

# **Whole Grain Intake in College Students and its Association with Body Mass Index**

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### **ABSTRACT**

The 2005 Dietary Guidelines for Americans recommend that Americans consume at least three servings of whole grain foods per day to reduce the risk of chronic disease and to help with weight maintenance. However, most Americans fall short of this recommendation. To reduce the prevalence of chronic disease, overweight, and obesity, health educators should promote healthy behaviors at young ages. The purpose of this study was to measure whole grain intake in college students and to determine its association with body mass index (BMI), a measure of overweight and obesity. The participants (N=164) were recruited from a freshmen level nutrition course (of 485 students) at Virginia Tech in spring of 2004. Students kept food records to record their usual diets for 14 days, and had their height and weight measured by the researchers in order to determine their BMI. On average, the students consumed  $5.4 \pm 1.7$  (mean $\pm$ SD) servings of grain based foods per day, of which 13% ( $0.71 \pm 0.76$  servings) were from whole grain foods. The students who were in the normal weight range (based on their BMI) consumed more servings of whole grains per day than the overweight and obese students (ANOVA with linear contrasts;  $p < 0.05$ ). Results from this study indicate that whole grain intake is low in college students, but similar to the national average, and higher in students with a normal body weight. Efforts should be made to help develop healthy eating habits in this population, including increasing whole grain intake.

## **Dedication**

This work is dedicated to my granddad, James Edward Saville, who at 95 is still teaching me how simple it is to live a healthy life.

*Good nutrition, like kung-fu, must be practiced every day to get the benefits*  
*Emil Mondoia "Sugars That Heal"*

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## **Chapter 1:**

### **INTRODUCTION**

It is estimated that over half of the adult American population is either overweight or obese (1), placing these individuals at an increased risk for health complications (2). The prevalence of overweight and obesity has steadily increased in recent years in adults (1), children, and adolescents (3,4) leading to a variety of dietary strategies by both health professionals as well as the popular press, in an attempt to help individuals maintain their body weight. It is important to focus on dietary strategies that help to prevent weight gain at an early age; because once an individual gains weight it can be very difficult to lose it later in life (5).

Recent research has suggested a protective effect from whole grain foods against weight gain in adults, and an inverse association between whole grain intake and body mass index (BMI), an indirect measure of body fat has been found in both children (6) and adults (7). The protective effect of whole grains against weight gain may be related to a) the fiber content of whole grain foods which enhance satiety, a feeling of fullness in between meals (8), or b) the effect of whole grain on improvements in blood glucose and insulin levels (9).

In addition to helping with weight maintenance, whole grain intake is associated with a reduced risk for developing cardiovascular disease and type 2 diabetes. Less than ten percent of the American public consumes the recommended minimum three servings of whole grain foods per day (10), indicating the potential for increasing whole grain consumption for most Americans. If there is evidence that whole grain foods can help with weight maintenance, then this fact can be incorporated into educational messages to motivate the general public to increase their consumption of whole grain foods.

The purpose of this study was to determine how many daily servings of whole grain foods college students at Virginia Tech typically consume, and if there is an association between whole grain intake and BMI in this population. In addition, this study determined the primary sources of whole grains in college students, as well as the reasons students choose to consume either whole or refined grain foods. This information can be used to design educational interventions in college students that attempt to improve the dietary habits of students, including increasing whole grain intake.

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## **Chapter 2:**

### **LITERATURE REVIEW**

#### **WHOLE GRAIN FOODS**

Cereal grains comprise a significant portion of the energy intake for populations throughout the world. In some societies, cereal grains account for over 70 percent of energy intake (1). The most common cereal grains consumed worldwide are wheat, rice, and corn. Other cereal grains include barley, sorghum, millet, rye, oats, teff, quinoa, and buckwheat. In the United States, the main dietary sources of cereal grains are yeast breads, pasta, rice, breakfast cereals, grain-based snack foods, and sweets such as cake, cookies, pies, and quick breads (2).

Whole grains contain three layers (bran, germ, endosperm) and each layer contains a variety of essential and non-essential nutrients. The bran layer is high in dietary fiber, resistant starch, B-vitamins, minerals, lignans, and flavonoids (which have antioxidant properties). The germ layer of whole grains contains unsaturated fatty acids, phytosterols, vitamin E, and essential minerals. The endosperm is primarily carbohydrate, but it also contains some protein, and B-vitamins (3,4).

Before cereal grains are consumed in the United States, they are usually subjected to some form of processing to increase consumer acceptance, palatability, and the shelf-life of the grain-based food (1). Grains such as wheat are milled to remove the bran and germ layers from the endosperm, resulting in “white flour”, which is enriched with some of the micronutrients lost during processing, such as thiamin, riboflavin, and niacin. Fortification of the flour with other nutrients such as folate, iron, and calcium has also become a common practice. This fortified

flour serves as the basis for most of the breads, cereals, snacks, and sweets consumed in the U.S.; and therefore it makes up a significant portion of the typical American diet. The milling process removes most of the dietary fiber, antioxidants, and micronutrients from the grain. In addition, milling actually increases the amount of carbohydrate and energy in the refined flour, because the endosperm is the most energy dense component of the grain (5).

## **DEFINING WHOLE GRAINS**

There is not a uniform definition of what foods should be considered whole grain, and which foods should be considered refined grain (4). Obviously a food such as brown rice, which has not been subjected to any processing, is a whole grain; and white flour, representing only the endosperm of the grain is a refined grain. However, it is difficult to differentiate between whole and refined grain foods for those that fall in between these two extreme examples, such as breakfast cereals and grain based snacks which contain both whole and refined grains. The U.S. Food and Drug Administration (FDA) has approved a health claim that can be put on the labels of foods which contain (by weight) greater than 50 percent whole grain. This means that the first ingredient on the food label must be a whole grain.

Researchers have used different whole grain definitions/classifications when measuring whole grain intake in different populations. This makes it difficult to compare research on whole grain intake and highlights the need for a specific definition of what foods should be considered whole or refined grain. Many studies use food frequency questionnaires (FFQ) to classify whole and refined grains, based on a cut-off of greater than 25 percent whole grain by weight to determine whether each serving of cereal grain based foods are whole or refined (6), while others

have attempted to use the 50 percent criteria from the FDA (4). More recent studies have attempted to estimate the quantity of whole grains consumed in grams per day, rather than servings per day (7). Despite these different methods used, they all usually produce similar results when comparing the effects of whole and refined grains on health outcomes. Yet no matter how whole grain foods are defined, it is clear that the actual intake of whole grain foods is quite low.

## **WHOLE GRAIN INTAKE**

The 2005 Dietary Guidelines for Americans recommend that all Americans consume at least three servings per day of whole grain foods, and that at least half of all grain products consumed come from whole grains (8). However, most Americans fall short of these recommendations. The best estimate of whole grain intake in the U.S. is from the Continuing Survey of Food Intakes by Individuals (CSFII) which was last conducted between 1994 and 1996 (2). For this study, the researchers interviewed a nationally representative sample of 9,323 adults on two non-consecutive days, and assessed their diets using the 24-hour multiple-pass recall method.

The results from the 1994-1996 CSFII found that most Americans consumed 6.7 servings per day of grain based foods, but only 15 percent of that total came from whole grain foods (2). Americans consumed an average of 1.0 serving of whole grain foods per day, primarily from yeast breads, breakfast cereals, and grain-based snacks. Whole grain consumers in this study tended to be older, white, non-smokers, supplement users, exercisers, in a higher income category than non-whole grain consumers, and not overweight. Therefore, whole grain intake

was associated with an overall healthy lifestyle in this population. Adolescents also consume an average of 1.0 serving per day of whole grain foods (9).

## **BARRIERS TO INCREASING WHOLE GRAIN INTAKE**

A lack of knowledge about the health benefits of whole grain foods is one of the barriers to increasing whole grain intake (10). Many consumers cannot differentiate whole grains from refined grain foods, and consumers are not familiar with how to prepare whole grain foods at home (4). Other barriers may include a higher price for some whole grain foods, a lack of options at restaurants, lack of convenience, and low palatability. Due to the low intake of whole grain foods in the U.S., efforts should be made to address these barriers, in order to meet the Dietary Guidelines for Americans goal of three servings per day-which may reduce the risk of chronic disease and weight gain.

## **WHOLE GRAINS AND HEALTH**

### WHOLE GRAINS AND MORTALITY

Epidemiological research on the effect of whole grain intake on the risk for various diseases has demonstrated a protective effect for whole grain foods against heart disease, type 2 diabetes, and cancer. Thus it should come as no surprise that whole grain intake is associated with a 13-17 percent reduction in all cause mortality, even after controlling for potentially confounding factors such as smoking, physical activity, and alcohol consumption (11-14). This

line of research demonstrates the ability of whole grain foods to reduce the risk of disease, yet it is limited in its ability to establish a cause and effect relationship. This methodology relies on self-reported dietary intake, usually in the form of a FFQ, food records, or 24-hour recalls. Self-reported food intake is often underreported (15), especially for obese individuals (16), and for unhealthy foods (17), therefore conclusions based on this method of dietary assessment are limited.

### WHOLE GRAINS AND CARDIOVASCULAR DISEASE

The Nurse's Health Study is a prospective epidemiological study that has been used to analyze the associations between dietary behaviors and health outcomes in female nurses (18). From 1984 to 1990, researchers from Harvard Medical School followed 75,521 nurses with no history of heart disease to determine the association between whole grain intake and the risk of coronary heart disease. Diets were assessed with FFQs completed every 2 years. The nurses who consumed the highest amount of whole grains (more than 1.77 servings/day) were 33 percent less likely to suffer a heart attack than those who consumed the fewest amount of whole grains (95% CI: 0.54, 0.84), even after controlling for age and smoking. Similar results have been demonstrated in both women (12,19) and men (20).

As mentioned earlier, epidemiological studies cannot show that the reduced risk of heart disease is caused by whole grain intake, it can only demonstrate an association. However, whole grain intervention studies have demonstrated improvements in biomarkers known to protect against cardiovascular disease risk. Barley consumption for five weeks was effective in lowering total and LDL cholesterol in hypercholesterolemic women (21). In hypercholesterolemic men,

barley (and other whole grains) lowered total and low density lipoprotein (LDL) cholesterol, triglycerides, while increasing high density lipoprotein (HDL) cholesterol after 5 weeks (22). A mixture of whole grains and legumes, consumed for 16 weeks resulted in reduced homocysteine, and lipid peroxidation (23), both of which contribute to heart disease. Putting together the information from these studies with the epidemiological research, the data support the statement that whole grain foods offer protection from heart disease, the number one cause of death in the United States (24).

### WHOLE GRAINS AND TYPE 2 DIABETES

In addition to protecting against heart disease, whole grain intake is associated with a reduced risk for developing type 2 diabetes (25-27), possibly due to the low glycemic index, high fiber content, and larger particle size of starch granules (28). Whole grain intake is also associated with improved insulin sensitivity in both children (29), as well as adults (30). Whole grain intake improved insulin sensitivity in obese hyperinsulinemic adults after just six weeks (31). The favorable effects of whole grains on blood glucose and insulin may reduce the risk for heart disease, and the metabolic syndrome, in addition to preventing diabetes.

### WHOLE GRAINS AND THE METABOLIC SYNDROME

The metabolic syndrome is characterized by impaired glucose metabolism and abnormal lipid concentrations. It is also associated with an increased risk for developing type 2 diabetes and cardiovascular disease. Specifically, if an individual has three or more of the following

conditions, they are diagnosed with the metabolic syndrome: abdominal obesity, hypertriglyceridemia, low HDL cholesterol, high blood pressure, and high fasting blood glucose. It is estimated that 26.7 percent of the American population has this condition, and are therefore at an increased risk for developing diabetes and heart disease (32).

Results from the Framingham Offspring Cohort study suggest that whole grain foods protect against this syndrome (33). In this study, participants in the highest quintile of whole grain intake were 38 percent less likely to have the metabolic syndrome than those in the lowest quintile of whole grain intake (95% CI: 0.45-0.86), after controlling for confounding lifestyle and dietary factors. This is likely due to the high fiber content, and low glycemic response induced by whole grain foods. In fact, the participants whose diets had the highest glycemic index were more likely to have the metabolic syndrome than those who consumed a diet with a low glycemic index (33). Similar results were found in adults living in Tehran (34), where whole grain intake was inversely associated with the metabolic syndrome, while refined grain intake was associated with an increased risk.

Intervention studies confirm the protective effects of whole grains on various aspects of this syndrome. As mentioned previously, consuming 20 percent of energy from whole grains raised HDL cholesterol, while lowering total cholesterol in hypercholesterolemic men (22). Consuming six to ten servings per day of whole grains for six weeks improved insulin sensitivity, and lowered fasting insulin levels in overweight hyperinsulinemic adults (31), when compared to subjects consuming the same amount of refined grains per day. It has been suggested that high fiber, low fat foods such as whole grains may be beneficial for individuals with the metabolic syndrome (35). These studies indicate that the increasing prevalence of the metabolic syndrome can be significantly reduced by increasing whole grain intake.

## WHOLE GRAINS AND CANCER

The protective effect of whole grains on chronic disease risk is typically attributed to their high fiber content, and low glycemic response. However, whole grains contain a variety of other essential and non-essential nutrients that may protect against various diseases, including certain forms of cancer. Antioxidants may help to prevent cancer by reducing oxidative stress in the body. Some whole grain foods contain the same amount of antioxidants as fruits and vegetables (36), which are considered to be the best dietary sources of these oxygen scavenging compounds. Some of the antioxidants in whole grains include essential nutrients such as vitamin E, beta carotene, zinc, selenium, copper, and manganese; while the main form of antioxidants in whole grains is likely to be the flavonoids and other phenolic acids present in cereal grains (37). Whole grains also contain lignans and isoflavones, which are phenolic compounds that may protect against certain hormonally induced forms of cancer (37).

A meta-analysis of case-control studies examining the association between whole grain intake and cancer supports the protective effects from whole grains on the risk of developing certain forms of cancer (38). The majority of studies reviewed in this analysis were cancers of the digestive tract. The researchers concluded that the evidence is supportive of a protective effect of whole grain intake on various forms of cancer, yet more research is needed due to the possibility of confounding inherent in case-control research.

## WHOLE GRAINS AND BODY WEIGHT

An excess amount of body fat is associated with an increased risk for many of the health complications discussed previously (39). Therefore it is essential to monitor body fat, and dietary factors associated with increases in body weight. There are several methods to measure body fat, and some are more accurate and precise than others. One common method for estimating adiposity is the body mass index (BMI), which is easy to measure and is positively correlated with body fat (40). While BMI is easy to measure (it only requires height and weight measurements), it is not as good a measure of body fat as other methods such as dual energy X-ray absorptiometry or underwater weighing. Despite its limitations, BMI is commonly used in large population based studies as measure of overweight and obesity.

A BMI  $\geq 25$  kg/m<sup>2</sup> indicates that an individual is overweight and a BMI  $\geq 30$  kg /m<sup>2</sup> indicates that an individual is considered obese (41). Using these criteria, it is estimated that 65.7 percent of the adult American population is either overweight or obese; and 30.6 percent of the population is estimated to be obese (42). These numbers have steadily increased in recent years, placing more Americans at an increased risk for obesity-related health complications. Children are also gaining weight at an alarming rate. Twice as many children between the ages of six and nine are overweight today than 30 years ago (43,44), however this population is classified as overweight based on percentiles based on age and sex, rather than the BMI cut-offs for adults.

## DIET AND BODY WEIGHT

While there is no doubt that the prevalence of overweight in the U.S. is increasing and is a serious threat to our nation's health, there is considerable doubt as to what dietary factors are responsible for this increase. It is generally recognized that the primary cause for weight gain is related to an energy imbalance (increase in energy intake, reduction in physical activity, or both), yet there remains a constant debate as to what specific dietary factors are responsible for the increase in overweight and obesity.

Some dietary factors which are believed to affect body weight are dietary fat, fiber, sugar, and the glycemic index (45). Foods high in fat and sugar are believed to increase body weight because they are energy dense, which means that they contain more calories per gram than less energy dense foods. High fiber foods may protect against weight gain because they have a low energy density, and promote satiety, which is a feeling of fullness in between meals (46,47). High-glycemic index (GI) foods such as refined grains and simple sugars are thought to increase appetite, and therefore body weight (48). Whole grain foods may protect against weight gain because they are often low in fat and added sugar, they are high in dietary fiber, and generally have a low GI.

## EPIDEMIOLOGICAL DATA

Liu and colleagues at the Harvard School of Public Health examined the association between whole grain intake and weight gain in women, using data from the Nurse's Health Study (49). Women in this study were followed from 1984 to 1996 and completed FFQs every two

years to assess their habitual dietary practices. Height and weight were self-reported by the women every two years. The analysis included data from 74,091 female nurses without diabetes, cardiovascular disease, or cancer. Participants were grouped into quintiles of whole grain intake and refined grain intake (based on the FFQs) to look at differences between individuals consuming high and low amounts of each type of cereal grains. Whole grain foods included dark bread, breakfast cereal (containing  $\geq 25\%$  whole grain), popcorn, oatmeal, wheat germ, bran, brown rice and other grains.

Women consuming more whole grains at baseline weighed less than women consuming fewer whole grain servings. All quintiles saw an increase in body weight over the 12 year prospective study. However, the women who increased their intake of whole grains during the study gained less weight during the study period ( $p$  for trend  $< 0.0001$ ). The same trend was found for women who increased their intake of dietary fiber during the study, indicating that the fiber content of whole grain foods may be partly responsible for the protective effect against major weight gain (49).

Similar results were found in male participants in the Health Professionals Follow-up Study, a prospective cohort that followed 51,520 male health professionals from 1986 to 1996 (50). Dietary intake was assessed with a FFQ, and participants were requested to provide brand names for the cereal based foods they consumed. These specific foods were then entered into a USDA national nutrient database to determine the percentage of whole grain and non-whole grain ingredients (by weight). The whole grain percentage for each specific food was then multiplied by the weight per serving to obtain the amount of whole grain consumed. Total bran and germ intake were also recorded separately using the same procedure. Thus the researchers determined the weight (in g/day) of whole grain, refined grain, bran, and germ that each

participant consumed per day. The use of multiple regression allowed the researchers to determine how changes in the intake of all of these (and other potentially confounding) variables were associated with changes in body weight during the study period.

The main sources of whole grains in this population were breakfast cereals, brown rice, oatmeal, and popcorn. Those in the highest quintile of whole grain intake were more likely to exercise, be non-smokers, have a lower BMI, and they consumed less dietary fat and alcohol, and more dietary fiber. Over the eight year follow-up period, all participants tended to gain weight. Whole grain intake was inversely associated with weight gain ( $p$  for trend  $< 0.01$ ), after adjusting for potential confounding variables. Both cereal fiber and fruit fiber (but not vegetable fiber) were also inversely associated with weight gain. Added bran resulted in a dose-dependent reduction in weight gain, while added germ did not (50).

This study found similar results to the Nurse's Health Study (49), even though the researchers used a different method to quantify whole grain intake. This study's methodology allowed for foods to be separated into their whole and non-whole grain components, which allows a better picture of the effect of whole grains on body weight. Most of the whole grain intake in the U.S. is from mixed foods, such as breakfast cereals and breads, which are not made entirely from whole grains.

## **COLLEGE STUDENTS' DIETARY PRACTICES**

In order to prevent major weight gain, which can lead to the chronic diseases discussed so far, it is essential to develop healthy eating habits at an early age, because the prevalence of

overweight and obesity increases with age (42). Young adults, who are in the transition from adolescence to adulthood, are one segment of the population that could be targeted to prevent weight gain. There is a tendency for significant weight gain in between adolescence and adulthood (42), therefore establishing a healthy diet in this segment of the population seems prudent.

College students are in a period of transition in their lifestyle as they move away from their parents' home into a more independent life. Poor eating habits established during college may continue into adulthood, and could contribute to weight gain or health complications. It is estimated that 20.5 percent of all college students are overweight, and this number increases to 28.8 percent for college students 25 years old or older (51). This is likely related to the students' diets, which are often low in fruits, vegetables, and dietary fiber, as well as to the low levels of physical activity in many college students (52). When young adults go away to college, they may choose high fat foods such as hamburgers, hot dogs, french fries, potato chips, cookies, etc. Researchers estimate that 20 percent of college students consume more than two servings per day of these high fat foods every day, while only 26 percent of students consume at least five servings of fruits and vegetables per day (51).

The transition to college life is often accompanied by weight gain. The "freshman 15" is a phrase that is commonly used to refer to the 15 pounds that some students gain when they go away to college for the first time. There is limited research on this phenomenon, however some researchers have documented gains in weight of four pounds over one semester (approximately 16 weeks) (53,54). Butler and colleagues found that female freshmen had a higher percent body fat and BMI after their first 20 weeks in college (55). These studies indicate that the transition to college life is likely accompanied by changes in either physical activity, food intake, or both.

Researchers at Cornell University followed freshmen for 12 weeks, to monitor their changes in body weight, and their dietary practices (54). Using regression analysis, the researchers found that several dietary practices predicted weight gain in this population. Some of these predictors were eating in “all you can eat” dining halls, eating “junk food” (although this was not well-defined), and the number of meals and snacks consumed per day. This study was successful in documenting significant weight gain during the freshman year, and highlights many of the factors in the college environment that can lead to poor dietary choices in this population. However, this study has several limitations. The dietary factors were only assessed with a survey; no objective measurements (other than body weight) were taken. This is likely to add to measurement bias. Also, body weight was measured with the students wearing seasonal clothing, and the second measurement was taken during the winter months. The researchers attempted to control for this, but it is possible that the difference in body weight was due to the extra clothing worn during the second measurement.

It is important to determine what dietary factors are associated with body weight changes in this population, so that researchers can develop educational messages and dietary interventions for college students that are specific for this population. It is estimated that 46 percent of college students desire to lose weight (51), so this population may be very receptive to dietary information about weight maintenance. Improving the diets of this population may help to reduce the increasing prevalence of overweight in this country.

## **SUMMARY**

Epidemiological data suggest a reduction in the risk for developing heart disease, type 2 diabetes, the metabolic syndrome, and certain forms of cancer by consuming diets high in whole grain foods. Whole grain intake also has a favorable effect on several biomarkers associated with these diseases such as blood lipids, glucose, and insulin. In addition, there is some evidence that whole grains may help to prevent weight gain. Whole grains contain many essential and non-essential nutrients not found in refined grains which may have synergistic effects on these disease states. Despite this evidence, whole grain intake in the U.S. is low, and many consumers are not aware of the protective effects of whole grains or the differences between whole and refined grain foods. Efforts should be made to increase whole grain intake to three servings per day to protect against chronic disease and to prevent weight gain. This message may be especially relevant to young adults, who need to be informed of the differences between whole and refined grains so that they can develop healthy eating habits throughout their lives

## **AIMS OF THE PRESENT STUDY**

To date, there are no studies investigating the association between whole grain intake and body weight in college students, nor are there any attempts to quantify whole grain intake in this population. The purpose of this study was to measure whole grain intake in college students, and to determine the association between whole grain intake and BMI in this population. In addition, the present study attempted to determine the primary sources of whole and refined grains in college students as well as the reasons that college students select whole and refined grains.

Taken together, this information can be used to design educational materials and interventions based on research specific to this population.

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**Chapter 3:**

**Whole Grain Intake in College Students and its Association with Body Mass Index**

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## ABSTRACT

The 2005 Dietary Guidelines for Americans recommend that Americans consume at least three servings of whole grain foods per day to reduce the risk of chronic disease and to help with weight maintenance. However, most Americans fall short of this recommendation. To reduce the prevalence of chronic disease, overweight, and obesity, health educators should promote healthy behaviors at young ages. The purpose of this study was to measure whole grain intake in college students and to determine its association with body mass index (BMI), a measure of overweight and obesity. The participants (N=164) were recruited from a freshmen level nutrition course (of 485 students) at Virginia Tech in the spring of 2004. Students kept food records to record their usual diets for 14 days, and had their height and weight measured by the researchers in order to determine their BMI. On average, the students consumed  $5.4 \pm 1.7$  (mean $\pm$ SD) servings of grain based foods per day, of which 13% ( $0.71 \pm 0.76$  servings) were from whole grain foods. The students who were in the normal weight range (based on their BMI) consumed more servings of whole grains per day than the overweight and obese students (ANOVA with linear contrasts;  $p < 0.05$ ). Results from this study indicate that whole grain intake is low in college students, but similar to the national average, and higher in students with a normal body weight. Efforts should be made to help develop healthy eating habits in this population, including increasing whole grain intake.

## INTRODUCTION

Epidemiological research has demonstrated a reduced risk for developing cardiovascular disease (1-3), type 2 diabetes (4-6), the metabolic syndrome (7,8), and certain forms of cancer (9) with high intakes of whole grain foods. Despite the protective qualities of whole grain foods on these disease states, whole grain intake in the U.S. remains well below the recommended three servings per day in adults (10), children, and adolescents (11). Recent research indicates that whole grain foods may also help to prevent weight gain. At present, over half of American adults are overweight or obese (12), placing these individuals at an increased risk for the diseases listed above. Dietary strategies that prevent weight gain, or help to maintain body weight, are needed to help slow the increasing prevalence of obesity.

Consumers who choose whole grain foods generally have an overall healthier diet and lifestyle than non-consumers (10), making it difficult to determine the effects of whole grains on risk for disease or weight gain. A healthy dietary pattern, including whole grains, fruits, vegetables, and reduced-fat dairy, was associated with smaller gains in BMI and waist circumference in adults followed for an average of 2 years (13). Cross-sectional data have found an inverse association between whole grain intake and body mass index (BMI) in both children (14) and adults (15). In addition, longitudinal data from the Nurse's Health Study (16) and the Health Professional's Follow-up Study (17) have found that adults who increase their intake of whole grains or dietary fiber gain less weight than their peers, after controlling for potentially confounding dietary and lifestyle factors.

Whole grains may help to prevent weight gain because of their effects on satiety and energy metabolism. Dietary fiber is one component of whole grains that may be responsible for

the protective effects of whole grains on weight gain. Fiber intake enhances satiety, through its effect on gastric emptying, gastrointestinal hormones, and because it requires significant chewing (18). In addition, whole grain foods generally have a low glycemic index, therefore they induce a slower release of glucose following consumption. Refined grains, in contrast have a higher glycemic index, resulting in higher levels of insulin to compensate for the elevated blood glucose levels, and therefore may inhibit the oxidation of lipids (19).

Most Americans meet the USDA recommendation of six servings per day of cereal grain-based foods, however only 15 percent of cereal grain intake comes from whole grains (10). It is important for health educators to identify barriers to increasing whole grain intake in the general population, so that future interventions can help more individuals meet the Dietary Guidelines for Americans goal of three servings of whole grain foods per day (20). If whole grain foods have a demonstrated effect on weight maintenance, then this may be used as a motivating factor for increasing the intake of whole grains in our society obsessed with weight loss.

It is estimated that the prevalence of overweight in college students is 20.5% (21), which is considerably lower than the prevalence for adults (65.7%) (12). It is important to educate college students (primarily young adults) how to prevent major weight gain throughout their lives. Almost half of all college students attempt some form of weight loss (21), indicating that this population may be responsive to dietary strategies that emphasize weight maintenance. Replacing refined grains with whole grain foods may be one dietary change that young adults can make to improve their overall diet quality, without adding a new food (or food group) to their habitual diets. The purpose of this study was to measure whole grain intake in college students and to determine the association of whole grain intake with body mass index (BMI) in

this population. In addition, this study determined the primary sources of whole grains, and the reasons for selecting whole and refined grains in this population.

## **METHODS**

### **STUDY DESIGN**

This study used a convenience sample of college students at a large state university in the southeast to assess whole grain intake, body mass index (BMI), and college students' perceptions of whole grain foods. A cross-sectional design was used to measure associations between these variables.

### **PARTICIPANTS**

College students at Virginia Tech were recruited from an introductory nutrition course during the spring semester of 2004, and invited to participate in the study. There were 485 students enrolled in the course, and all students were encouraged to volunteer as participants. Incentives were offered to encourage participation in the study, such as a gift card to a local supermarket, and bonus points in the class. Prior to participation, all participants received and signed an informed consent form (Appendix A), detailing their responsibilities as participants, and informing them of the risks and benefits from their participation. The procedures were approved by the Institutional Review Board at Virginia Tech (Appendix F). Participants were excluded from analysis if they did not complete all measurements, had a health condition that may affect their intake of grain based foods (such as a grain allergy), or if they were following a low-carbohydrate diet for weight loss.

## **DIET ASSESSMENT**

Participants were given instructions on how to complete a seven-day food record, and forms to record their habitual food and beverage intake for seven continuous days (Appendices D and E). Participants recorded the time at which they ate each food as well as their physical activity for each day. Participants were encouraged to specify the brand names of all foods consumed whenever possible, and to be as specific as possible when recording all foods. Serving sizes were estimated, and some basic guidelines and examples were provided to improve the accuracy of self-reporting. Each participant completed the seven-day food record on two separate occasions, approximately one month apart. Food records were entered into Nutritionist Pro™ (version 2.1.13; First DataBank, San Bruno, CA) by the researchers to determine each participant's average daily intake of energy and dietary fiber during the study period. Data are reported as the average of the 14 days. Fiber intake was reported in grams of fiber per 1000 kcal, to control for total energy intake.

Participants also completed two survey instruments, on two separate occasions, one month apart. Data are reported from the initial administration only. One instrument provided information about the participants' demographic characteristics, physical activity, and habitual dietary practices (Appendix B) and the other instrument (developed by the researchers) asked participants to estimate their habitual intake of whole and refined grain foods and assessed the students' perceptions towards whole grain and refined grain foods (Appendix C). This instrument asked the participants to estimate their total intake of grain based foods, and what proportion of their intake was from whole grain foods. Briefly, the grain survey asked the

students to estimate how often they consumed grain based foods, how many servings they usually consumed, and what proportion of their usual intake of grain based foods was from whole grains, rather than refined grains. Responses from this survey were reported in whole grain servings per day, to determine how accurately the students could estimate their intake of whole grain foods.

## **WHOLE GRAIN INTAKE ASSESSMENT**

Whole grain foods were defined as foods that contained either a whole grain or bran as the first ingredient on the food label (22). Food records (14 days) were used to determine each participant's average daily intake of all grain based foods. Each food (including the brand name, if provided) was recorded on a list, and the researchers went into the supermarket to determine which foods would count as whole grain, based on the food labels. Examples of whole grain ingredients include whole wheat flour, whole oat flour, whole grain corn, and brown rice.

If the participant stated that he or she consumed "wheat bread", but did not specify the brand, it was counted as a whole grain, even though not all products labeled as wheat bread are made primarily from whole wheat. This method allows for an overestimation of total whole grain intake, but is similar to the methods used by other researchers (1,2). All other grain-based foods were assumed to be made from refined grains, unless they specified a specific product or brand that could be identified as whole grain. For example, "pasta" was assumed to be refined grain, unless the food records indicated that it was whole-wheat pasta, and "cereal" was assumed to be refined grain cereal unless it was a brand that listed a whole grain as the first ingredient, such as "Cheerios." Serving sizes for all grain based foods were also recorded and used to

determine each participant's average daily intake of whole and refined grain foods during the two week period (in servings per day). To control for individuals consuming high quantities of total grain based foods, the percent of grain based foods that came from whole grains was also determined. This was used to determine if the proportion of grains coming from whole grains was associated with body mass index, independent of the total number of servings per day of grain foods.

To determine the primary sources of whole grains in the students' diets, all whole grain foods were categorized into cereal, bread, snack food, etc., based on the responses from the food records.

## **ASSESSMENT OF BODY WEIGHT AND ENERGY REQUIREMENTS**

Participants arranged a time to meet with the researchers to have their height and weight measured. These measurements were made with the participants wearing light clothing, with their shoes removed. Height and weight were measured using a balance beam scale with stadiometer (Seca). Height was recorded to the nearest  $\frac{1}{4}$  inch, and weight was measured to the nearest  $\frac{1}{4}$  pound. Height was converted to cm (1 inch=2.54 cm), weight was converted to kg (1 lb=2.205kg), and BMI was calculated by dividing  $\text{kg/m}^2$ . All participants were grouped into either normal (18.5-24.99), overweight (25.0-29.99), or obese (30.0+) categories based on their BMI (in  $\text{kg/m}^2$ ) (23). Underweight participants ( $\text{BMI}<18.5$ ) were not included in the analysis, because there is less information available on the risk for disease in this population, and because there very few students were in this category.

To estimate each participant's daily energy requirements, the Harris Benedict Equation (HBE) (24) was used to estimate basal metabolic rate (BMR). This estimate of BMR was compared to the participants' reported energy intake (from the food records) to determine whether the participants underreported their food intake (25). For overweight and obese participants, energy requirements were based on their adjusted body weight, derived from the Hamwi formula (26), with the assumption that only 25 percent of adipose tissue is metabolically active (27). If reported energy intake was below 80 percent of their estimated BMR, the participant was considered an under-reporter. This is a very conservative estimate; it was selected because under-reporting was very common in this sample population. Results are presented both with and without the under-reporters.

## **PHYSICAL ACTIVITY ASSESSMENT**

In addition to recording their food intake for 14 days, participants also recorded all physical activity during the two weeks of data collection. Participants recorded the type of activity and how long they exercised on the back of each day's food record (Appendix E). It was assumed that all students were lightly active, because they must walk across campus to get from class to class. Physical activity beyond 60 minutes of walking per day was recorded in minutes per day for each participant, to determine if it was associated with BMI.

## **STATISTICAL ANALYSIS**

Data were analyzed using a one-way analysis of variance (ANOVA) with BMI category as the independent variable, and whole grain intake (in servings/day), percent of total grains from whole grains, and fiber intake (in g/1000kcal) as the dependent variables. Overweight and obese participants were compared to the normal weight participants using an ANOVA with linear contrasts procedure to test the hypothesis that normal weight students would consume more whole grains per day than their overweight peers.

Reported whole grain intake (servings/day) from the food records was compared to the estimated whole grain intake (servings/day) from the survey, using the Pearson Correlation Coefficient. Regression analysis was used to test for potentially confounding variables which may affect BMI, including age, gender, and physical activity. All analyses were performed with SAS (version 9.1; Cary, NC). For all analyses, statistical significance was set at  $p < 0.05$ . Variables with a non-normal distribution were transformed to their natural log prior to analysis.

## RESULTS

### STUDY POPULATION

Of the 485 students enrolled in the nutrition course that served as the source for participants in this study, approximately 265 volunteered to participate. Of these 265 volunteers, 164 students (34% of students enrolled in the course) met all of the criteria for this study, and were included in the current analysis. Characteristics of the sample population are summarized in Table 1. The students reported consuming an average of 1780 calories per day, and 30 percent of the students were classified as either overweight or obese based on BMI ( $BMI \geq 25$ ). Regression analysis indicated that physical activity and age were not predictors of BMI, but gender explained 11 percent of the variability in BMI ( $R^2=0.1154$ ;  $p<0.0001$ ). Five students were classified as underweight ( $BMI < 18.5$ ). Data from these participants was used only in the analysis of whole grain, and total grain intake in college students; the comparisons between normal weight and overweight participants only included data from the 159 students whose BMI was  $\geq 18.5$ .

### WHOLE GRAIN INTAKE

On average, the students reported consuming  $5.4 \pm 1.73$  (mean  $\pm$  sd) servings per day of grain based foods per day, with 13 percent of that amount coming from whole grain foods ( $0.71 \pm 0.76$  servings/day). The main sources of whole grains in the students' diets were ready to

**Table 1: Characteristics of sample population**

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<b>Age (years)</b>	19.9±3.24 range = 18-53
<b>Male</b>	n=42 (26%)
<b>Female</b>	n=121 (74%)
<b>Freshmen</b>	40%
<b>Sophomore</b>	31%
<b>Junior</b>	15%
<b>Senior</b>	14%
<b>BMI (kg/m<sup>2</sup>)</b>	23.9±4.12 range = 16.9-43.0

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N=164

Data are reported as mean (±SD)

**Table 2: Dietary intake data (by BMI category)**

<b><u>BMI</u></b>	<b><u>Normal</u></b> (n=110)	<b><u>Overweight</u></b> (n=39)	<b><u>Obese</u></b> (n=10)
<b>Total grain intake</b> (servings/day)	5.33±1.72	5.47±1.88	5.59±1.30
<b>Whole grain</b> <b>intake</b> (servings/day)	0.808±0.778*	0.546±0.700	0.307±0.361
<b>Whole grain as</b> <b>percent of total</b> <b>grain</b>	14.8±12.8*	9.1±10.3	5.9±7.7
<b>Fiber (g) /1000kcal</b>	7.7±3.0*	7.3±2.4	5.3±1.2
<b>Total kcal/day</b>	1731±492	1887±564	1938±455

N=159

Data are reported as mean (±SD)

\*Significantly different from overweight and obese (ANOVA; p<0.05)

**Table 3: Dietary intake data (by BMI category) after removing under reporters**

<b><u>BMI</u></b>	<b><u>Normal</u></b> (n=98)	<b><u>Overweight</u></b> (n=32)	<b><u>Obese</u></b> (n=8)
<b>Total grain intake (servings/day)</b>	5.55±1.70	5.81±1.70	5.90±1.27
<b>Whole grain intake (servings/day)</b>	0.82±0.81*	0.62±0.74	0.22±0.31
<b>Whole grain as percent of total grain</b>	14.2*	9.2	3.7
<b>Fiber (g)/1000kcal</b>	7.44±2.59*	7.00±2.06	5.06±1.24
<b>Total kcal/day</b>	1822±438*	2025±517	2120±258

N=143

Data are reported as mean (±SD)

\*Significantly different from overweight and obese (ANOVA; p<0.05)

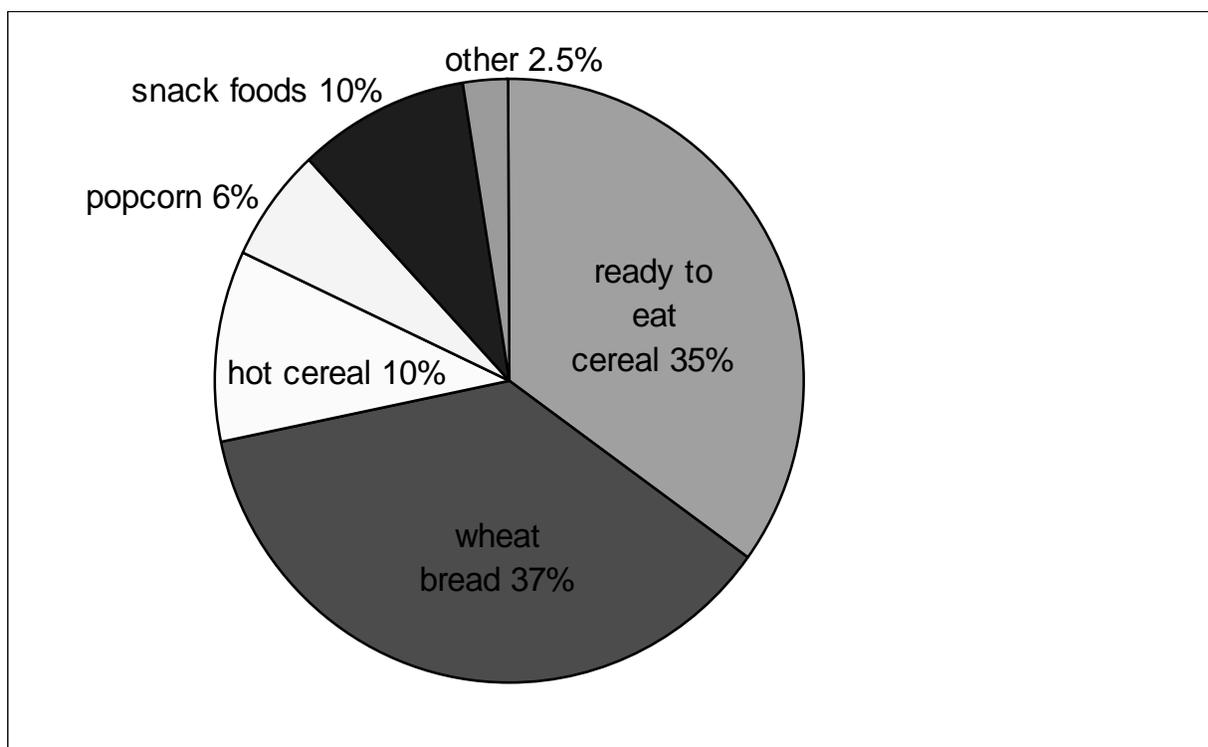
eat cereals, and whole wheat bread (Figure 1). Whole grain intake was significantly higher ( $p < 0.05$ ) in the normal weight students than in those who were either overweight or obese (Table 2). Whole grain intake as a percent of total grain intake was also significantly higher ( $p < 0.05$ ) in the non-overweight students, when compared to their overweight/obese peers.

Fiber intake was very low in this population (13.0 g/d). The normal weight students had significantly higher fiber intake (g/fiber per 1000 kcal) than the overweight and obese students (Table 2). Seventeen students were removed from the analysis, due to underreporting on their food records ( $< 80\%$  estimated BMR). After re-analyzing the data, there were no changes in statistical significance for any of the variables of interest, with the exception of energy intake, which was significantly higher in the overweight/obese students (Table 3).

## **SURVEY RESULTS**

The whole grain survey instrument was used to estimate whole grain intake in this population. When compared to the food records, the survey tended to underestimate total grain intake and overestimate whole grain intake. On average, the students estimated that 41 percent of their total grain intake came from whole grain foods (Table 4) while the food records indicated that whole grain foods made up 13 percent of their total grain intake. The survey results showed a weak correlation with the food records for estimating total grain intake, and servings per day of whole grains (see Table 4). The survey was a slightly better predictor for estimating whole grain intake as a percent of total grain intake, despite the fact that the students consistently overestimated their reported intake of whole grain foods.

**Figure 1: Sources of whole grains in college students' diets**



**Table 4: Whole grain intake from survey instrument; compared to food record**

	Food Record	Survey	R <sup>2</sup> -value
Total grain intake (servings/day)	5.4±1.73	3.86±1.94	0.1548*
Whole grain intake (servings/day)	0.71±0.76	1.71±1.49	0.1932*
Whole grains as a percent of total grain intake	13.0	41.3	0.2715*

Data are reported as mean (±SD)

\*Pearson Correlation Coefficient; p<0.05

The primary reasons students reported for selecting whole grain foods were the health benefits (70% of participants), and fiber content (63%) associated with whole grains. Refined grain foods were selected primarily for their taste (70%) and convenience (53%).

## **DISCUSSION**

The main finding from this study was that whole grain intake is very low in college students, but similar to the national average of 1.0 servings per day (10). The intake of cereal grain foods was slightly less than the national average of 6.7 servings per day, but the proportion of cereal grain foods from whole grains (13%) was similar to the national average of 15 percent. Students in the normal weight category consumed less than half of a serving more per day of whole grain foods on average than the overweight/obese students. This difference was statistically significant, but it is unlikely that this small difference is the only explanation for the differences in BMI.

Individuals who consume more whole grain foods often consume less dietary fat, more fruits and dairy products, and exercise more (10). So it is possible that the association between whole grain intake and BMI is due to some other factor that was not controlled for in this study. Healthful dietary patterns, including fruits, vegetables, reduced-fat dairy, and whole grains were associated with less weight gain in a prospective study of men and women (13), highlighting the synergistic effects of a balanced diet on weight maintenance, but similar to the present study it is also limited by its cross-sectional design.

Defining whole grain foods is difficult, because there is no uniform definition for whole grain foods. This study included all foods containing a whole grain, or bran as the first

ingredient, similar to the methods reported by Montgomery and colleagues (22). This is a simple strategy for consumers to follow, but it does not necessarily guarantee that the food contains greater than 50 percent whole grain by weight. Other studies have reported the intake of whole grains in grams per day, rather than servings per day (17). This method creates a more accurate estimate of whole grain intake, because it separates foods into their whole and non-whole grain components for classification. For example, a serving of breakfast cereal containing whole grain as the first ingredient would be classified as a serving of whole grain using the methodology in the present study. However, this would overestimate whole grain intake, because there are other ingredients in the cereal that are not whole grains. A more accurate estimate of whole grain intake would determine the proportion of whole grain in the food, to determine the actual quantity of whole grains consumed, rather than just servings of foods containing whole grain. Also, including “wheat bread” as a whole grain results in an overestimation of whole grain intake, because many breads labeled as “whole grain” or “mixed grain” are not made entirely from whole grains.

The food records indicated that college students’ intake of total grain, and whole grain were slightly below the national average. This is likely to be due to under-reporting on the food records. The ratio of reported energy intake (from the food records) to estimated BMR was 1.12, indicating that under-reporting was very common. Removing the 21 participants who reported consuming less than 80 percent of their estimated BMR increased this ratio to an average of 1.19. Underestimating serving sizes may be responsible for the chronic under-reporting. For example, if a student reported eating one serving of pasta, it was recorded as  $\frac{1}{2}$  cup, but the dining centers on campus usually serve at least one cup of pasta for a standard serving. The same is true for a slice of pizza; many dining centers on campus serve slices of pizza that would be considered two

or three servings of refined grain, yet all pizza was recorded as just one serving of refined grain. Therefore, it is likely that total grain intake in this population is the same as the national average, but the food records were not able to accurately estimate this.

BMI was measured by the researchers, rather than reported by the participants, which increased the accuracy of this measurement. Based on BMI, 30 percent of the population was either overweight or obese. This is considerably lower than the national average of 65.7 percent of U.S. adults (12), but higher than the national average for college students (20.5%) (21). This may be due to the sampled population, who were enrolled in an introductory nutrition course. It is possible that some of the students took the course because they were overweight, and were hoping to learn how to manage their own weight. However, some participants may have been misclassified, because BMI is not considered to be the best estimate of body fat.

This study attempted to validate a survey instrument to estimate whole grain intake in this population by comparing the survey responses to the food records (which are believed to be a reasonable predictor of whole grain intake). The students consistently over-estimated their whole grain intake (using the survey instrument), and underestimated their total grain intake. This may be due to the survey's inability to accurately estimate grain intake, or it may reflect a lack of knowledge about whole grains in this population. The participants estimated that 41 percent of their grain intake came from whole grains, indicating that they may not know what foods are whole grains, and which are refined grains. After the data collection was completed, several companies added whole grains to their ready to eat cereals and many companies began taking advantage of the FDA's approved health claim label for their whole grain products. This strategy may help consumers become more aware of whole grains, and their role in disease prevention.

In conclusion, college students' intake of whole grain foods was low (less than one serving per day). Overweight and obese students consumed significantly fewer servings of whole grains, and less dietary fiber than normal weight students. The students over-estimated their intake of whole grain foods (using the whole grain survey instrument), indicating the need to educate this population about whole grains.

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## **Chapter 4:**

### **SUMMARY**

This study found whole grain intake in college students to be significantly below the recommended three servings per day, or half of total grain intake as recommended in the 2005 Dietary Guidelines for Americans. The under-reporting on the students' food records may be partly responsible for the low intake of total cereal grains (5.4 servings per day), but the intake of whole grains as a percentage of total grain intake (13%) was very close to the national average of 15 percent.

Limitations to this study include the study design (cross-sectional), which is not able to determine a causal association between variables; the sample population (nutrition students), who may not be representative of the general student body; and the low response rate (34%). In addition, defining whole grains is very difficult, because there is no uniform definition of what a whole grain food is.

Interventions that focus on increasing whole grain intake in this population may want to emphasize the importance of eating whole grains for breakfast to help maintain body weight. This is because a) many of the most frequently consumed sources of whole grains were breakfast foods, and b) many college students desire to lose weight.

This study was able to show an inverse association between whole grain intake and BMI. This information may help to motivate more young adults to increase their consumption of whole grain foods, nutrient dense foods that have many health benefits.

## **IMPLICATIONS FOR RESEARCH AND PRACTICE**

There is a need to educate young adults about what foods are considered whole grain, and which foods are refined grain, and the impact of whole grain intake on health and body weight. Dietary and educational interventions may want to use weight maintenance as a motivator when promoting the consumption of whole grains and other healthy foods, because many college students desire to lose weight.

Many of the whole grain foods college students consume such as ready to eat cereal, oatmeal, bread, and snack bars are eaten for breakfast, therefore interventions could emphasize the importance of eating breakfast to increase whole grain intake. College students often eat at dining centers on campus, so in order to increase whole grain intake, it is essential to increase the availability of whole grain options at campus dining centers. Some of the popular foods available on campus such as pizza, rice, and sandwich buns are only available as refined grains, even though they could be offered as whole grains. This makes it difficult for students to increase their whole grain intake.

Researchers should develop a quick, easy to use survey instrument that can accurately estimate whole grain intake that could be used as a screening tool to determine what segments of the population do (and those that do not) meet the whole grain recommendation. Based on the results from this study, this will be difficult to do, because many consumers are not aware of what foods are considered whole grains.

**Table 5: Examples of whole and refined grain foods in college students' diets**

<b>Whole grain foods</b>	<b>Refined grain foods</b>
<b>Cheerios</b>	<b>Apple Jacks</b>
<b>Cinnamon Toast Crunch</b>	<b>Cap'n Crunch</b>
<b>Honey Nut Cheerios</b>	<b>Corn Flakes</b>
<b>Life Cereal</b>	<b>Corn Pops</b>
<b>Lucky charms</b>	<b>Corn Chex</b>
<b>Mini-Wheats</b>	<b>Cream of wheat</b>
<b>Raisin Bran</b>	<b>Froot Loops</b>
<b>Shredded Wheat</b>	<b>Honey bunches of Oats</b>
<b>Total</b>	<b>Special K</b>
<b>Wheaties</b>	
	<b>Nutrigrain bar</b>
<b>Oatmeal</b>	<b>White rice</b>
<b>Wheat bread</b>	<b>Pasta</b>
<b>Brown rice</b>	<b>Pizza</b>
<b>Popcorn</b>	<b>Bread/Bagels/Buns</b>
<b>Triscuit crackers</b>	<b>Pop-Tarts</b>
<b>Nature Valley oats and honey bar</b>	<b>Cookies/cakes/muffins</b>

Figure 2: Total cereal grain intake: food records vs. survey

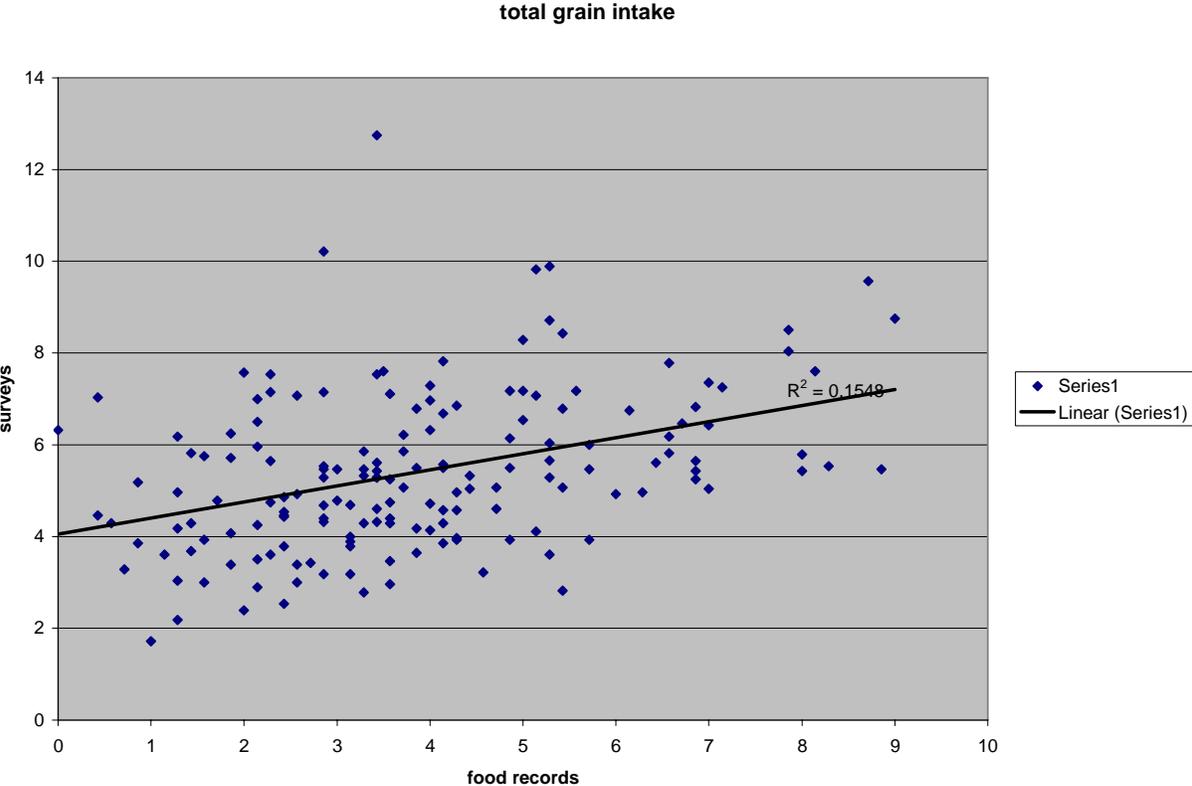


Figure 3: Whole grain intake in college students: food records vs. survey

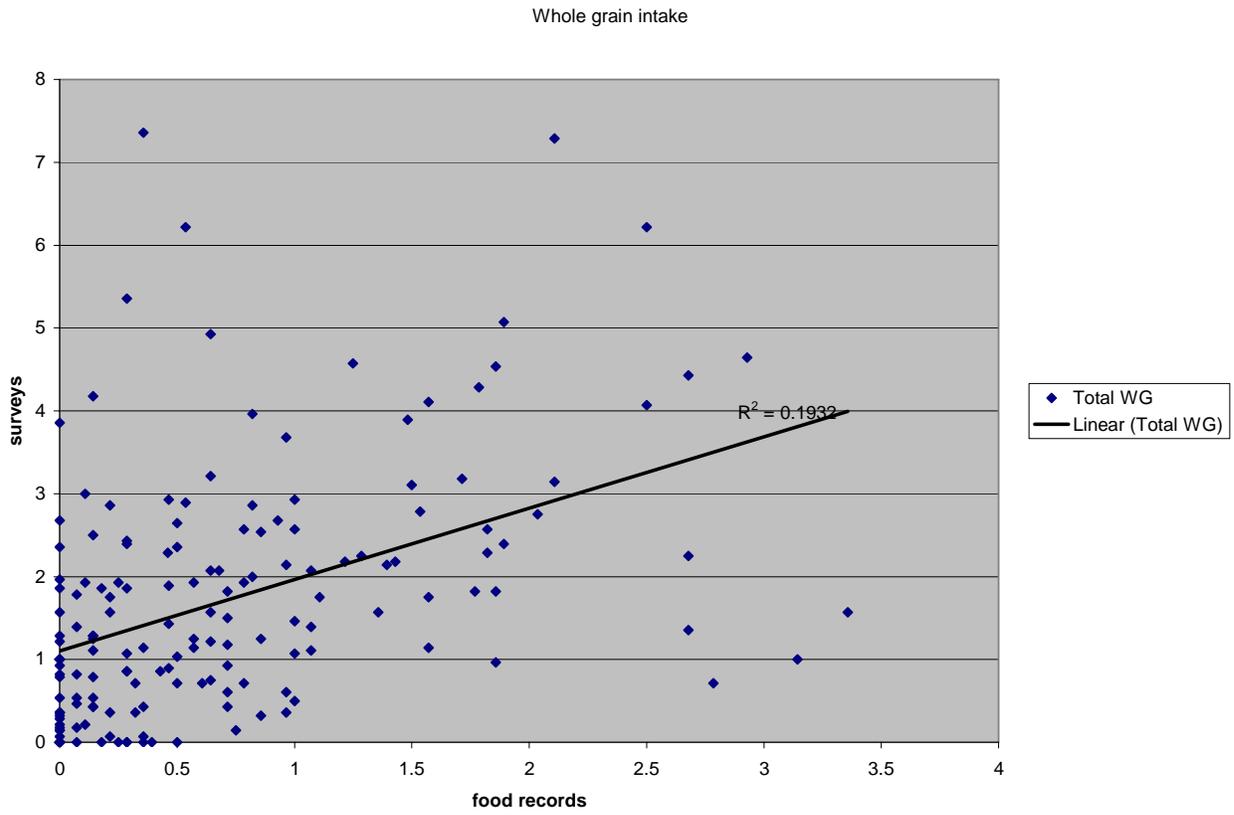
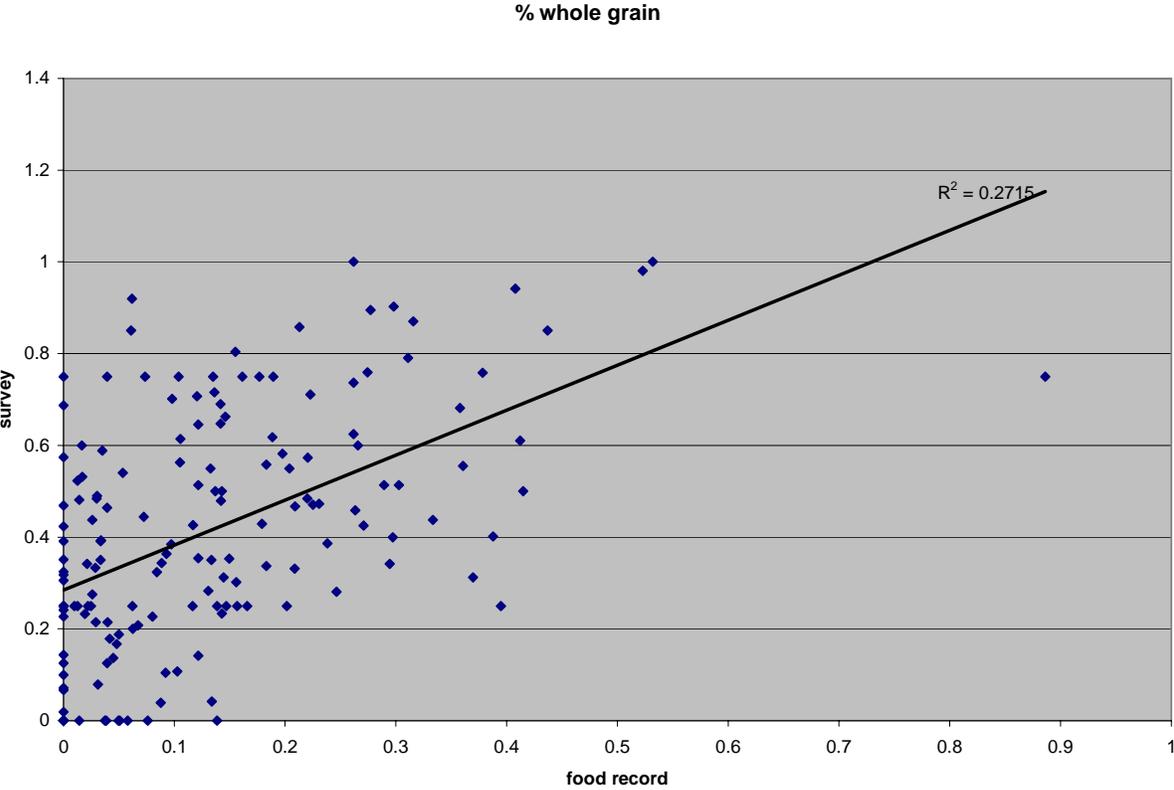


Figure 4: Percent of total grain intake from whole grains: food records vs. surveys



## **Appendices**

## **Appendix A: Informed Consent Form**

# VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

## Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project: Effects of Breakfast in College Students: a Pilot Study

Investigators: Kathy Hosig, Ph.D, MPH, R.D. and Linda Davis, M.S., R.D.

### I. Purpose of this Research/Project

All students enrolled in HNFE 1004 for Spring 2004 will be invited to participate in this study. The purpose of the study is to collect information about what college students eat, their physical activity, and their weight and height. The information will be used to find out if breakfast habits are related to overall diet, physical activity and weight in college students.

### II. Procedures

If you decide to participate in this study, you will be asked to do each of these things at two different times in the semester (once near the beginning and once at the end):

- 1) fill out a survey in class that takes about 20 minutes to do
- 2) keep a record of what you eat and your physical activity for 7 days – this takes about 10 minutes each day
- 3) have your weight and height measured (this is already a requirement for the class)

Weight and height will be measured in a faculty office (Dr. Hosig's office in 227 Wallace) by either Dr. Hosig or a graduate research assistant. The door will be open. You will keep your clothes on but will be asked to remove any outer clothing such as hat, coat, sweater and shoes. There will be a sign-up sheet for this so that you can come at your convenience.

### III. Risks

The risks or discomforts involved with this study are small. Your weight and height will be measured privately – no one but the researchers will see your individual results. Keeping the food and activity record will require you to be responsible and remember to do it after each time you eat, but the time it takes is short.

### IV. Benefits

If you participate in this study, you will benefit from analysis of the nutrient content of your diet by a trained nutrition researcher. This is an excellent way to help assess your risk of diseases such as heart disease, cancer, diabetes, and stroke. You may request a copy of the nutrient analysis from your food record once the food records are analyzed. If you would like a summary of the results of the study, you may contact the researchers during the summer to receive these results.

You will also be able to meet the course requirement to have your weight and height measured by being able to schedule this measurement at a time convenient for you.

These benefits are not guaranteed, because the researchers cannot promise that the study will proceed as planned.

### V. Extent of Anonymity and Confidentiality

All of your information from the study will be confidential. Your name will not be used on the survey, food and activity record, and weight and height forms. Instead, you will be given a special code number that will be on these forms. The researchers will keep a list of names and code numbers in a locked file cabinet. This list is to make sure that the correct code number is put on the forms you get so that all of your information has the same code number. When you receive a survey or food and activity record, the top sheet will have only your name on it. Once you receive the form, you will be instructed to remove the top sheet so that your name is no longer on the form.

### VI. Compensation

If you participate in this study, you can receive up to \$10 as a gift certificate to either Kroger or Walmart for doing the survey, food and activity record and measurement of weight and height at the beginning of the semester. This is

broken down as \$2 for completing the survey in class, \$7 for completing the 7-day food and activity record, and \$1 for weight and height.

Only people who complete all of the first part of the study at the beginning of the semester will be allowed to participate at the end of the semester. This is because both parts of the study are needed to answer the research questions of the study.

If you participate at the end of the semester, you can receive up to 5 points of extra credit for HNFE 1004. This is broken down as 2 points for completing the survey in class and 3 points for completing the 7-day food and activity record. No extra points will be given for weight and height, since that is already a course requirement.

## **VII. Freedom to Withdraw**

If you agree to participate in this study, you are free to withdraw or stop participation at any time without penalty. You will receive compensation for any part of the study that you have completed, as shown above. If you choose to withdraw, your grade in the course will not be affected. You will not receive extra credit points for any parts of the study that you did not complete, but the points that you have earned for the course will not be reduced.

If the researchers decide that you should not continue as a subject due to missing data or incomplete information on study forms, you may be asked to withdraw from the study. If this happens, you will receive compensation as above for any parts of the study that you completed. Your grade for the course will not be affected, but you may not be able to earn all 5 possible extra credit points.

## **VIII. Subject's Responsibilities**

I voluntarily agree to participate in this study. I have the following responsibilities:

Complete two in-class surveys, complete two 7-day food and activity records, and have weight and height measured twice (each will be once at beginning and once at end of semester).

## **X. Subject's Permission**

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered and have been given a copy of this form to keep. I hereby acknowledge the above and give my voluntary consent:

PRINTED NAME: \_\_\_\_\_

\_\_\_\_\_  
Signature

Date \_\_\_\_\_

Should I have any pertinent questions about this research or its conduct, and research subjects' rights, and whom to contact in the event of a research-related injury to the subject, I may contact:

Dr. Kathy Hosig  
Investigator

(540) 231-4900/ [khosig@vt.edu](mailto:khosig@vt.edu)  
Telephone/ e-mail

Dr. William Herbert  
Departmental Reviewer

(540) 231-6565/ [wgherb@vt.edu](mailto:wgherb@vt.edu)  
Telephone/ e-mail

Dr. David Moore  
IRB Chair

(540) 231-4991/ [moored@vt.edu](mailto:moored@vt.edu)  
Telephone/ e-mail

## **Appendix B: Survey Instrument**

## Health Habits Pilot Study

This survey is about eating fruits and vegetables and physical activity. Filling out the information is voluntary, and your name will not be recorded. You will be providing valuable information needed to write a grant proposal to the National Cancer Institute if you fill out this survey.

**Your Assigned Code Number:** \_\_\_\_\_

**Today's Date:**

\_\_\_\_\_

**Major:** If you have declared or are seriously thinking about a major, please tell me what it is. If you are not sure what you are going to major in, check that choice.

Major: \_\_\_\_\_ **If Unsure** → \_\_\_\_\_ Not sure

**Age:** What is your age? \_\_\_\_\_ years

**Class:** If you are enrolled as an undergraduate student, are you currently classified as a (circle one):

Freshman

Sophomore

Junior

Senior

**Gender:** Please circle your gender: Female Male

**Weight:**

Has your weight changed in the past 6 months? (circle) Yes No

If your weight has changed in the past 6 months, was this change on purpose? (circle)

Not applicable

Yes

No

If your weight has changed in the past 6 months, please write in the amount you have gained or lost in the past 6 months: (check N/A if not applicable)

\_\_\_\_\_ N/A

\_\_\_\_\_ pounds gained

\_\_\_\_\_ pounds lost

### Breakfast

For this survey, breakfast is defined as eating something within 2 hours of waking up.

1. How many days per week would you say you eat breakfast? (circle your answer)

0 1 2 3 4 5 6 7

2. When you eat breakfast, what do you eat most often for breakfast? (write it in the space below)

Please be specific and write in your complete usual breakfast, including drink, etc. – include amounts if possible

## **Appendix C: Whole grain survey instrument**

## We Need Just a Little More Information, Please.....

Please answer these questions about the grain-based foods you eat. Grain-based foods are foods that are made from grains such as wheat, corn, rye, oats, barley, rice, millet, sorghum, etc. Examples of these foods are bread, tortillas, muffins, bagels, cereals, pasta, rice, corn chips. Whole grain foods are grain-based foods made with whole grains, and include 100% whole wheat bread, breakfast cereals made from whole grains, brown rice, popcorn, and oatmeal-just to name a few.

**How many days of the week do you eat grain-based foods for breakfast?**

\_\_\_ (Please enter a number from 0 to 7)

**When you do eat grain-based foods for breakfast, on average, how many servings of grain-based foods do you typically consume?** *A serving is one slice of bread, ½ cup of cold cereal, ½ cup of hot cereal, half of a bagel or English muffin, etc.*

\_\_\_ 0      \_\_\_ 1      \_\_\_ 2      \_\_\_ 3 or more

**When you do consume grain-based foods for breakfast, how often do you select a whole grain food?**

*Examples may include oatmeal, whole grain cereal, whole-wheat toast, etc.*

\*(Please estimate what percentage of your cereal grain intake is from whole grain foods)

\_\_\_ Never      \_\_\_ 25%      \_\_\_ 50%      \_\_\_ 75%      \_\_\_ 100%

**How many days of the week do you eat grain-based foods for lunch?**

\_\_\_ (Please enter a number from 0 to 7)

**When you do eat grain-based foods for lunch, on average, how many servings of grain-based foods do you typically consume?** *A serving is one slice of bread, a small roll, ½ cup of pasta or rice, or a 6-inch tortilla*

\_\_\_ 0      \_\_\_ 1      \_\_\_ 2      \_\_\_ 3 or more

**When you do consume grain-based foods for lunch, how often do you select a whole grain food?**

*Examples may include whole wheat bread, brown rice, or whole wheat tortillas*

\*(Please estimate what percentage of your cereal grain intake is from whole grain foods)

\_\_\_ Never      \_\_\_ 25%      \_\_\_ 50%      \_\_\_ 75%      \_\_\_ 100%

**How many days of the week do you eat grain-based foods for dinner?**

\_\_\_ (Please enter a number from 0 to 7)

**When you eat grain-based foods for dinner, on average, how many servings of grain-based foods do you typically consume?** *A serving is a small roll, ½ cup pasta or rice, one slice of bread, or ½ of a hamburger bun*

\_\_\_ 0      \_\_\_ 1      \_\_\_ 2      \_\_\_ 3 or more

**When you do consume grain-based foods for dinner, how often do you choose whole grain foods?**

\*(Please estimate what percentage of your cereal grain intake is from whole grain foods)

\_\_\_ Never      \_\_\_ 25%      \_\_\_ 50%      \_\_\_ 75%      \_\_\_ 100%

How many days of the week do you eat grain-based foods for snacks?

\_\_\_ (Please enter a number from 0 to 7)

**When you eat grain-based foods for snacks, on average how many servings per day of grain-based foods do you typically consume?** *A serving is 3-4 crackers, one slice of bread, one slice of a quick bread, or one small muffin, one cup of popcorn, 3-4 small cookies, one cup of corn chips*

\_\_\_ 0      \_\_\_ 1      \_\_\_ 2      \_\_\_ 3 or more

**When you do consume grain-based foods for snacks, how often do you choose whole grain foods?**

*Examples include popcorn, whole-grain crackers, etc.*

\*(Please estimate what percentage of your cereal grain intake is from whole grain foods)

\_\_\_ Never      \_\_\_ 25%      \_\_\_ 50%      \_\_\_ 75%      \_\_\_ 100%

Please mark an "x" beside all of the following reasons why you choose to consume whole grain foods.

- \_\_\_ I do not ever choose whole grain foods
- \_\_\_ I like the taste
- \_\_\_ I always have
- \_\_\_ They are a good source of fiber
- \_\_\_ They reduce the risk of developing diseases
- \_\_\_ Whole grains are healthy
- \_\_\_ I am trying to lose weight
- \_\_\_ Whole grains are cheaper than refined grain foods
- \_\_\_ Grains form the base of the Food Guide Pyramid
- \_\_\_ Other reasons (please indicate other reasons) \_\_\_\_\_

Please mark an "x" beside all of the following reasons why you choose to consume foods made from refined grains, such as white bread, white rice, etc.

- \_\_\_ I do not ever choose refined grain foods
- \_\_\_ I like the taste
- \_\_\_ I always have
- \_\_\_ They are healthy
- \_\_\_ They reduce the risk of diseases
- \_\_\_ I am trying to lose weight
- \_\_\_ They are convenient
- \_\_\_ They are affordable
- \_\_\_ Grains form the base of the Food Guide Pyramid
- \_\_\_ Other reasons (please indicate other reasons) \_\_\_\_\_

Is your current intake of grain-based foods representative of your intake over the past six months?

\_\_\_ Yes      \_\_\_ No

Do you have any health condition, or lifestyle preference which affects your intake of grain-based foods?

- \_\_\_ Celiac disease/gluten intolerance
- \_\_\_ Food allergies/sensitivities to grains (corn, wheat)
- \_\_\_ Follow a low-carbohydrate diet
- \_\_\_ Other reasons (Please indicate other reasons) \_\_\_\_\_

## **Appendix D: Instructions for completing food records**

## Instructions for Completing the 7-Day Food Record

It is extremely important that you take this part of the study seriously. We need for you to be as complete and specific as possible.

1. Please don't forget to write down **what time you got up** for the day!!!!
2. Please write down **everything** you eat or drink as soon as possible after you consume it.
3. Include **anything** you "eat", including hard candy, gum, etc.
4. Please fill out each column for each food item
  - Time  
We need this to see if timing of eating makes a difference in the things we are looking at
  - Amount  
We need this to be able to enter your food intake correctly into the computer. Use your best judgment, and here are some tips:
    - a. 1 cup is about the size of a baseball (or a half-pint milk carton from the cafeteria, or your fist if your hand is average size) – also usually 1 scoop of main dish at a cafeteria
      - i. ½ cup is about the size of a tennis ball (usually 1 scoop of side dish at a cafeteria)
      - ii. 1 teaspoon is about the size of the end of your thumb – 3 teaspoons is 1 tablespoon
      - iii. ¼ cup is about the size of a golf ball
      - iv. 3 ounces of meat is about the size of a deck of cards
    - b. Try to use amounts such as cups, tablespoons, ounces, etc. if possible, but just describe the amount if you are not sure
    - c. If the item is a standard size at a fast food restaurant, you can just say exactly what the item was and what size (small/medium/large, 6-inch/12-inch, single/double, etc.) – remember to say WHERE you ate
    - d. If you make it yourself, tell us how many pieces/slices of EACH thing on sandwiches, how much of EACH condiment or topping, etc.
    - e. For drinks, tell us whether it was regular or diet, sweet or unsweetened, and the SIZE (small/medium/large, 8-oz/12-oz/16-oz./20-oz./24-oz), and anything you added (i.e. cream, sugar, etc.) – **please don't forget to include drinks!!!**
    - f. If the item is one "pack" or "package", please tell us the size of the package – should be on the package itself
    - g. For any foods that you can, especially bread/cereal/pasta/rice, etc., please tell us the **BRAND NAME and PRODUCT NAME** of the food you ate.]
  5. **Examples of complete entries: use your own information and serving sizes, of course!!!**

**Please email me at [khosig@vt.edu](mailto:khosig@vt.edu) if you have any questions about how to enter a food that you ate – I will respond quickly**

- a. Kellogg's Complete Bran Flakes – 1.5 cups
  - b. Pepperidge Farms Multi-Grain Bagel – 1 large bagel (12oz per 6 bagels)
  - c. Entenmann Chocolate Cake Donuts, large – 2 donuts
  - d. Chips Ahoy Chewy Chocolate Chip Cookies – 4 cookies
  - e. Quaker Chewy Granola Bars (peanut butter and chocolate chip) – 2 bars
  - f. Kraft Singles 2% American Cheese – 1 slice
  - g. Plumrose Deli Ham, baked – 2 slices
  - h. Kraft Light Done Right ranch salad dressing – 3 tablespoons, ¼ cup, etc.
- CONTINUES.....(over)**
- i. Kroger 2% milk – 1 cup

- j. Subway 6-inch turkey/ham with provolone on honey/oat bread with mayo, mustard, pickle, black olives, etc.
- k. Firehouse large pepperoni and mushroom pizza, regular crust (or thin crust, etc.) – 4 slices
- l. Chef Salad at Dietrick – large with 1 cup lettuce, ¼ cup ham, ¼ cup turkey, 1 egg, ¼ cup cheese, ½ cup croutons, ¼ cup bacon bits, ¼ cup green pepper, ½ cup regular (as opposed to low fat or fat free) French dressing
- m. Spaghetti with meat sauce – 2 cups pasta with 1 cup sauce and ¼ cup Parmesan Cheese
- n. Mello Yello (regular) – 20oz bottle (or 12oz can, etc.)
- o. Dr. Pepper (diet) – 20oz bottle (or 16oz cup, etc.)
- p. Hardees 1/3 pound thickburger with mayo, mustard, lettuce, tomato
- q. Wendy’s single cheeseburger with lettuce, tomato, mayo
- r. Krispy Kreme chocolate glazed crème-filled doughnut – 2 doughnuts
- s. Sweet tea – Big Gulp at 7-Eleven (indicate ounces if you know it)
- t. Beer – indicate how many draft beers, how many cans, name and whether regular or light
- u. Extra sugar-free gum – 1 slice
- v. Skittles candy – 1 bag (1.15 ounce)
- w. Apple – 1 large
- x. Banana – 1 medium
- y. Broccoli with cheese sauce – ¾ cup
- z. Campbell’s Chunky Vegetable Beef soup – 1 can
- aa. Great Value saltine crackers – 8 squares
- bb. Canned peaches in heavy syrup (or light syrup or juice) – ½ cup, or 4 slices
- cc. Kraft Easy Mac macaroni and cheese – 2 packages
- dd. Kroger macaroni and cheese from mix – 2 cups
- ee. Tuna sandwich – 1 can tuna in oil (drained), 3 tablespoons regular mayo, dash salt and pepper, 2 slices Kroger sandwich bread
- ff. Peanut butter sandwich – 3 tablespoons Jif peanut butter, 1 tablespoon grape jelly, 2 slices Arnold 7-grain bread
- gg. Ramen noodles, oriental flavor – 1 package (3 oz)
- hh. Sbarro broccoli and spinach stromboli, small
- ii. Sbarro large drink, Dr. Pepper
- jj. Casserole with pasta, chicken, carrots, corn, lima beans, peas – 1.5 cups total (could put recipe in “special notes” column if you made it or know the proportions)
- kk. Red grapes – 1 cup (or might use number such as 10 grapes, if you count them, or say 1 handful, 2 handfuls, etc.)

6. **Please don’t forget to write down your physical activity** for the day on the back of the food/activity record, even if you don’t use the back for food

Again, please be specific about what you did, how strenuous it was, and how long

**Examples (use actual time, etc.):**

- a. basketball, full court, 20 minutes
- b. jogged, 10-minute mile, 45 minutes
- c. cardio machines, 30 minutes
- d. walked, 40 minutes total
- e. bicycle, outdoor, 1 hour
- f. racquetball, 30 minutes
- g. land aerobics class, 30 minutes
- h. lifted weights, total actual lifting time 20 minutes

## **Appendix E: Sample food record**



**Food/Activity Record -- Page 2 of 2**

Time	Food Eaten - How Prepared	Amount Eaten	Special Notes

**Physical Activity**

Please list any physical activity you had today.

Type of Activity	Time Spent in	Special Notes

APPENDIX F: IRB Approval

04-031



Institutional Review Board

Dr. David M. Moore  
IRB (Human Subjects) Chair  
Assistant Vice Provost for Research Compliance  
CVM Phase II, Duckpond Dr., Blacksburg, VA 24061-0442  
Office: 540/231-4991; FAX: 540/231-6033  
email: moored@vt.edu

DATE: February 9, 2004

MEMORANDUM

TO: Kathy Hosig HNFE 0430  
Linda Davis HNFE 0430

FROM: David Moore 

SUBJECT: IRB Expedited Approval: "Effects of Breakfast in College Students" IRB # 04-031

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective February 9, 2004.

cc: File  
Department Reviewer William G. Herbert HNFE

## VITA

Nick Rose plans to pursue his doctorate in community nutrition at Virginia Tech

### EDUCATION

**M.S., Human Nutrition, Foods, and Exercise (2005)**  
**Virginia Tech**  
Blacksburg, Virginia

**B.S., Human Nutrition Foods and Exercise (2002)**  
**Virginia Tech**  
Blacksburg, Virginia

### EXPERIENCE

**Graduate Teaching Assistant**  
**Virginia Tech (2004-2005)**

### AWARDS AND SCHOLARSHIPS

Janet Cameron Scholarship (2004) for graduate study related to food culture at Virginia Tech  
Hepler Fellowship to support thesis research at Virginia Tech (Summer 2004)  
BSI undergraduate research award to support laboratory research at Virginia Tech (2002)  
VT Culinary Collection prize for original research paper (2002)

### PUBLICATIONS AND PRESENTATIONS

“Whole grain intake in college students and its association with body mass index” Abstract accepted for poster presentation at the Society for Nutrition Education’s annual meeting (2005)

“Do fruits and vegetables cost less at the farmer’s market than at the supermarket?” Abstract accepted for poster presentation at the Society for Nutrition Education’s annual meeting (2005)

“Coming Together: Virginia’s Food, Festivals, and Communities” *Virginia Culinary Thymes*; Issue 3: Summer 2002.  
[http://spec.lib.vt.edu/culinary/CulinaryThymes/2002\\_03/03Rose.html](http://spec.lib.vt.edu/culinary/CulinaryThymes/2002_03/03Rose.html)

Niba LL and Rose N. “Effect of soaking solution concentration on resistant starch and oligosaccharide content of adzuki, fava, lima and mung bean” *Journal of Food Technology*; 2003:1(1):4-8.