	0.12	Hamburger bun	6.77
cheeseburger		0.06	0.06	0.12	meat + bun	13.53
cheeseburger		0.06	0.06	0.12	roll	N/A
cheeseburger		0.06	0.06	0.12		
cheeseburger		0.05	0.06	0.12		
cheeseburger		0.06	0.06	0.12		
cheeseburger		0.06	0.06	0.12		
hamburger		0.05	0.06	0.11		
hamburger		0.05	0.06	0.11		
SUM	379	0.57	0.6	1.18		
MEAN		0.057	0.06	0.118		
		NOTE: bun weighed = meat juiced soaked buns				
Plate waste calculations						
weight of meat + buns (kg)	44.722	=(number served) x (meat + bun weight mean)				
Consumed weight of meat + buns (kg)	31.192	=(weight of meat + buns) - (waste weight meat + bun)				
% food consumed	69.75%	=(consumed weight of meat + buns)/(weight of meat + buns) x 100				
% plate waste	30.25%	=(100 - % food consumed)				
weight of meat waste (kg)	22.74	=(number served) x (meat weight mean)				
Consumed weight of meat (kg)	15.98	=(weight of meat waste) - (waste weight meat)				
% food consumed	70.27%	=(consumed weight of meat)/(weight of meat) x 100				
% plate waste	29.73%	=(100 - % food consumed)				
weight of hamburger buns (kg)	21.603	=(number served) x (hamburger bun weight mean)				
consumed weight (kg)	14.833	=(weight of hamburger buns) - (waste weight hamburger bun)				
% food consumed	68.66%	=(consumed weight of hamburger buns)/(weight of hamburger buns) x 100				
% plate waste	31.34%	=(100 - % food consumed)				

TOTAL PLATE WASTE CALCULATION FOR ROLLS

April 25th Plate waste			
TOTALS	Number served	roll weight	Total waste weight (kg)
Roll	404	0.04	4.79
Roll		0.04	0
Roll		0.04	0
Roll		0.04	
Roll		0.04	
Roll		0.04	
Roll		0.04	
Roll		0.04	
Roll		0.04	
Roll		0.04	
SUM	404	0.4	4.79
MEAN		0.04	
Plate waste calculations			
weight of rolls (kg)	16.16	=(number served) x (roll weight mean)	
Consumed weight (kg)	11.37	=(weight of rolls) - (waste weight roll)	
% food consumed	70.36%	=(consumed weight of rolls)/(weight of rolls) x 100	
% plate waste	29.64%	=(100 - % food consumed)	

APPENDICES: Study II

Appendix A: Instructions for Food Record Form

Dear Parent and participating child,

Attached you will find a sheet where we would like you to record the food you eat for the following time period_____.

Directions:

- During the appointed time frame, we would like your child to record their food intake. This specific time will be located at the top of this sheet and the attached food record sheet. These times have been individualized for each child participating based on when the individual interview is to be held.

- During this specific time, we would like your child to write down all of the foods or beverages they eat. Please include ALL foods and drinks. This includes water and snacks throughout the day.

- Please try and be as specific as possible and include the brand names if applicable and amounts you ate in the description of food column.

Examples:

1. This is an example of a prepared product bought from the store.

Food I Ate or Drank (Filled out by child)	When did you eat this food? Check one	Description of Food (Filled out by parent or child)	Where did you eat this food? Check one
Pizza	Breakfast ☐ Lunch ☐ Dinner ☒ Snack ☐	2 slices of Tony's sausage (about ¼ of the pizza)	At home ☒ At school ☐ Restaurant ☐ Other ☐
Salad	Breakfast ☐ Lunch ☐ Dinner ☒ Snack ☐	Dole just lettuce ¾ cup with 2 tbsp of hidden valley ranch lite ranch dressing	At home ☒ At school ☐ Restaurant ☐ Other ☐
Soda	Breakfast ☐ Lunch ☐ Dinner ☒ Snack ☐	Coke 12 oz can	At home ☒ At school ☐ Restaurant ☐ Other ☐

2. This is an example of food made at home.

Food I Ate or Drank (Filled out by child)	When did you eat this food? Check one	Description of Food (Filled out by parent or child)	Where did you eat this food? Check one
Pork chops	Breakfast ☐ Lunch ☐ Dinner [X] Snack ☐	Boneless 4oz breaded and baked in oven	At home [X] At school ☐ Restaurant ☐ Other ☐
Broccoli	Breakfast ☐ Lunch ☐ Dinner [X] Snack ☐	Fresh steamed 5 floweret's	At home [X] At school ☐ Restaurant ☐ Other ☐
Mashed potatoes	Breakfast ☐ Lunch ☐ Dinner [X] Snack ☐	Betty Crockers instant garlic and butter about 1/2cup	At home [X] At school ☐ Restaurant ☐ Other ☐
Water	Breakfast ☐ Lunch ☐ Dinner [X] Snack ☐	Tap water 2 cups	At home [X] At school ☐ Restaurant ☐ Other ☐

Please feel free to call Renee (952)-451-6994 with any questions when filling out the record form.

Thanks for your participation,

Renee

Food Record

Children:
Write down the names of all the foods you eat and drink on ___________________________
From _____________________Until______________________
In the first column write down the food you ate during the above time.
In the second column check the boxes when you ate the food.
In the last column check the box where you ate the food.
Parents or Children:
Write a description of the foods (meals and snacks) on the lines in the third column.

Food I Ate or Drank (Filled out by child)	When did you eat this food? Check one	Description of Food (Filled out by parent or child)	Where did you eat this food? Check one
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐

PLEASE REMEMBER TO BRING THIS FORM ALONG TO YOUR INTERVIEW.

Food I Ate or Drank (Filled out by child)	When did you eat this food? Check one	Description of Food (Filled out by parent or child)	Where did you eat this food? Check one
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐
	Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐		Home ☐ School ☐ Restaurant ☐ Other ☐

PLEASE REMEMBER TO BRING THIS FORM ALONG TO YOUR INTERVIEW.

Appendix C: Whole Grain Inventory

Name_____Date_____

Directions: Fill in the box next to any of the following whole grain products you CURRENTLY have in your home. Specify type, brand or flavor if applicable. Look in all the areas where you store foods made with whole grains including pantries, cupboards, refrigerators and freezers. If you have whole grain items that are not on the list, please write the items on the lines provided. This survey should take about 10-15 minutes to complete.

Whole Grain Pasta and Grains

Arrowhead mills

- ❑ buckwheat ground oats
- ❑ millet

Barilla Plus Pastas

- ❑ specify type_____
- ❑ specify type_____

Dececco pasta

- ❑ specify type_____
- ❑ specify type_____

Food for life Ezekiel pasta

- ❑ specify type_____
- ❑ specify type_____

Healthy Harvest noodles

- ❑ specify type_____
- ❑ specify type_____

Hodgson mills

- ❑ whole wheat couscous
- ❑ whole wheat pasta

Knorr Lipton pasta sides

- ❑ chicken
- ❑ alfredo

Kraft

- ❑ Super mac and cheese

Other miscellaneous grains

- ❑ barley
- ❑ quinoa
- ❑ whole wheat couscous

Other not listed

- ❑ specify food_____
- ❑ specify food_____

Whole Grain Rice

Knorr Lipton rice sides

- ❑ sesame chicken
- ❑ chicken broccoli

Near East

- ❑ wheat pilaf
- ❑ chicken and herbs
- ❑ taboule

Rice a roni savory whole grains

- ❑ chicken and herb
- ❑ roasted garlic italiano

Uncle Ben's

- ❑ long grain and wild rice

Other miscellaneous rices

- ❑ brown rice
- ❑ wild rice

Other not listed

- ❑ specify food_____
- ❑ specify food_____
- ❑ specify food_____
- ❑ specify food_____

Tacos/Tortillas

Corn taco shell (hard)

- ❑ specify brand_____

Cruz

- ❑ whole grain flour tortillas

La tortilla

- ❑ whole grain flour tortillas

Mission

Resers

- ❑ whole grain flour tortillas

Corn tortilla (soft)

- ❑ specify brand_____

Other not listed

- ❑ specify_____
- ❑ specify_____

❑ whole wheat flour tortilla

❑ specify_____

Frozen Waffles

Eggo

❑ Nutrigrain waffles

Kashi

❑ Go Lean waffles

Other not listed

❑ specify food_____

❑ specify food_____

❑ specify food_____

Pizza

Di Giorno's Harvest Wheat Pizza

❑ specify type_____

South Beach Diet Pizza

❑ specify type_____

Freschetta Pizza with Wheat Crust

❑ specify type_____

Tombstone Harvest Wheat Pizza

❑ specify type_____

Other not listed

❑ specify food_____

❑ specify food_____

❑ specify food_____

Frozen Entrees

South Beach Diet Frozen Entrees

❑ Cashew chicken & sugar snap peas

❑ Mediterranean style chicken with couscous

Other not listed

❑ specify food_____

❑ specify food_____

Lean Cuisine Frozen Entrees

❑ Rosemary chicken

❑ Pork with cherry sauce

❑ Chicken pecan

❑ Lemongrass chicken

❑ Lemon chicken

Bagels/English Muffins

Natural Ovens Bagels

❑ Whole Grain and Brainy

❑ Golden Crunch Bagels

Pepperidge Farms

❑ 100% Whole Wheat Mini Bagels

Village Hearth

❑ 100% Whole Wheat bagels

Thomas Products

☐ 100% Whole Wheat Mini Bagels

☐ 100% Whole Wheat Bagel-Hearty Grains

☐ 100% Whole Wheat English Muffins

Other not listed

❑ Specify food_____

❑ Specify food_____

Granola Bars

Nature Valley Granola Bars

❑ specify type_____

Quaker Granola Bars

❑ specify type_____

Other not listed

❑ specify food_____

❑ specify food_____

❑ specify food_____

Cookies

South Beach Diet

❑ Oatmeal Chocolate Chip Cookies

❑ Peanut Butter Cookies

Fig Newtons

❑ Whole Grain Fig Newtons

Chips Ahoy Cookies

❑ Whole Grain Chips Ahoy

Other not listed

❑ Specify food_____

❑ Specify food_____

Cooked Cereal

Kashi Cooked Cereals

- ❑ Go Lean
- ❑ Heart to Heart

Other not listed

- ❑ Specify food_____

Other cooked cereals

- ❑ Maypo
- ❑ Oatmeal
- ❑ Nature's Hand
- ❑ Red River Cracked Wheat

Dry Cereal

Various brands

- ❑ All Bran (any kind)
- ❑ Bran Flakes
- ❑ Cinnamon Toast Crunch
- ❑ Cheerios (any kind)
- ❑ Cocoa Puffs
- ❑ Cookie Crisp
- ❑ Count Chocula
- ❑ Eggo Cereal
- ❑ Fiber One (any kind)
- ❑ French Toast Crunch
- ❑ Frosted Chex
- ❑ Frosted Mini Wheats (any kind)
- ❑ Frosted Shredded Wheat
- ❑ Golden Grahams
- ❑ Granola
- ❑ Grape Nuts
- ❑ Grape Nut Flakes
- ❑ Kix
- ❑ Life (any kind)
- ❑ Lucky Charms (any kind)
- ❑ Oatmeal Crisp (any kind)
- ❑ Oatmeal Squares (any kind)
- ❑ Peanut Butter Toast Crunch
- ❑ Raisin Bran
- ❑ Raisin Bran Crunch
- ❑ Raisin Nut Bran
- ❑ Reese's Puffs
- ❑ Shredded Wheat
- ❑ Trix
- ❑ Total (any kind)
- ❑ Wheat Chex
- ❑ Wheaties
- ❑ Uncle Sam

Cub Foods Brand Cereal

- ❑ Apple Cinnamon Toasted Oats
- ❑ Cinni-Mini Crunch
- ❑ Nutty Nuggets
- ❑ Oats and More

Malt O Meal Bagged Cereals

- ❑ Apple Cinnamon Toasty O's
- ❑ Honey Nut Toasty O's
- ❑ Mini Spooners (any kind)

Kashi Cereals

- ❑ Autumn Wheat
- ❑ Go lean
- ❑ Go Lean Crunch
- ❑ Good Friends (any kind)
- ❑Heart to Heart
- ❑ Mighty bites

Post Selects

- ❑ Banana Nut Crunch
- ❑ Cranberry Almond Crunch
- ❑ Great Grains Raisins, Dates, & Pecans
- ❑ Maple Pecan Crunch

Quaker Cereals

- ❑ Oat Bran
- ❑ Toasted Oatmeal

South Beach Diet Cereals

- ❑ Toasted Wheats
- ❑ Whole Grain Crunch

Sunbelt Cereals

- ❑ Berry Basic
- ❑ Granola Cereal (any kind)

Other not listed

- ❑ specify food_____
- ❑ specify food_____
- ❑ specify food_____

Bread and Buns

Brownberry Bread Products

- ☐ 7 Grain
- ☐ 12 Grain
- ☐ 100% Whole Wheat
- ☐ Double Fiber
- ☐ Dutch Country 100% whole wheat
- ☐ Dutch Country Oats & Honey
- ☐ Dutch Country Sandwich
- ☐ German Dark Wheat
- ☐ Healthy Multi grain
- ☐ Natural Wheat
- ☐ 100% Whole Wheat Sandwich Buns

Country Hearth Bread Products

- ☐ 100% Whole Wheat
- ☐ Cracked Wheat
- ☐ Stone Ground

Earth Grains

- ☐ 100% whole wheat
- ☐ 100% whole wheat made with honey

Great Harvest Bread Products

- ☐ Flax Oat Bran
- ☐ Honey Whole Wheat
- ☐ Multigrain
- ☐ Raisin Whole Wheat
- ☐ Sunflower Whole Wheat

Healthy Choice

- ☐ Hearty 7-grain

Home Pride

- ☐ 100% whole wheat
- ☐ Honey whole wheat

Mestemacher

- ☐ specify type_____

Natural Ovens Bread Products

- ☐ 100% Whole Grain
- ☐ Harvest Grain
- ☐ Health Max
- ☐ Honey Wheat
- ☐ Hunger Filler
- ☐ Multi-Grain
- ☐ Oatmeal
- ☐ Whole Grain White

New French

- ☐ Whole Grain Ciabatta

Pepperidge Farms

- ☐ 15 Grain
- ☐ Light Style Bread Soft Wheat
- ☐ Honey Oat
- ☐ Honey Whole Wheat

Sara Lee Bread Products

- ☐ 100% Whole Wheat
- ☐ Delightful 100% Whole Wheat
- ☐ Heart Healthy 100% Multigrain
- ☐ Soft & Smooth Whole Grain White
- ☐ 100% Whole Wheat Bakery Buns

Thomas

- ☐ 100% Whole Wheat Cinnamon Raisin Swirl

Weight Watchers

- ☐ Whole Wheat bread

Wonderbread Products

- ☐ 100% Whole Wheat
- ☐ Made with Whole Grain White

Other not listed

- ❑ specify food_____
- ❑ specify food_____

Frozen Dough/Bread/Rolls

Alexia
- ☐ Whole Grain Whole Wheat Rolls

Pillsbury
- ☐ Oven Baked 100% Whole Wheat

Rhodes
- ☐ 100% Whole Wheat Bread

Other not listed
- ❑ specify food_____

Chips and Snacks

Beartios Tortilla Chips
- ☐ specify type_____

Corn Nuts (any kind)
- ☐ specify flavor_____

Doritos
- ☐ specify flavor_____

Fritos
- ☐ specify flavor_____

Garden of Eatin Tortilla Chips
- ☐ specify flavor_____

Sun Chips
- ☐ specify flavor_____

Tostitos
- ☐ specify type_____

Popcorn
- ☐ specify type_____

Quaker Rice Cakes
- ☐ multi-grain
- ☐ brown rice
- ☐ mini brown rice

Other not listed
- ☐ specify food_____
- ☐ specify food_____
- ☐ specify food_____

Whole Grain Flour, Mixes, and Grain

Whole wheat flour
- ☐ specify brand_____

Whole grain pancake mix
- ☐ specify brand_____

Other not listed
- ☐ specify food_____
- ☐ specify food_____
- ☐ specify food_____

Whole Grain Crackers

Pepperidge Farms
- ☐ Whole Grain Goldfish Crackers

Ry Krisp
- ☐ specify type_____

Siljans
- ☐ Whole Rye Crispbread

Other not listed
- ☐ Specify food_____

South Beach Diet
- ☐ Whole Wheat Crackers

Triscuits
- ☐ specify flavor_____

Wheat Thins
- ☐ 100% Whole Grain

Other not listed
- ☐ specify food_____

Please answer the following questions:

1. When you filled out this form, was it based on the usual amount of food that you have available in your home?

   ❑ Yes ❑ No ❑ Unsure

   b) If No, do you usually have more or less of any of these foods?

   ❑ More ❑ Less

2. Do you usually give your child a vitamin pill?

❑ Yes ❑ No

b) If yes, specify name brand and type_____
_____

3. What is your relationship to the child in this study?

❑ Parent (includes step-parent and foster parent)
❑ Grandparent
❑ Aunt or Uncle
❑ Sibling
❑
❑ Other, specify: _____

About You

Directions: Check one box for each question unless otherwise indicated. Please answer these questions about yourself and not your child.

1. How old are you? _____ years

2. What is your gender? ❑ Female ❑ Male

3. What is your highest level of formal education?

☐ Up to 8th grade
☐ Some high school
☐ High school graduate or GED
☐ Some college or technical school
☐ College graduate (4-year college or university or advanced degree)

4. Which of the following best describes your employment status?(Mark only one.)

☐ Student
☐ Homemaker
☐ Not employed
☐ Employed part-time
☐ Employed full-time
☐ Retired

5. Which of the following do you consider yourself to be? (Mark only one.)

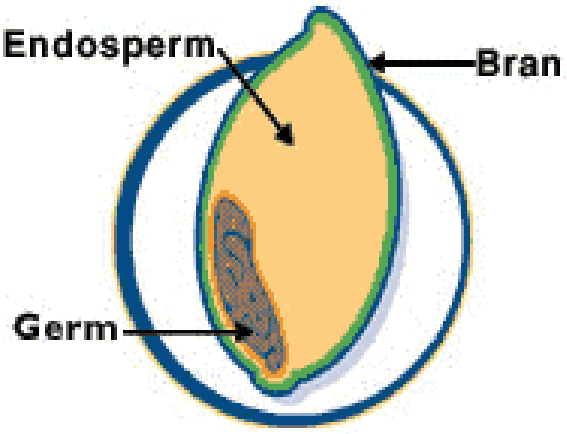
☐ American Indian or Alaska Native
☐ Asian or Asian American
☐ Black or African American
☐ Hispanic or Latino
☐ White or Caucasian
☐ Other, specify: _____

PLEASE RETURN TO SCHOOL WITH YOUR CHILD. THESE WILL BE COLLECTED AT THE INTERVIEWS.
THANK YOU FOR YOUR PARTICIPATION.

Food Choices Survey

This survey will help us learn more about choices you make when choosing foods. There are no right or wrong answers, so just answer each question as best you can.

What is a whole grain? A whole grain contains all parts of the grain kernel.



Each whole grain is made up of 3 parts:

- **Bran**: "outer shell" that protects the seed, contains antioxidants, B vitamins and fiber.
- **Endosperm**: "largest portion", contains starchy carbohydrates, proteins and small amounts of vitamins and minerals.
- **Germ**: food for the seed, contains B vitamins, some protein, minerals, and fats.

Some common grains are corn, rice, oats and wheat.

What is a refined grain? Refined grain contains only the endosperm and not the bran and germ parts of the grain kernel.

WHOLE GRAIN FOODS
Whole grain foods are those that list "whole grain" as the "first ingredient" on the label.
SOME EXAMPLES INCLUDE:
Popcorn
Oatmeal
Triscuits
Whole wheat bread
Brown rice

REFINED GRAIN FOODS
Refined grain foods are those that list "enriched flour" as the "first ingredient" on the label.
SOME EXAMPLES INCLUDE:
Saltine crackers
White bread made from refined grain flour
White rice
Rice Krispies

Directions: The following questions ask you how much you like whole grain foods. Please put an **"X"** in the box for the best answer for each question.

	Never tried it	I hate it	I don't like it	It's OK	I like it	I love it
Oatmeal	❑	❑	❑	❑	❑	❑
b. Whole grain cereal (like Mini wheats, Total, Cheerios)	❑	❑	❑	❑	❑	❑
c. Whole grain bagels or English muffins	❑	❑	❑	❑	❑	❑
d. Pizza with whole grain crust	❑	❑	❑	❑	❑	❑
e. Whole grain bread (like whole wheat bread or rolls)	❑	❑	❑	❑	❑	❑
f. Whole grain crackers (like Triscuits, "Whole grain" Wheat thins)	❑	❑	❑	❑	❑	❑
g. Popcorn	❑	❑	❑	❑	❑	❑
h. Whole wheat noodles like spaghetti	❑	❑	❑	❑	❑	❑
i. Brown rice	❑	❑	❑	❑	❑	❑
j. Corn chips (like Doritos, Fritos, or Sun Chips)	❑	❑	❑	❑	❑	❑
k. Whole wheat tortilla	❑	❑	❑	❑	❑	❑
l. Whole grain pancakes, waffles, or French toast	❑	❑	❑	❑	❑	❑
m. Hard taco shell	❑	❑	❑	❑	❑	❑
n. Corn tortilla	❑	❑	❑	❑	❑	❑

Directions: The following questions ask you to think about your beliefs about whole grain foods. Please put an **"X"** in the box beside your best answer for each question.

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
Whole grain foods keep me from being hungry between meals.	❑	❑	❑	❑	❑
Whole grain foods make me gain weight.	❑	❑	❑	❑	❑
Whole grain foods are good for me.	❑	❑	❑	❑	❑
Whole grain foods help me think better at school.	❑	❑	❑	❑	❑
Whole grain foods make me constipated.	❑	❑	❑	❑	❑
Whole grain foods help me grow strong.	❑	❑	❑	❑	❑
Whole grain foods keep my heart healthy.	❑	❑	❑	❑	❑
Whole grain foods upset my stomach and give me gas.	❑	❑	❑	❑	❑
Whole grain foods give me energy to run and play.	❑	❑	❑	❑	❑
Eating more whole grain foods pleases my parents.	❑	❑	❑	❑	❑

Directions: The next questions ask about whether you are able to do eat whole grain foods. Please put an **"X"** in the box beside the best answer for each question.

I can eat whole grain foods when...	I'm not sure I can	I'm a little bit sure I can	I know I can
a. I don't like whole grain foods.	❑	❑	❑
b. I eat at restaurants.	❑	❑	❑
c. My friends don't eat whole grain foods.	❑	❑	❑
d. I don't have time to make whole grain snacks.	❑	❑	❑
e. I would rather eat other grain foods instead.	❑	❑	❑
f. There are no whole grain foods I like available.	❑	❑	❑
G I don't know which foods are whole grains.	❑	❑	❑
h. I have many other food choices.	❑	❑	❑
i. I want half of the grain foods I eat to be whole grain.	❑	❑	❑

1. How many servings of whole grain foods do you need to eat every day?

I don't know	None	One third of all the grain foods I eat	Half of all the grain foods I eat	All of the grain foods I eat
❑	❑	❑	❑	❑

About You

Directions: Check one box for each question unless you are told to "mark all that apply".

1. What grade are you in?
   - ☐ 4th grade
   - ☐ 5th grade
   - ☐ 6th grade

2. What is your gender? ☐ Female ☐ Male

3. How old are you? _____years

4. Which of the following do you consider yourself to be?
(Mark all that apply.)
   - ☐ American Indian or Alaska Native
   - ☐ Asian or Asian American
   - ☐ Black or African American
   - ☐ White or Caucasian
   - ☐ Hispanic or Latino
   - ☐ Other, specify: _____

When you have completed the survey, please check to make sure you have answered all the questions you wanted to. Thank you for your participation!

APPENDICES: Study III

Appendix A: Protocol Dine Coding

EATING BEHAVIORS

I. BITE (B)

Definition: Any taking of solid food into the mouth. The food must pass between the child's lips before it is considered a bite. Only code a bite after the food passes the child's lips.

A. Examples of 1 bite:

1. Child takes multiple bites of corn off the cob WITHOUT removing the cob from his/her mouth.
2. Child requires more than 1 interval to suck spaghetti into his/her mouth.
3. If the child uses his/her thumb and index finger to pick something up from plate or table and places it in his/her mouth, regardless of whether the food is obvious.
4. If food falls out of the child's mouth, but is immediately replaced within the current interval, it is coded as one bite not two.

In addition, a "Spit up" is not coded since the food fell out and was replaced. If the child eats what has fallen out in subsequent intervals, then it is coded as a new bite as appropriate.

B. Non-examples:

1. Putting an empty utensil in the mouth.
2. Taking a filled utensil from a serving dish to the plate, where food is removed, after which the serving utensil is brought to the mouth.
3. Licks: licking fingers is not coded as a bite unless there is an obvious glump of food on fingers.

II. SIP (S):

Definition: Bringing a glass, cup, straw, or spoonful of liquid to the lips. Includes water. A sip is terminated by removal of the vessel from the lips.

A. Drinking from cup or container (milk or juice): When child is drinking from a container holding liquid, only discrete sips can be coded. If the child drinks continuously from this container, this is represented by coding 1 sip in the interval in which the child begins to drink. For a new sip to be coded, the container must be removed and then brought back up to the lips. There is no limit to the number of discrete sips that can be scored within an interval.

III. SPIT-UP (Sp):

Definition: Refers to any time the child spits-up, spits out or purposely drops food from his/her mouth. Action may be deliberate or involuntary. Also included are instances when food comes out of the mouth as a result of overfeeding and is not replaced. A BITE MUST BE CODED BEFORE A SPIT-UP CAN OCCUR. if the child purposely removes food from his/her mouth (with hand or utensil) and then replaces it within the same or subsequent interval, this is not coded as spit up.

VI. SEGMENT/REMOVE INSIDE (Sg)

Definition: Refers to any time the child is dividing any part of a food item for any reason or Refers to taking the inner part of a food out and consuming only this inner part.

Action may be deliberate or involuntary.

A. Examples of segment

1. Child uses utensils to cut a piece of Salisbury steak before eating.
2. Child uses hands to tear a piece of roll off to place in the mouth.
3. Child only eats sloppy joe and not the bun.
4. Child only eats BBQ pork and not the bun.
5. Child removes the inside of a bread product and leaves the outer shell
6. Child removes the cheese from inside the cheese stick or stuff crust pizza and eats the cheese but leaves the crust/bread.
7. Child unrolls burrito shell and removes this part off of the remaining in tacked burrito.

V. COMBINE (C)

Definition: Refers to any time the child directly adds something to the food to increase moisture content or flavor. Only include edible items. Do not include items previously added that analyzer did not see added. DO NOT INCLUDE WIPE/DUNK. WIPE/DUNK is a separate category.

A. Examples of adding:

1. Child adds condiments to a hamburger such as ketchup.
2. Child adds salt or pepper to food.
3. If the child uses a utensil to add items to a food such as butter to a roll.
4. Adding spaghetti sauce to a bread item.
5. Child mixes vegetables and mashed potato before eating the mashed potatoes.
6. Child uses a food item as a utensil, such as using tortilla chips to pick up sauce or using a roll to eat mashed potatoes

B. Non-examples of adding:

1. Child added ketchup to hamburger before sitting down.
2. Gravy added to mashed potatoes during the serve.
3. Child pours liquid on the tray. This maybe considered play and will be discussed under the PLAY section.

VI. WIPE/DUNK (W)

Definition: Refers to any time the child uses food items to add or remove a liquid sauce. This can include adding sauce (such as dunking) to a food item or wiping excess sauce from a food item.

A. Examples of wipe:

1. Child uses roll to finish the spaghetti sauce on the tray.
2. Child wipes pizza on side of tray to get excess sauce off.
3. Child dunks maxi stick into marinara sauce.
4. Child wipes excess burrito filling on tray.
5. Child dunks chicken nugget into bbq or ketchup on tray.

LICKING UTENSIL (LS):

Definition: Refers to any time the child licks a utensil with out having fodd on the utensil.

Examples of licking utensil

Child licks the spoon totally clean after eating soup off of the spoon.
Child licks the spoon after eating corn off of spoon.
3. Child Licks food off of fingers. The food is handheld and does not require a utensil. Therefore the fingers are considered the utensil.

LICKING FOOD (L)

Definition: Refers to any time the child licks a food to consume it or taste it.

Examples of licking food

Licking the frosting off of a cupcake to consume it.
Licking jelly off of a sandwich to consume it.

CHILD BEHAVIORS

REQUESTS FOR FOOD (Q):

Definition: Any verbal or nonverbal behavior initiated by the child in which the child asks for additional food or a new food from a friend.

Examples: Includes asking for or pointing and receiving food from another person.

PREPARATION (Prep)

Definition: Any preparation a child may have to do prior to eating food that is not related to any other topic already mentioned.

Example: Child having to open milk container.
Child having to open wrapper on sandwich (saran wrap) prior to eating.
Arranging the sandwich a certain way before eating.

CHILD TALK (CT):

Definition: Any verbalization by the target child. A verbalization is defined as a complete phrase or a single word that stands alone.

A. **Verbal Child -** talk for a verbal child includes recognizable conversation

Examples: Talking

humming or singing
Nyah, nyah, nyah

Non-examples:
Nodding or other nonverbalizations (unless in the case of a nonverbal child verbalizing with "uh, uh, uh." The verbalization is coded but not the nodding, etc.)
Grunts by a verbal child

XII. AWAY (A):

Definition: Any time the child is more than an arm's length from his/her place of food (regardless if standing or sitting).

A. QUALIFICATIONS:
   1. A Play (P) cannot be coded while the child is Away (A).
   2. Bites and Sips are the only child behaviors that can be coded if child is away and is visible on camera.

B. Examples:
   1. The child gets up and walks away from the table.

C. Non-examples:
   1. Do not code an Away (A) if the plate has been removed from the table by the friend/teacher for a second helping and the child remains seated at the table.
   2. The child stands more than an arm's length from his/her plate but takes his/her main source of food and eats while standing next to the table.

OBSTRUCTIVE VIEW (O):

While observing the tape, if the child being observed is obstructed for any reason put an O in the space.

Examples of obstruction:

Child sitting next to person stands up and blocks view.
Child turns away from the camera and talks to another child.

DISTRACTION (DT):

Definition: Includes anything during the lunch that occurs that distracts or takes time away from the child from eating. play with toys or use of food-related materials as play objects. This code is scored on an occurrence/nonoccurence basis within an interval.

Examples of distractions

Play with Toys - includes any time a child touches, picks up, or handles an object that is clearly identified as a toy.

Play with Food or Related Items - includes play with food, utensils, plate, or other objects related to eating. Handling these objects is considered play when the child uses them for a purpose for which they are clearly not intended. Use of such objects must also be clearly repetitious and exaggerated to be coded.

Examples: Child makes repeated sweeping arm motion with fork in hand.
Twirling a bunch of grapes.
Repeated tossing of food up and down.
Playing "drums" on the table with a fork.
Stacking food.
Playing with bread, making it into shapes

Child is focused on something other than eating lunch**.**

Examples: Child playing with something under the table
Child dancing in their seat
Child turned around to talk to another table of friends

Wiping face with Napkin or playing with napkin

Child is away from food.

Examples: Child puts head below the table
Child turns back to the food to talk to friend or look at a distraction.

Qualification: Play is coded only if the child is within reach of his/her food. Consequently, a Play and an Away cannot be coded simultaneously.

CLEAN UP (CU)

Definition: Refers to the child cleaning up their area from lunch which may include collecting garage, repacking lunch box, or wiping the tables.

Appendix B: Recording Templates

Child Eating Behaviors

	0	10	20	30	40	50	1min	10	20	30	40	50	2min	10	20	30	40	50
	3min	10	20	30	40	50	4min	10	20	30	40	50	5min	10	20	30	40	50
	6min	10	20	30	40	50	7min	10	20	30	40	50	8min	10	20	30	40	50
	9min	10	20	30	40	50	10min	10	20	30	40	50	11min	10	20	30	40	50
	12min	10	20	30	40	50	13min	10	20	30	40	50	14min	10	20	30	40	50
	15min	10	20	30	40	50	16min	10	20	30	40	50	17min	10	20	30	40	50

B = bite, **S** = Sip, **Sp**= spit up, **Sg** = segmenting food or remove inside, **W** = wipe or dunk, **C** = combine, **L** = licking food, **LS** = licking utensils, **Q**=request for food, **Prep**=food preparation before eating, **CT**=child talk(any verbalization by the target child), **A**=Away from food; **O**=obstructive view, **DT** = distraction or playing with food

Child Behaviors

	0	10	20	30	40	50	1min	10	20	30	40	50	2min	10	20	30	40	50
	3min	10	20	30	40	50	4min	10	20	30	40	50	5min	10	20	30	40	50
	6min	10	20	30	40	50	7min	10	20	30	40	50	8min	10	20	30	40	50
	9min	10	20	30	40	50	10min	10	20	30	40	50	11min	10	20	30	40	50
	12min	10	20	30	40	50	13min	10	20	30	40	50	14min	10	20	30	40	50
	15min	10	20	30	40	50	16min	10	20	30	40	50	17min	10	20	30	40	50

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Appendix C: Focus Group Questions

Focus Group Questions:

1. Out of the 3 choices available at lunch, how do you decide what you want to eat?
2. How are the foods (X, Y, Z) similar?
3. Based on your choices, give me some reasons for choosing X,Y, Z.
4. Are there any other textures, flavors, smells, or appearances you noticed about X, Y, and Z?
5. How do you eat X, Y, Z?
6. If product (W) was offered at lunch, would you choose it?
7. Those that said yes, would you choose this as a main meal or a dessert?
8. Are there any other textures, flavors, smalls or appearances you noticed about W?
9. What would you change about the product W, X, Y or Z?

Last group additional questions

10. Are whole grain products eaten at your home?
11. Were the products you ate today whole grain?
12. Would a word list (like the one just handed out) have been beneficial during the discussion today?