

The Effects of the Consumption of High-Fiber Bread  
on an Overweight Population

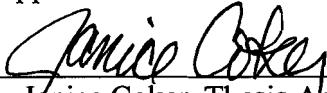
by

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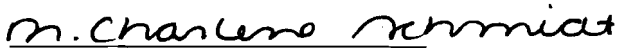
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ABSTRACT

The health benefits of a high fiber diet have been known since the 19<sup>th</sup> century with many different forms of studies conducted to show its advantages. Though not all of the pathophysiological benefits are understood about diets including high fiber whole grains and high fiber breads, many studies in recent years show strong evidence of significant inverse relationships with body mass index, total cholesterol, low density lipoprotein, and fasting insulin levels.

The purposes of this study were to 1) determine the effects of increasing the consumption of breads containing high fiber on an overweight population's diet, 2) evaluate if the health risks associated with heart disease would decrease, 3) determine if increased fiber consumption affected liver function and to evaluate food frequency consumption of various foods over the study period.

A total of 21 female participants completed the study with nine in the control group and 12 in the experimental group. Participants were randomly assigned to either a control group receiving information on the benefits of a high fiber diet or into an experimental group receiving information on the benefits of a high fiber diet and breads high in fiber. The experimental group picked up bread bimonthly and was instructed to gradually increase their consumption. Participants were instructed to consume three slices of bread per day for the first two weeks, gradually increasing up to six slices of bread per day for the final two weeks by increasing their consumption one slice per day every two weeks over the course of the eight week study. At four and eight weeks both the control group and experimental group were asked to return for follow-up and to complete a food frequency questionnaire.

One, four, and eight week body weight, body composition, body mass index, blood glucose, lipid profile, liver enzyme function tests and food frequency data were analyzed using SPSS statistical software. Means, standard deviations and two way analysis of variance with repeated measures on week 1, week 4, and week 8, using “CON EXPO” were determined.

Results indicated that there were no significant differences found within each group or between groups in any comparison as result of increased high fiber whole grain bread consumption. However, the findings did show an association between decreased mean cholestrol, triglycerides and low density lipoprotein values in participants given an informational handout illustrating the nutritional benefits of eating a high fiber diet.

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## Chapter I: Introduction

Diet and nutrition are important factors in the promotion and maintenance of good health throughout the entire life span. Their role as determinants of chronic health risk and life span is well established and therefore occupy a prominent position in prevention activities.

The burden of chronic diseases is rapidly increasing worldwide. It has been calculated that in 2001, chronic diseases contributed approximately 60% of the 56.5 million total reported deaths in the world and approximately 46% of the global burden of disease (World Health Organization [WHO], 2003). The proportion of the burden of cardiovascular diseases is expected to increase to 57% by 2020. Almost half of the total chronic disease deaths are attributable to cardiovascular diseases. Obesity and diabetes are also showing worrying trends, not only because these conditions affect a large proportion of the population, but also because they have started to appear earlier in life.

Many chronic diseases are largely preventable. Although more basic research may be needed on some aspects of the mechanisms that link diet to health, the currently available scientific evidence provides a sufficiently strong and plausible basis to justify taking action now and using nutrition as a preventative method to fight many chronic diseases.

According to the American Dietetic Association (2005), the Dietary Guidelines for Americans provide science-based advice to promote health and to reduce risk for major chronic diseases through diet and physical activity. Major causes of morbidity and mortality in the United States are related to poor diet and a sedentary lifestyle. Some specific diseases linked to poor diet and physical inactivity include; cardiovascular



disease, type 2 diabetes, hypertension, osteoporosis, and certain cancers. Furthermore, poor diet and physical inactivity resulting in an energy imbalance (more calories consumed than expended) are the most important factors contributing to the increase in overweight and obesity in this country. Coupled with physical activity, following a diet that does not provide excess calories according to the recommendations should enhance the health of most individuals.

The Dietary Guidelines encourage the consumption of three or more ounce-equivalents of whole-grain products per day, with the remainder of the recommended grain sources from enriched or whole-grain products. In general, at least half of the grains in a daily diet should come from whole grains.

#### *Statement of the Problem*

The purpose of this study was to determine the effects of increasing the consumption of breads containing high fiber on an overweight population's diet and to evaluate if the health risks associated with heart disease would decrease. A secondary purpose was to evaluate if participants' food frequency consumptions of less nutritious foods would change.

#### *Research Objectives*

1. To determine if overweight individuals who receive information on the benefits of high fiber diets and gradually increase their consumption of bread containing high fiber to six slices per day differ from overweight individuals who receive information on the benefits of high fiber diets after a period of 8 weeks.
2. To determine if the consumption of bread containing high fiber by overweight individuals decreased risk factors specifically associated with heart disease.

3. To determine if the increased consumption of high fiber breads changes the frequency of less nutritious foods consumed and reported by overweight individuals.
4. To determine if the increased consumption of high fiber bread would have a detrimental impact on liver function.

#### *Assumptions of the Study*

There are two assumptions apparent in this research. The first is that subjects will be consistent in the consumption of the requested gradual increase of high fiber bread from three slices per day during the initial 2 weeks of their experiment up to six slices of bread per day during the final 2 weeks. Second, when completing their food frequency questionnaires it is assumed that the participants will answer in the most accurate way possible.

#### *Definition of Terms*

*American Dietetics Association.* The American Dietetic Association is the nation's largest organization of food and nutrition professionals.

*Appetite.* The integrated response to the sight, smell, thought, or taste of food that initiates or delays eating.

*Balance (dietary).* Providing foods in proportion to each other and in proportion to the body's needs.

*Basal metabolic rate (BMR).* The rate of energy use for metabolism under specified conditions: after a 12 hour fast and restful sleep, without any physical activity or emotional excitement, and in a comfortable setting.

*Basal metabolism.* The energy needed to maintain life when a body is at complete digestive, physical, and emotional rest.

*Blood lipid profile.* Results of a blood test that reveal a persons total cholesterol, triglycerides, and various lipoproteins.

*Body composition.* The proportions of muscle, bone, fat, and other tissue that make up a person's total body weight.

*Body mass index (BMI).* An index of a person's weight in relation to height; determined by dividing the weight (in kilograms) by the square of the height (in meters). This measure has the least correlation with body height and the highest correlation with independent measures of body fatness for adults.

*Calories.* Units by which energy is measured. One calorie is the amount of heat necessary to raise the temperature of 1 kilogram of water 1 degree Celsius.

*Chylomicrons.* Are large lipoprotein particles that are created by the absorptive cells of the small intestine and transport exogenous lipids to adipose, cardiac, and skeletal tissues.

*Constipation.* The condition of having infrequent or difficult bowel movements objectively assessed by (1) fewer than three stools per week are passed while a person is eating a high-residual diet; (2) more than three days go by without the passage of a stool; or (3) the weight of stool passed in one day totals less than 35 grams.

*Diabetes Mellitus.* A disorder of carbohydrate metabolism characterized by altered glucose regulation and utilization, usually resulting from insufficient amount or ineffective insulin usage.

*Dietary reference intakes (DRI).* A set of nutrient intake values for healthy people in the United States and Canada set forth by the Food and Nutrition Board

*Digestion.* The process in which food is broken down into absorbable units by the body.

*Fibers.* In plant foods, the nonstarch polysaccharides that are not digested by human digestive enzymes, although some are digested by the gastrointestinal (GI)

tract bacteria. Fibers include: cellulose, hemicelluloses, pectins, gums, and mucilages, and the nonpolysaccharides lignins, cutins, and tannins.

*Food frequency questionnaire.* A frequency record of foods most commonly eaten by a person over a given period of time such as day, week, or month.

*Glucose.* A monosaccharide, also commonly referred to as blood sugar.

*High density lipoprotein (HDL).* The type of lipoprotein that transports cholesterol from the blood stream to the liver from the cells; composed primarily of protein.

*High fiber.* Five grams or more fiber per serving. A high fiber claim made on food that contains more than three grams of fat per serving and per 100 grams of food must declare total fat.

*Insoluble fiber.* Indigestible fibrous food components that do not dissolve in water.

*Low density lipoprotein (LDL).* The type of lipoprotein derived from very-low-density lipoproteins (VLDL) as VLDL triglycerides are removed and broken down; composed primarily of cholesterol.

*Nutrients.* Chemical substances obtained from food and used in the body to provide energy, structural materials, and regulating agents to support growth, maintenance, and repair of the body's tissues. Nutrients may also reduce the risk of some diseases.

*Overweight.* Body weight above some acceptable weight that is usually defined in relation to height (such as BMI) that places individuals at an increased risk for some comorbidities.

*Refined.* The process by which the coarse parts of a food are removed.

*Satiating.* Having the power to suppress hunger and inhibit eating.

*Satiation.* The feeling of satisfaction and fullness that occurs during a meal and halts eating. Satiation usually determines how much food is consumed during a meal.

*Satiety.* The feeling of fullness and satisfaction that occurs after a meal and inhibits eating until the next meal. Satiety determines the amount of time that passes between meals.

*Stools.* Waste matter discharged from the colon; also called feces.

*Limitations of the Study*

The limitations of this study are that the subjects may not consume the appropriate amounts of bread in the given time frames and answer honestly and accurately on the food frequency questionnaire.

## Chapter II: Literature Review

### *Introduction*

This chapter is divided into three major sections. The first will elaborate on the prevalence and effects of overweight and obesity. The second concentrates on the diagnostic and screening criteria used in this study. The final section discusses the impact of the dietary modification of increased fiber and breads on health.

### *Weight Imbalance: Overweight and Obesity*

Overweight is defined as a state in which weight exceeds a standard based on height (Mahan & Escott-Stump, 2000). Obesity is characterized by an excess accumulation of fat either generalized or localized and is a determinant of health and well being (Shils, Olson, Shike, & Ross, 1999). Overweight and obesity are present in males and females, all races and ethnicities, and all age groups. Disparities do exist, however, and the prevalence of overweight and obesity is higher in women who are of members of racial and ethnic minorities compared with non-Hispanic white women. Gender differences are also evident. Mexican American and non-Hispanic black women have a higher prevalence of overweight and obesity compared with men of the same race. This picture reverses in non-Hispanic white men and women, with men having a higher prevalence of overweight and obesity than women (Mahan & Escott-Stump, 2004). Over half of the adults in the United States are now considered overweight or obese with the prevalence especially high among women, the poor, blacks, and Hispanics (Whitney & Rolfes, 2005).

Obesity has reached epidemic proportions globally, with more than 1 billion adults overweight – at least 300 million of them clinically obese – and is a major



contributor to the global burden of chronic disease and disability (World Health Organization, 2003). Being overweight or obese can occur only in the face of a positive energy balance, so in this case, it is a nutritional disease. Obesity results from a failure of the homeostatic mechanisms that balance energy intake and outgo in normal people (Shils et al., 1999).

Overweight and obesity have been directly linked with mortality and many chronic ailments including cardiovascular disease, elevated triglyceride levels, increased cholesterol, diabetes, hypertension, respiratory problems, gallbladder disease, arthritis and cancer (Shils et al., 1999).

The previously described health effects of obesity impose a significant economic cost. These costs have been estimated for numerous developed countries including the United States. Obesity leads to a national economic burden estimated at \$93 billion per year (American Dietetic Association, 2005). Individuals who are also obese have health-care costs that are an average of 37% higher than non-obese people. These estimated costs are conservative because they reflect only the costs of diagnosing and treating illnesses caused by obesity. Other relevant costs include direct costs related to the treatment of obesity, indirect costs related to the loss of productivity caused by morbidity and premature death, and intangible costs related to reductions in the individual's quality of life.

Ultimately, any intervention to facilitate weight loss or prevent weight gain must result in an appropriate relation between energy expenditure and energy intake within the individual: to facilitate weight loss, energy expenditure must exceed energy intake (National Institute of Health, 1998). Among obese adults, weight loss is advocated

primarily because of its anticipated and demonstrated positive effects on risk factors for diabetes and cardiovascular diseases including lowered blood pressure in hypertensive or non-hypertensive individuals.

*Body mass index.* BMI is a tool for indicating weight status in adults. The BMI describes relative weight for height:  $BMI = \text{weight (kilograms (kg))} / \text{height (meters squared (m}^2\text{))}$  (Whitney & Rolfes, 2005). A BMI of 18.5 – 24.9 for adults represents a healthy target either for overweight people to achieve or for others to not exceed (Center for Disease Control, 2004a). A BMI from 25.0 – 29.9 classifies individuals as overweight and a BMI over 30 classifies individuals as obese.

BMI is only one of many factors used to predict risk for disease. BMI cannot be used to tell a person if he/she has a disease such as diabetes or cancer (Center for Disease Control, 2004a). However, mortality increases as excess weight increases. People with a BMI greater than a value of 35 are twice more likely to die prematurely than people with a BMI less than 25. The risks associated with increased BMI appear to also be greater for Caucasians than for African Americans (Whitney & Rolfes, 2005).

The advantage of using BMI as an indicator is that weight and height are easily measured by relatively untrained individuals and with easily obtainable and accurate equipment. Another advantage is that internationally accepted definitions of BMI can be used to assess obesity across studies globally and for subgroups of a population (Center for Disease Control, 2004a). However, BMI can be misrepresentative if an individual has a overly large body frame or is overly muscular.

*Type II diabetes mellitus.* Type II diabetes mellitus is the most common form of diabetes mellitus. In type II diabetes mellitus, either the body does not produce enough

insulin or cells cannot take up the insulin. Insulin is necessary for the body to be able to use glucose in the cell and inappropriate levels can result in disorders such as heart disease, stroke, kidney disease, eye complications, neuropathy, nerve damage, circulation, skin complications, gastroparesis, and diabetes mellitus, and depression (American Diabetes Association, 2005).

An estimated 30 million people worldwide had diabetes mellitus in 1985 (World Health Organization, 2005a). A decade later, the global burden of diabetes mellitus was estimated to be 135 million. The latest World Health Organization estimate – for the number of people with diabetes mellitus, worldwide, in 2000 – was 171 million. This is likely to increase to at least 366 million by 2030. Two major concerns are that much of this increase in diabetes mellitus will occur in developing countries, due to population growth, aging, unhealthy diets, obesity and sedentary lifestyles. There is also a growing incidence of type II diabetes mellitus – which accounts for about 90% of all cases – at a younger age. In developed countries most people with diabetes are retired in contrast to in developing countries where those individuals most frequently affected are in the middle, productive years of their lives, aged between 35 and 64. The number of deaths attributed annually to diabetes is around 3.2 million. Diabetes mellitus has become one of the major causes of premature illness and death in most countries, mainly through the increased risk of cardiovascular disease.

Because of its chronic nature, the severity of its complications, and the means required to control them, diabetes is a costly disease, not only for affected individuals and their families, but also for the health care systems and society. Studies in India estimate that, for a low-income Indian family with an adult with diabetes, as much as 25% of

family income may be devoted to diabetes care (World Health Organization, 2005a). For families in the USA with a child who has diabetes, the corresponding figure is 10% of family income.

Diabetes mellitus affects approximately 16 million people in the United States and accounts for about one sixth of all expenditures for health care (American Family Physician, 1999). Ninety percent of patients with diabetes have type II diabetes mellitus and often require oral agents or insulin for glucose control. The mortality rate in patients with diabetes may be up to 11 times higher than in persons without the disease. Diabetes mellitus is a leading cause of blindness, renal failure, and foot and leg amputations in adults. Managed care and budgeted resources challenge clinicians to provide comprehensive health care to patients with diabetes mellitus.

#### *Diagnostic and Screening Criteria*

*Fasting blood glucose.* As reported by the College of American Pathologists (2005) in 1997, the Expert Committee on the Diagnosis and Classification of Diabetes was convened to reexamine the classification and diagnostic criteria for diabetes based on the 1979 publication of the National Diabetes Data Group. As a result of its deliberations, the expert committee recommended several changes to the diagnostic criteria for diabetes and for lesser degrees of impaired glucose regulation. The use of a fasting plasma glucose, or FPG, test for the diagnosis of diabetes was recommended, and the cut point separating diabetes from nondiabetes was lowered from a FPG > 140 mg/dl to > 126 mg/dl (College of American Pathologists, 2005). This change was based on data that showed an increase in prevalence and incidence of diabetic retinopathy beginning approximately at a FPG of 126 mg/dl, as well as on the desire to reduce the discrepancy

that existed in the number of cases detected by the FPG of > 140 mg/dl and the 2-h value in the OGTT (2-h plasma glucose) of > 200 mg/dl.

In November 2003, the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus recommended that the criteria to diagnose diabetes remain as previously defined (College of American Pathologists, 2005). However, the lower cut point defining impaired fasting glucose, or IFG, was reduced from > 110 mg/dl to > 100 mg/dl. Thus, "normal" would now be defined as a FPG of < 100 mg/dl. These diagnostic criteria for diabetes mellitus were restated in January 2005.

*Lipid panel.* When individuals are overweight, obese, or have diabetes mellitus, their risk of heart attack or stroke is increased because of the damage the disease can inflict on blood vessels. Unhealthy levels of cholesterol and triglycerides increase the risk even farther.

A lipid panel test helps determine the risk for these kinds of cardiovascular problems by measuring the levels of cholesterol and triglycerides in circulating blood. A lipid panel — also called a lipid profile — usually includes four measurements of the types of fats (lipids) in blood: total cholesterol, total triglycerides, low-density lipoprotein (LDL), and high-density lipoprotein (HDL). Each measurement will be discussed in more detail.

Though cholesterol increases with age, a desirable lipoprotein value of cholesterol level is less than 200 mg/dl for all age ranges and times (Mahan & Escott-Stump, 2000). A total cholesterol measurement captures cholesterol contained in all lipoprotein fractions: 60%-70% is carried on LDL, 20%-30% on HDL, and 10%-15% on VLDL. There is a direct, positive relationship between total serum cholesterol and CHD.

Populations that consume diets high in saturated fatty acids have increased blood cholesterol levels and CHD incidence and mortality. The Third Report of the Expert Panel on Detection, Evaluation, and Treatment on High Blood Cholesterol in Adults reaffirms that “lowering total cholesterol and LDL reduces CHD risk. A 10% reduction in total cholesterol has been shown to decrease CHD incidence by 30% (Center for Disease Control, 2004b).

Triglycerides help the body store fat and are usually found in fat tissue, with only low levels normally present in blood. The triglyceride-rich lipoproteins include chylomicrons, VLDL, and any remnants or intermediary products formed in catabolism. Triglyceride levels are classified as normal (<150 mg/dl), borderline high (150-199 mg/dl), high (200 – 499 mg/dl) and very high (>500 mg/dl) (Mahan, 2000).

LDL is the primary cholesterol carrier in blood; consequently total cholesterol levels and LDL cholesterol levels are highly correlated. A desirable LDL level is less than 130 mg/dl (Mahan & Escott-Stump, 2000). LDL is sometimes called the "bad" cholesterol because too much of it in the blood causes the accumulation of fatty deposits (plaques) in the arteries (atherosclerosis), reducing blood flow and leading to heart disease. In addition, in people with diabetes, LDL cholesterol molecules tend to be smaller and denser than in people without diabetes, causing further damage to blood vessels.

HDL is sometimes called the "good" cholesterol because it helps carry LDL cholesterol for disposal, keeping arteries clear and blood circulating freely. HDL particles contain more protein than any of the other lipoproteins, which accounts for their theoretical metabolic role as a reservoir of the apolipoproteins that direct lipid

metabolism (Mahan & Escott-Stump , 2000). Apo A-1, the main apolipoprotein in HDL, is involved in tissue cholesterol removal. High HDL levels are therefore associated with low levels of chylomicrons, VLDL, and small, dense LDL. Desirable HDL cholesterol is greater than 40 mg/dl for men. Because women have higher HDL cholesterol than men, and HDL cholesterol levels of greater than 45 mg/dl is recommended in women.

Although these lipids are necessary for the body to function normally, the kind and amount present in blood are correlated with an increased risk of heart disease. Together, the four laboratory values can provide clues about the risk of having a heart attack, stroke, or other blood vessel damage (Mayo Clinic, 2004a).

Cross-population, within population, and clinical studies have consistently shown that a high serum cholesterol level is correlated with increased coronary heart disease and mortality (Mayo Clinic, 2004a). In the past 30 years, the carriers of blood lipids and their carrier proteins, lipoproteins, have come to the forefront as predictors of risks.

Each class of lipoproteins actually represents a continuum of particles. The ratio of protein to fat determines the density; thus, particles with more protein are denser. The physiologic role of lipoproteins includes transporting lipids to cells for energy or storage and serving as a substrate for prostaglandins, tromboxanes, and leukotrienes (Mayo Clinic, 2004a). Because of different metabolic roles, the lipoproteins also vary in extent of atherogenicity.

A standard lipoprotein profile includes measurement of total cholesterol, LDL cholesterol, HDL cholesterol, and triglyceride levels after a 12 hour fast. Most clinical laboratories cannot quantify LDL cholesterol directly; the Friedewald formula ( $LDL =$

$(TC) - (HDL) - (TG/5)$  is used for the calculation. Consequently, a lipid profile must be taken in the fasting state (8-12 hours after eating) to allow time for chylomicrons to clear.

Results of a lipid panel are listed as a set of numbers in milligrams per deciliter (mg/dl). The results are categorized as optimal, near optimal, borderline high risk, high risk and very high risk (Mayo Clinic, 2004a).

*Liver function test.* Liver function tests generally refer to blood tests that evaluate the presence of liver disease and determine the extent of the disease. These tests include liver enzymes, which are markers for liver cell or biliary duct injury as well as markers of the ability of the liver to make proteins (Mayo Clinic, 2004b).

A liver panel is used to detect liver damage or disease. It usually includes six tests that are run at the same time on one blood sample including: alanine aminotransferase, alkaline phosphatase, aspartate aminotransferase, bilirubin profile, albumin, and total protein.

One or more of these tests are ordered when symptoms suspicious of a liver condition are noticed. These include: jaundice, dark urine, or light-colored bowel movements; nausea, vomiting and/or diarrhea; loss of appetite; vomiting of blood; bloody or black bowel movements; swelling or pain in the belly; unusual weight change; or fatigue or loss of stamina (labtestsonline.org, 2006). One or more of these tests may also be ordered when a person has been or may have been exposed to a hepatitis virus; has a family history of liver disease; has excessive alcohol intake; or is taking a drug that can cause liver damage.

Alanine aminotransferase (ALT) is used to determine if a patient has liver damage. ALT is an enzyme involved in the metabolism of the amino acid alanine (NIH,



2005). ALT is in a number of tissues but it is in highest concentrations in the liver. Injury to the liver results in release of the enzyme into the blood. Normal range can vary according to a number of factors, including age and gender with the normal value from 7-56 IU/L (international units per liter).

Alkaline phosphatase (ALKP) is an enzyme in the blood, intestines, liver, and bone cells. Its chemical structure varies (called isoenzymes) depending on where it is produced (National Institute of Health, 2005). This test makes it possible to determine where a problem has originated. When bones are growing, liver cells are damaged, or a biliary obstruction occurs, alkaline phosphatase levels rise considerably. The normal value is 20 to 140 IU/L with the test about 80% accurate for identifying specific locations of cancers or disease.

Aspartate aminotransferase (AST) is in high concentration in heart muscle, liver cells, skeletal muscle cells, and to a lesser degree, in other tissues (National Institute on Health, 2005). Although elevated serum AST is not specific for liver disease, it is used primarily to diagnose and monitor the course of liver disease (in combination with other enzymes such as ALT, ALKP, and bilirubin). The normal range is 10 to 34 IU/L.

Bilirubin is a breakdown product of hemoglobin (National Institute of Health, 2005). Total and direct bilirubin are usually measured to screen for or to monitor liver or gall bladder dysfunction. This test is useful in determining if a patient has liver disease or a blocked bile duct. Bilirubin metabolism begins with the breakdown of red blood cells. Red blood cells contain hemoglobin, which is broken down to heme and globin. Heme is converted to bilirubin, which is then carried by albumin in the blood to the liver.

In the liver, most of the bilirubin is chemically attached to a glucuronide before it is excreted in the bile (National Institute of Health, 2005). This "conjugated" bilirubin is called direct bilirubin; unconjugated bilirubin is called indirect bilirubin. Total serum bilirubin equals direct bilirubin plus indirect bilirubin.

Conjugated bilirubin is excreted into the bile by the liver and stored in the gall bladder or transferred directly to the small intestines (National Institute of Health, 2005). Bilirubin is further broken down by bacteria in the intestines to urobilins, which contribute to the color of the feces. A small percentage of these compounds are reabsorbed and eventually appear in the urine, where they are referred to as urobilinogen.

The normal range for total bilirubin is 0.3 to 1.9 mg/dl, direct bilirubin 0.0 to 0.3 mg/dl, indirect bilirubin 0.0-0.1 mg/dl (National Institute of Health, 2005).

Total protein (TP) is a rough measure of all serum proteins. Protein measurements can reflect nutritional state, kidney disease, liver disease, and many other conditions (National Institute of Health, 2005). If total protein is abnormal, further tests must be performed to identify which protein fraction, and then which specific protein, is abnormal.

Serum proteins are grossly separated into albumin and globulins (National Institute of Health, 2005). That is, total protein equals albumin plus globulin. Globulins are roughly divided into alpha-1, alpha-2, beta, and gamma globulins. Normal values may vary slightly from laboratory to laboratory but are typically range from 6.0 to 8.3 g/dl.

Albumin levels can contribute in determining liver disease or kidney disease and if enough protein is being absorbed by the body (National Institute on Health, 2005).

Albumin is the protein of highest concentration in plasma and transports many small molecules in the blood (for example, bilirubin, calcium, progesterone, and drugs). It is also of prime importance in maintaining the oncotic pressure of the blood (that is, keeping the fluid from leaking out into the tissues).

Because albumin is synthesized by the liver, decreased serum albumin may result from liver disease (National Institute of Health, 2005). It can also result from kidney disease, which allows albumin to escape into the urine. Decreased albumin may also be explained by malnutrition or a low protein diet. Normal values may vary slightly from laboratory to laboratory but are typically range from 3.4 to 5.4 g/dl (National Institute of Health, 2005).

### *Dietary Modification*

*Dietary fiber.* The definition of dietary fiber has always been controversial. However, one of the most widely accepted definitions states that “Fiber is composed of the plant polysaccharides and lignins which are resistant to digestion by the digestive enzymes of man” (Shils et al., 1999). It is a physiological rather than chemical response.

Dietary fiber was originally called crude fiber, a term from ruminant nutrition that referred to the fraction of plant material that was resistant to ruminant digestion and therefore of no nutritional value (Shils et al., 1999). It constituted the very resistant cellulose lignin fraction of what is now called dietary fiber. The chief dietary fiber components of interest are the water-insoluble celluloses, hemicelluloses, and lignins, and the water-soluble pectice substances, gums, and mucilates.

The health benefits of eating cereal and high fiber plant foods in general were promoted in the 19<sup>th</sup> century by the well-known health advocates Graham and Kellogg in

America and Allision in Britain (Shils et al., 1999). However, much of the interest generated in the later half of this century is the results of the work of Denis Burkitt and Hugh Trowell. From their experiences of over 30 years of medical and surgical practice, and subsequent studies of disease incidence in other countries, they proposed that many Western diseases resulted from malabsorption to low fiber diets including colonic disorder, constipation, diverticular disease, colon cancer, and such systemic disorders as hyperlipidemia, cardiovascular disease, diabetes, and obesity.

Since their original hypothesis, results of studies involving fiber have been controversial. Most studies have varying levels of fiber, minerals, protein, and other substances in the diet that are also important and contribute to the confusion when comparing different studies. Many times the type of fiber is also variable, and indications are that insoluble fibers are more likely than soluble fibers to have adverse effects (Shils et al., 1999).

Though controversy surrounds much of the research, there is a clear body of evidence that supports fiber's effect on the body with such physiological effects as lowering plasma cholesterol levels, modifying the glycemic response, improving large bowel function, and lowering nutrient availability which occurs in both isolated fiber fractions and in fiber-rich foods.

According to Bowman and Russell (2001), many studies in humans and animals have shown that certain types of dietary fiber lower plasma cholesterol concentrations. These studies have been done with foods rich in dietary fiber, fractions from foods that are fiber enriched, and isolated polysaccharides. Many of these studies were conducted with relatively high intakes of fiber sources and meta-analysis indicates that a diet

containing 2-10 grams of fiber per day is associated with cholesterol lowering effects. These studies note that reduction in total plasma cholesterol are in ranges from 5%-10%, although decreases of up to 25% have been reported. Almost invariably, the reductions occur in LDL cholesterol fraction with little or no change in HDL cholesterol (Bowman & Russell, 2001).

It is unclear how dietary fiber lowers cholesterol. There are several hypotheses that have been put forth over the years. They involve increased steroid excretion as bile acids or cholesterol, decreased cholesterol synthesis, or increased removal of cholesterol from the plasma (Bowman & Russell, 2001).

Fiber also plays an integral role in total diabetes care and management. In persons with type II diabetes mellitus, increasing fiber from 24 grams per day to 50 grams per day has been reported to improve glycemic control, reduce hyperinsulinemia, and decrease plasma lipids (Chandalia et al., 2000).

In 2001, Bowman and Russell reported associations between high-fiber diets and a lower incidence of certain chronic disorders, such as cardiovascular diseases and the improvement in glucose tolerance with fiber intakes, typically with the greatest reduction coming from the consumption of more than 20g/day. Bowman and Russell (2001), also reported that another important role of fiber in the prevention of these health concerns may lie in its impact on improving short-term, meal specific satiety. Though it is widely known that high levels of fiber are needed to maintain optimal health, the recommendations vary greatly from culture to culture (Bowman & Russell, 2001).

*Bread.* Humans have eaten some form of bread since the Neolithic era, when cereal grains were crushed and mixed with water to form a thick paste that could be

cooked over the fire and consumed (Essortment, 2002). The Egyptians, in approximately 2600 BC were lucky enough to have a sufficient amount of wild yeasts in the air from brewing beer to accidentally discover its uses in leavening bread. Workers were often paid in loaves of bread. Paintings in the pyramids show that the dead were buried with loaves of bread, to provide sustenance in the afterlife.

Greek sailors and merchants brought the Egyptian flour back to Greece, where bread baking flourished (Essortment, 2002). Rome took over the enterprise after their conquest of Greece, and in 150 BC formed the first Baker's Guilds. Guilds were not only a way to garner professional respect, but a way to protect the public. The Baker's Guilds in England were held to strict standards, with harsh punishments for overcharging and/or adulterating the bread.

During the early Middle Ages, much of the bread returned to unleavened loaves, although the Normans reintroduced leavened bread in 1191 (Essortment, 2002). By the early 13th century, millers became more important--their job of turning wheat to flour not only allowed for more gradations of flour, but the practice of keeping up to a quarter of the flour produced made millers quite wealthy and thus of no little importance in their towns and villages.

The lack of millers in the early days of colonial America, along with the lack of wheat, posed problems for the housewife (Essortment, 2002). How to make bread without the basic ingredients? The presence of corn quickly led to the invention of cornbread (alternately referred to johnny-cake or journey cake). Even after wheat became common, those in the Southern colonies had trouble making loaves of bread rise due to the high heat and humidity that killed off the necessary wild yeasts. Biscuits became the

avored flour-based bread, while cornbread remained popular as well. The advent of roller flour mills in the 1800s led to even more highly processed flour--which led to lighter and whiter loaves, even if not as nutritious as the coarser whole wheat.

Unfortunately, due to the increase in availability of highly processed flours and breads, consumption of whole grain breads has decreased (Whole Grains Council, 2005). This is unfortunate because 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, cooked, and/or bleached), the food product often does not deliver approximately the same rich balance of nutrients that are found in the original grain seed.

There are two major differences between white bread and whole grain breads - how they are processed and how healthful they are. The flour for both is made from wheat berries, which have three nutrient-rich parts: the bran (the outer layers), the germ (the innermost area) and the endosperm (the starchy part in between). Whole wheat is processed to include all three nutritious parts, but white flour uses only the endosperm. Because of this, whole wheat is also much higher in fiber, vitamins [B.sub.6] and E, magnesium, zinc, folic acid and chromium.

Recent epidemiologic investigations have found that whole grain intake is associated with reduced risk of various chronic diseases, especially cardiovascular diseases, diverticular disease, constipation and diabetes (Harvard School of Public Health, 2006). It has also been found that fasting insulin was 10% lower during consumption of the 6-10 serving whole-grain diet including whole wheat breads than

during consumption of the refined-grain diet and breads (mean difference:  $-15 \pm 5.5$  pmol/L;  $P = 0.03$ ; Pereira et al., 2002).

According to the indications of a study published in 2002 with nearly 3000 participants, whole grains and whole grain breads that were high in fiber were shown to have a significant inverse relationships with BMI, total cholesterol, LDL, and fasting insulin levels (Lairon, Arnault, Bertrais, Planells, Clero, Hercberg & Boutron-Ruault, 2005).

A recent study of nearly 40,000 women using a semi-quantitative food frequency questionnaire was published in 2002. This study also indicted that women who consumed the greatest number of fiber rich whole grains including breads had inverse relationships with relative risk factors associated with cardiovascular disease (Lui, Buring, Sesso, Rimm, Willett, & Manson, 2002).



### Chapter III: Methodology

The purpose of this study was to determine the effects of increasing the consumption of breads containing high fiber on an overweight population's diet, to evaluate if the health risks associated with heart disease would decrease, determine if increased fiber consumption affected liver function or if participants' food frequency consumption of unhealthy foods would change. Included in this chapter are subject selection and description, recruitment procedures, instrumentation and data collection procedures and analysis.

#### *Subject Selection and Description*

Participants of this study were 18 years of age or older. The participants were volunteers solicited by advertisement in the Dunn County Newspaper and through the UW-Stout faculty email. Upon response, participants were informed of dates and times available for their evaluations.

During the initial evaluation participants were given a consent letter (Appendix A) indicating testing procedures, confidentiality, potential risks, and benefits of the research. Additional questions regarding the testing were also answered at this time.

Assurance that the participants' participation was voluntary was stated through email, on the consent form, and during each of the three testing procedures. All questions about their participation were answered honestly and completely by the examiner through email, on the telephone, and in person.

Upon initially submitting the food frequency questionnaire and consent form, participants were weighed using a Tanita™ TBF-410GS bioelectrical impedance scale. This non-invasive device calculated the participants' weight, BMI, and body

composition. Participants who did not accurately follow the guidelines for the test emailed to them (Appendix B) with the consent letter (Appendix A) and those whose BMI was under 25 were informed they did not fit the desired qualifications for the experiment.

Participants were randomly assigned to either a control group receiving only information on the benefits of a high fiber diet (Appendix D) or an experimental group receiving information on the benefits of a high fiber diet (Appendix D) and breads high in fiber. The experimental group members were instructed to gradually increase their consumption from three slices of bread per day for the first two weeks up to six slices of bread per day for the final two weeks by increasing their consumption one slice per day every two weeks over the course of the eight week study. Participants receiving the bread were assigned bimonthly dates and times available for pickup of their bread. If their schedules did not allow, alternate arrangements were made available. At four and eight weeks both the control and experimental groups were asked to return with a completed food frequency questionnaire and for follow-up testing of their body weight, body composition, blood glucose, BMI, lipid profile, and liver enzyme function.

#### *Instrumentation*

The instruments employed in this study were a food frequency questionnaire (Appendix C) used to obtain the participants eating habits and a Tanita™ bioelectrical impedance scale to obtain the participants body weight, BMI, and body composition. Blood samples of the participants were taken and analyzed at Red Cedar Medical Center in Menomonie, Wisconsin to determine blood glucose, lipid profile, and enzyme functions.

*John Hopkins food frequency questionnaire (Appendix C).* A food frequency questionnaire is a retrospective review of intake frequency – that is food consumed per day, per week, and per month. For ease of evaluation the food frequency chart organizes foods into groups that have common nutrients. Because the focus of the food frequency questionnaire is the frequency of consumption of food groups rather than of specific nutrients, the information obtained is general, not specific, for certain nutrients (Mahan & Escott-Stump, 2004).

*Tanita™ TBF-410GS bioelectrical impedance scale.* Age group, gender and height were entered into the scale prior to the participant stepping onto the platform. Electrodes in the foot sensor pads sent a low, safe signal through the body. Weight was calculated automatically along with body fat content and BMI in less than a minute. Tanita™ Bioelectrical Impedance Analysis (BIA) is considered the world leader in electronic scales (Tanita, 2004). BIA measures the impedance or resistance to the signal as it travels through the water that is found in muscle and fat. The more muscle a person has, the more water their body can hold. The greater the amount of water in a person's body, the easier it is for the current to pass through it. The higher the fat composition, the more resistance to the current. BIA is safe and is not painful. The signal used in body fat monitors can not be detected or felt by the participant.

*Blood withdrawal procedures.* Laboratory testing was conducted before week one and after weeks four and eight with an approximate time of 15 minutes required per testing session. A professional laboratory technician withdrew all blood samples using the following procedures:

- Cleaned port with alcohol swab.

- Connected the blood sampling needle to the blood collection sleeve.
  - The blade end was inserted into the sleeve.
- Connected slip-lock end into the blood sampling port of the stopcock.
- Inserted discard blood tube into the blood collection sleeve until the blade "grabbed" the top of the tube.
- Turned the stopcock off towards the flush system.
- Pushed the vacuum tube into the sleeve.
  - Obtained at least 3 mL discard.
  - Disposed of discard sample in sharps container.
- Turned stopcock to 45° between each tube change. Turned stopcock before removing the sample tube.
- Collected remaining samples - used the minimum amount of blood required to obtain sample.
- When a sample was being drawn:
  - Ensured that a total volume of 5 mL or more has been obtained prior to drawing.
  - Obtained blood gas sample AFTER drawing.
  - Ensured stopcock was not turned to 90° between tube changes.
- After the last sample was drawn, turned stopcock "off" to patient catheter.
- Covered sampling port with several gauze squares.
- Tilted sampling port downward.
- Pulled flush device, back flushing into gauze until port was completely free of blood.

- Turned stopcock to sampling port.
- If any blood remained in port, it was cleaned with an alcohol swab.
- Replaced cap.
- Flushed catheter until all evidence of blood was cleared.

### *Data Collection*

In February, 2005, permission to conduct this study was obtained through the University of Wisconsin-Stout Institutional Review Board. The participants were 21 volunteers solicited by advertisement in the Dunn County Newspaper and through the UW-Stout faculty email. Upon response, participants were informed of dates and times available for their evaluations.

Upon completing the consent form participants were weighed using a Tanita™ bioelectrical impedance scale. Participants who did not accurately follow the guidelines for the procedure emailed to them with the consent letter (Appendix A) and those whose BMI was  $< 25$  were informed they did not fit the desired qualifications for the experiment. Confidentiality was maintained by rotating participants through the assessment lab using portable privacy curtains.

Participants were randomly assigned to either a control group receiving information on the benefits of a high fiber diet or into an experimental group receiving information on the benefits of a high fiber diet and breads high in fiber containing ground flaxseed. The experimental group members were instructed to gradually increase their consumption from three slices of bread per day for the first two weeks up to six slices of bread per day for the final two weeks by increasing their consumption one slice per day every two weeks over the course of the eight week study. Participants receiving the

bread were assigned bimonthly dates and times available for pickup of their bread. If participants' schedules did not allow alternate arrangements were made available. At four and eight weeks both the control group and experimental groups were asked to return with a completed food frequency questionnaire (Appendix C) and for follow-up testing of their body weight, body composition, blood glucose, BMI, lipid profile, and liver enzyme function.

#### *Data Analysis*

All body weight, body composition, and BMIs were recorded upon measurement on the Tanita™ scale. All blood glucose, lipid profile, and liver enzyme function tests were analyzed at Red Cedar Medical Center, Menomonie, Wisconsin. The Food Frequency Questionnaire (Appendix C) was used to analyze the consumption of food groups and general nutrient intakes.

The one-, four-, and eight weeks body weight, body composition, BMI, blood glucose, lipid profile, liver enzyme function tests and food frequency data were entered into SPSS (Statistical Package for the Social Science) statistical software to interpret and separate all data. Means and standard deviations for participant weight, body composition, BMI, lipid profile, liver panel, and food frequency were calculated.

## Chapter IV: Results

This primary purpose of study was to evaluate the effects of increasing the consumption of high fiber breads on an overweight population's diet and assessing if health risks associated with heart disease would decrease due to the increased consumption. A secondary purpose was to evaluate if participants' food frequency consumption or liver function would change due to the increased fiber and whole grain consumption.

Initially, approximately 75 inquiries were received by potential participants. After screening individuals to insure appropriate BMI > 25 there were 39 participants, however, after each was emailed with details of the study, a consent form (Appendix A) and a date for initial testing only approximately 30 attended the initial scheduled testing. During the initial briefing of the details and review of the consent form one participant no longer wished to participate in the study. Six more did not return for the week four follow up testing. One participant was removed from the study due to lack of continued bread consumption recommendations. Since only one male completed the study, his data was removed to make the finding solely applicable to females.

There were a total of 21 female participants who completed the study with nine in the control group and 12 in the experimental group. At the 1-, 4-, and 8-week timeframes body weight, body composition, BMI, blood glucose, lipid profile, liver enzyme function tests and food frequency data were gathered and entered into SPSS statistical software to determine data means and standard deviations. Two way analysis of variance with repeated measures on week 1, week 4, and week 8, using "CON EXPO" were

determined. There was no significant differences found within each group or between groups in any comparison using a significance factor of 0.5.

#### *Anthropometric Data*

A BMI of 18.5 – 24.9 for adults represents a healthy target body weight. A BMI from 25.0 – 29.9 classifies individuals as overweight and a BMI over 30 classifies individuals as obese (Center for Disease Control, 2004a). Table 1 indicates the mean starting and ending BMI for both the control and experimental groups exceeded 29.5 in all measured values. As shown in Table 1 there was an insufficient decrease, and in some cases an increase in both the mean weight, BMI and body fat percentages of the control and experimental groups after no consumption and consumption of high fiber breads. There were no significant differences found within each group or between groups in any comparison using a significance factor of 0.5.

#### *Fasting Blood Glucose*

“Normal” fasting blood glucose is considered a value of < 100 mg/dl (College of American Pathologists, 2005). Table 2 indicates the mean fasting blood glucose of the control group decreased from 94.38mg/dl during week 1 testing to 78.5mg/dl during week 8 testing. The mean fasting blood glucose of the experimental group decreased 2.44 mg/dl from 87.92-85.48 mg/dl during week 8 testing. There were no significant differences found for fasting blood glucose within each group or between groups in any comparison using a significance factor of 0.5.



Table 1

*Adjusted Mean (M) and Standard Deviation (SD) Results for Anthropometric Data of Control and Experimental Groups*

	Week 1		Week 4		Week 8	
	Control	Exp.	Control	Exp.	Control	Exp.
Weight (pounds)	182.5 ± 19.5	186.70 ± 35.40	182.6 ± 20.2	187.02 ± 34.10	181.80 ± 19.86	187.5 ± 33.60
BMI	30.33 ± 3.10	29.54 ± 4.60	30.43 ± 3.10	29.67 ± 4.50	30.33 ± 3.10	29.84 ± 4.40
Body Fat (%)	43.39 ± 6.37	40.09 ± 5.28	43.56 ± 5.58	40.75 ± 5.36	43.76 ± 5.36	39.80 ± 7.55

Note. Control  $\bar{N}$  = 9; Experimental  $\bar{N}$  = 12; BMI= body mass index.

Table 2

*Adjusted Mean (M) and Standard Deviation (SD) Results for Fasting Blood Glucose of Control and*

*Experimental Groups*

	Week 1		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
Blood Glucose (mg/dl)	94.38 ± 7.35	87.92 ± 9.17	99.50 ± 12.00	94.33 ± 9.43	78.50 ± 8.47	85.42 ± 11.51

Note. Control  $\bar{N}$  = 9; Experimental  $\bar{N}$  = 12

### *Lipid Profile*

A desirable lipoprotein value of cholesterol level is less than 200 mg/dl. Triglyceride levels are classified as normal (<150 mg/dl), borderline high (150-199 mg/dl), high (200 – 499 mg/dl) and very high (>500 mg/dl) (Mahan and Escott-Stump, 2000). A desirable LDL level is less than 130 mg/dl. Desirable HDL cholesterol is greater than 40 mg/dl. Because women have higher HDL cholesterol than men, and HDL cholesterol level of greater than 45 mg/dl is recommended in women.

Table 3 indicates the four lipid tests that were evaluated over the course of the eight week study. It shows the mean week one cholesterol of the experimental group at 213.25 mg/dl with a 7.42 mg/dl decrease in mean cholesterol to 205.83 mg/dl during week eight. The week one triglyceride level of the experimental group was 133.5 mg/dl with an 11.92 mg/dl decrease in mean triglycerides to 121.58 mg/dl during week eight. The mean HDL of the experimental group was 49.58 mg/dl with a mean increase of 1.34 mg/dl to 50.92 mg/dl during week eight. The mean LDL level of the experimental group was 135 mg/dl during week one with a mean decrease of 3.17 mg/dl to 121.83 mg/dl during week eight.

Table 3 also indicates the week one mean cholesterol of the control group as 201.88mg/dl with a mean decrease of 23.13 mg/dl to 178.75 mg/dl during week eight testing. The week one mean triglyceride levels of the control group was 170.13 mg/dl with a 41.38mg/dl decrease in mean triglycerides to 121.58 mg/dl during week eight. The mean LDL of the control group was 50.38 mg/dl with a 2.5 mg/dl decrease in mean HDL to 47.88 mg/dl during week eight. The mean LDL of the control group was 114.13

mg/dl during week one with a 13.17 mg/dl point decrease in mean LDL to 101.63 mg/dl during week eight.

There were no significant differences found in lipids within each group or between groups in any comparison using a significance factor of 0.5.

### *Liver Enzymes*

Liver enzyme function analysis was conducted solely at the request of the research sponsor to determine if increased consumption of high fiber bread had a detrimental impact on liver function.

Normal alanine aminotransferase (ALT) values range from 7-56 IU/L, normal alkaline phosphatase (ALKP) values range from 20 to 140 IU/L, normal aspartate aminotransferase (AST) levels range from 10 to 34 IU/L, the normal range for total bilirubin (TBIL) is 0.3 to 1.9 mg/dl, direct bilirubin (DBIL) ranges from 0.0 to 0.3 mg/dl, indirect bilirubin (UCBIL) ranges from 0.0-0.1 mg/dl, total protein typically ranges from 6.0 to 8.3 g/dl and normal albumin ranges from 3.4 to 5.4 g/dl (NIH, 2005).

Table 4 shows the results of the liver enzyme tests. It indicates that the experimental group's mean total protein increased by 0.06 gm/dl, mean albumin increased by 0.01g/dl, mean AST decreased by 1.05 IU/L, mean ALT increased by 2.12 IU/L, mean ALKP increased by 2.83 IU/L, mean TBIL decreased by 0.2 mg/dl, mean UCBIL decreased by 0.125 mg/dl, mean CBIL decreased by 0.083 mg/dl, and mean direct BIL decreased by 0.008 mg/dl over the eight week study period.

Table 4 also shows that the control group's mean total protein increased by 0.12gm/dl, mean albumin decreased by 0.03g/dl, mean AST increased by 2.75IU/L, mean ALT decreased by 0.13IU/L, mean ALKP decreased by 0.13IU/L, mean TBIL decreased

by 0.075mg/dl, mean UCBIL decreased by 0.05mg/dl, and that there was no change in CBIL or direct BIL over the eight week study period. There were no significant differences found in liver enzymes within each group or between groups in any comparison using a significance factor of 0.5.

Table 3

*Adjusted Mean (M) and Standard Deviation (SD) Results for Lipid Profile of Control and Experimental Groups*

	Week 1		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
Cholesterol (mg/dl)	201.88 ± 37.16	213.25 ± 42.63	183.5 ± 41.24	202.17 ± 36.39	178.75 ± 39.61	205.83 ± 39.53
Triglycerides (mg/dl)	170.13 ± 130.73	133.5 ± 34.83	125.63 ± 60.30	124.50 ± 44.47	128.75 ± 41.50	121.58 ± 58.32
HDL (mg/dl)	50.38 ± 13.09	49.58 ± 12.15	52.50 ± 12.06	52.50 ± 9.52	47.88 ± 16.64	50.92 ± 10.31
LDL (mg/dl)	114.13 ± 28.53	135.00 ± 35.29	105.88 ± 35.94	124.67 ± 32.97	101.63 ± 33.24	121.83 ± 49.42

Note. Control N = 9; Experimental N = 12; HDL= High density lipoproteins; LDL= Low density lipoproteins.

Table 4

*Adjusted Mean (M) and Standard Deviation (SD) Results for Liver Enzymes of Control and Experimental Groups*

	Week 1		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
Total Protein (mg/dl)	7.14 ± 0.26	7.36 ± 0.36	7.39 ± 0.19	7.36 ± 0.30	7.26 ± 0.45	7.42 ± 0.32
Albumin (mg/dl)	4.16 ± 0.16	4.17 ± 0.32	4.35 ± 0.20	4.23 ± 0.26	4.13 ± 0.34	4.18 ± 0.26
AST (IU/L)	28.25 ± 15.80	33.00 ± 16.42	27.75 ± 12.60	31.75 ± 25.48	31.00 ± 21.76	31.50 ± 14.61
ALT (IU/L)	35.88 ± 23.80	37.08 ± 23.96	37.25 ± 20.30	36.92 ± 34.72	33.75 ± 33.36	33.75 ± 22.00
ALKP (IU/L)	79.63 ± 22.50	83.25 ± 34.17	79.75 ± 25.10	83.75 ± 39.41	79.50 ± 25.35	86.08 ± 36.20
TBIL (mg/dl)	0.49 ± 0.10	0.78 ± 0.20	0.49 ± 0.10	0.69 ± 0.19	0.41 ± 0.10	0.58 ± 0.24
UCBIL(mg/dl)	0.49 ± 0.10	0.78 ± 0.18	0.49 ± 0.10	0.68 ± 0.18	0.44 ± 0.12	0.65 ± 0.24
CBIL (mg/dl)	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.08 ± 0.29
DBIL (mg/dl)	0.00 ± 0.00	0.01 ± 0.03	0.00 ± 0.00	0.09 ± 0.03	0.00 ± 0.00	0.00 ± 0.00

Note. Control N = 9; Experimental N = 12; AST= asparatate aminotransferase; ALT= alanine aminotransferase; ALKP= alkaline phosphatase; TBIL= total bilirubin; UCBIL= indirect bilirubin; CBIL= conjugated bilirubin; DBIL= direct bilirubin

### *Food Frequency Questionnaire*

Codes were assigned to each consumption frequency category. A code number “1” was assigned to foods consumed one time or less per month. A code number “2” was assigned to foods consumed two to three times per month. A code number “3” was assigned to foods consumed one to two times per week. A code number “4” was assigned to foods consumed three to four times per week. A code number “5” was assigned to foods that were consumed five or more times per week. Data was analyzed with a two-way analysis of variance with repeated measures on the original values assigned to each person’s answers.

### *Combination Foods*

All measures are expressed as frequency of consumption determined by two-way analysis with repeated measures. Table 5 shows the difference in consumption of combination foods among the experimental and control groups. Neither group had any significant changes in the foods listed on the food frequency questionnaire at a significance factor of 0.05. There was also less than a 0.6 category consumption increase or decrease in any of the items eaten by either group.

### *Proteins*

All measures are expressed as frequency of consumption determined by two-way analysis with repeated measures. Table 6 shows the difference in consumption of protein foods among the experimental and control groups. Neither group had any significant changes in the foods listed at a significance factor of 0.05. There was also less than a one unit consumption increase or decrease in any of the items eaten by either group.



*Fats, Oils and Sweets*

All measures are expressed as frequency of consumption determined by two-way analysis with repeated measures. Table 7 indicates insufficient change in the consumption of foods categorized as fats, oils and sweets. Neither group had any significant changes in the foods listed at a significance factor of 0.05. Only butter or oils used in cooking and butter or margarine on bread had a mean that decreased more than one unit over the eight week period in the control group with only the mean chocolate consumption decreased by more than one category over the eight week period in the experimental group.

Table 5

*Adjusted Mean (M) and Standard Deviation (SD) Results for Combination Food Consumption of Control and Experimental Groups*

	Week 1		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
Pizza	2.00 ± 0.93	2.08 ± 0.52	2.00 ± 1.31	1.75 ± 0.45	1.88 ± 0.99	2.00 ± 0.74
French Fries, Hash Browns	1.63 ± 0.92	1.27 ± 0.47	1.75 ± 0.89	1.46 ± 0.69	1.75 ± 0.89	1.818 ± 0.87
Frozen Food Entrée	1.38 ± 0.52	1.634 ± 1.03	1.25 ± 0.46	1.46 ± 0.93	1.38 ± 0.74	2.00 ± 1.62
Lasagna, Chili	1.25 ± 0.46	1.64 ± 0.51	1.25 ± 0.46	1.55 ± 0.52	1.38 ± 0.52	1.455 ± 0.52
Chinese Food	1.13 ± 0.35	1.73 ± 0.65	1.38 ± 0.52	1.91 ± 0.81	1.38 ± 0.52	2.00 ± 0.52

Note. Control  $N = 9$ ; Experimental  $N=12$ ; Measures expressed as frequency of consumption determined by two-way analysis with repeated measures. Items means reflect the following response choices: 1= /Month or less; 2= 2-3/month; 3= 1-2/per week; 4= 3-4/per week; 5= 5 or more/per week.

Table 6

*Adjusted Mean (M) and Standard Deviation (SD) Results for Proteins*

	Week 0		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
Beef, Veal	2.13 ± 0.99	2.75 ± 0.97	2.38 ± 0.92	2.75 ± 0.87	2.25 ± 0.89	2.67 ± 0.78
Pork	1.74 ± 0.76	2.17 ± 0.84	1.74 ± 0.76	1.67 ± 0.78	1.74 ± 0.76	1.92 ± 0.79
Ham	1.25 ± 0.46	1.47 ± 0.79	1.50 ± 0.93	1.58 ± 1.08	1.38 ± 0.52	1.67 ± 0.99
Lean Lunch Meat	1.50 ± 0.93	2.10 ± 1.10	1.38 ± 0.74	2.80 ± 1.32	1.63 ± 0.92	2.50 ± 1.27
Poultry	3.13 ± 1.13	3.08 ± 0.90	2.75 ± 0.71	3.17 ± 0.58	3.00 ± 0.76	2.83 ± 0.58
Salmon	1.25 ± 0.46	1.36 ± 0.67	1.50 ± 0.54	1.55 ± 0.82	1.38 ± 0.77	1.46 ± 0.82
White Fish	1.71 ± 0.76	1.64 ± 0.67	1.86 ± 0.69	1.73 ± 0.65	1.43 ± 0.54	2.00 ± 0.78
Shellfish	1.00 ± 0.00	1.18 ± 0.41	1.00 ± 0.00	1.19 ± 0.41	1.13 ± 0.35	1.46 ± 0.69
Soy Protein	1.00 ± 0.00	1.27 ± 0.65	1.00 ± 0.00	1.55 ± 1.29	1.00 ± 0.00	1.64 ± 1.43
Legumes	2.25 ± 1.17	2.46 ± 0.93	2.25 ± 0.71	2.36 ± 0.51	2.13 ± 0.84	2.09 ± 0.70
Egg Sub.	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
Eggs	2.75 ± 1.04	2.75 ± 1.01	2.38 ± 0.74	2.58 ± 0.67	2.75 ± 0.71	2.67 ± 1.07

Ground Beef	2.88 ± 1.25	2.92 ± 0.90	2.50 ± 0.93	2.50 ± 0.91	2.63 ± 0.77	2.67 ± 0.78
Ground Poultry	1.13 ± 0.35	1.18 ± 0.60	1.00 ± 0.00	1.09 ± 0.30	1.38 ± 0.52	1.09 ± 0.30
Fried Chicken	1.38 ± 0.74	1.46 ± 0.52	1.25 ± 0.71	1.18 ± 0.41	1.13 ± 0.35	1.36 ± 0.67
Hot Dogs, Sausage	1.00 ± 0.00	1.73 ± 0.91	1.00 ± 0.00	1.55 ± 0.52	1.25 ± 0.46	1.55 ± 0.82
Pepperoni, Salami, Bologna	1.25 ± 0.46	1.64 ± 0.51	1.25 ± 0.46	1.46 ± 0.52	1.38 ± 0.52	1.46 ± 0.69
Bacon, Breakfast Sausage	1.63 ± 0.74	1.50 ± 0.67	1.50 ± 0.54	1.50 ± 0.52	1.50 ± 0.54	1.67 ± 0.89
Peanut Butter	2.38 ± 1.69	3.17 ± 1.38	2.25 ± 1.58	3.75 ± 0.97	2.00 ± 1.60	4.08 ± 0.79
Nuts	3.13 ± 1.46	3.17 ± 1.53	2.63 ± 1.30	2.92 ± 1.31	2.63 ± 1.30	2.92 ± 1.31

Note. Control  $N = 9$ ; Experimental  $N = 12$ ; Measures expressed as frequency of consumption determined by two-way analysis with repeated measures. Items means reflect the following response choices: 1= /Month or less; 2= 2-3/month; 3= 1-2/per week; 4= 3-4/per week; 5= 5 or more/per week.

Table 7

*Adjusted Mean (M) and Standard Deviation (SD) Results for Fats, Oils, and Sweets*

	Week 0		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
High Fat Ice Cream	1.38 ± 0.52	1.90 ± 0.87	1.63 ± 1.06	1.80 ± 0.92	2.00 ± 0.54	1.80 ± 1.03
Potato Chips, Popcorn	2.25 ± 1.28	2.08 ± 0.52	2.12 ± 1.13	1.83 ± 0.72	1.88 ± 0.64	1.75 ± 0.75
Donuts, Pastries	1.75 ± 0.71	1.64 ± 0.51	2.00 ± 1.07	1.46 ± 0.52	1.88 ± 0.99	1.27 ± 0.47
High Fat Muffins	1.25 ± 0.46	1.55 ± 0.52	1.25 ± 0.46	1.46 ± 0.69	1.50 ± 0.93	1.46 ± 0.52
Cookies	2.38 ± 1.30	2.82 ± 0.75	2.38 ± 1.19	2.46 ± 0.82	2.50 ± 1.31	2.00 ± 1.00
Cake or Pie	1.25 ± 0.46	1.64 ± 0.51	1.50 ± 1.69	2.00 ± 0.78	1.50 ± 0.76	1.55 ± 0.52
Chocolate	2.88 ± 1.62	3.64 ± 1.36	2.25 ± 1.49	3.18 ± 1.17	2.50 ± 1.41	2.55 ± 1.13
Light Salad Dressing	2.25 ± 1.04	2.36 ± 1.50	2.63 ± 1.41	2.91 ± 1.58	2.75 ± 1.28	2.82 ± 1.08
Regular Salad Dressing	2.13 ± 1.13	2.18 ± 0.98	2.00 ± 0.93	2.27 ± 1.19	2.13 ± 1.13	2.00 ± 1.10
Regular Mayonnaise	1.50 ± 0.54	1.64 ± 0.81	1.63 ± 0.52	2.00 ± 1.27	1.38 ± 0.52	1.91 ± 0.94
Butter or Oils/Cooking	3.63 ± 1.51	3.64 ± 1.36	3.75 ± 1.49	3.46 ± 1.21	2.88 ± 1.36	3.18 ± 1.08
Butter or Margarine/Bread	3.75 ± 1.17	3.73 ± 0.91	2.86 ± 1.64	4.06 ± 1.04	2.63 ± 1.60	3.73 ± 1.49

Cream Cheese, Sour Cream	1.88 ± 0.99	2.17 ± 0.84	1.88 ± 0.84	2.00 ± 0.95	1.88 ± 0.64	2.17 ± 1.03
Hard Candy	2.50 ± 1.60	1.83 ± 1.19	2.63 ± 1.69	1.42 ± 0.90	2.25 ± 1.39	1.42 ± 0.90
Jelly	1.75 ± 0.89	1.91 ± 0.83	1.88 ± 0.99	2.91 ± 1.14	1.75 ± 1.04	2.91 ± 1.38
Soda or Sweetened Beverage	2.13 ± 1.64	1.92 ± 1.31	1.75 ± 0.89	1.83 ± 1.40	2.50 ± 1.51	2.17 ± 1.47

Note. Control  $\bar{N}$  = 9; Experimental  $\bar{N}$  = 12; Measures expressed as frequency of consumption determined by two-way analysis with repeated measures. Items means reflect the following response choices: 1 = /Month or less; 2 = 2-3/month; 3 = 1-2/per week; 4 = 3-4/per week; 5 = 5 or more/per week.

### *Fruits and Vegetables*

Table 8 indicates insufficient change in the consumption of foods categorized as fruits or vegetables with neither group had any significant changes in the foods listed at a significance factor of 0.05. Table 8 also indicates that there was less than a one serving consumption increase or decrease in all fruit and vegetables identified in both the control and experimental group over the 8-week period.

### *Starches*

All measures are expressed as frequency of consumption determined by two-way analysis with repeated measures. Table 9 indicates insufficient change in the consumption of foods categorized as starches with no group having any significant changes at a significance factor of 0.05.

Table 9 also indicates that there was less than a one category consumption increase or decrease in all starches identified in the control group. However, there was a one category decrease in white bread consumption with intake declining from two to three times per month to less than once per month. There was also a 1.42 category increase in whole wheat or rye consumption in the experimental group over the eight week period increasing participant consumption from one to two servings per week to nearly five or more servings per week. Less than a one category consumption increase or decrease change in all other starches consumed was reported by the experimental group.

Also interesting to note is that consumption of high fiber cereal for the experimental group decreased slightly over the course of the eight week study. This

could be due to the potential replacement of these cereals in exchange for the increased consumption of high fiber bread.

Also noteworthy is the fact that though the consumption of whole grain bread by the control group remained stable over the course of the study. However, the consumption of whole grain bread by the experimental group increased from one to two times per week to five or more times per week over the course of the first four weeks of the study to then only slightly decrease down to less at 3-4 servings per week.



Table 8

*Adjusted Mean (M) and Standard Deviation (SD) Results for Fruits and Vegetables*

	Week 0		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
Raw Fruit	4.25 ± 0.71	4.17 ± 1.03	3.75 ± 1.04	4.33 ± 1.23	4.00 ± 0.93	4.08 ± 1.00
100% Fruit Juice	2.38 ± 1.60	2.60 ± 1.35	2.50 ± 1.77	2.5 ± 1.35	2.50 ± 1.51	2.30 ± 1.34
Canned Fruit	1.25 ± 0.46	2.08 ± 0.90	1.38 ± 0.74	1.83 ± 0.94	1.38 ± 0.52	1.75 ± 0.87
Dried Fruit	1.63 ± 1.06	1.82 ± 1.08	2.25 ± 1.49	1.82 ± 0.87	1.75 ± 1.17	1.82 ± 0.87
Green Salad	3.63 ± 1.06	3.42 ± 1.24	3.63 ± 1.06	3.58 ± 1.00	3.88 ± 0.84	3.50 ± 0.91
Vegetable Juice	1.00 ± 0.00	1.91 ± 1.22	1.00 ± 0.00	1.91 ± 1.30	1.00 ± 0.00	2.00 ± 1.48
Vegetable Soup/Stew	1.75 ± 0.89	2.27 ± 1.01	1.88 ± 0.84	2.00 ± 1.27	1.75 ± 0.71	2.00 ± 1.18
Tomato Sauce	2.38 ± 0.92	2.46 ± 0.80	2.25 ± 0.71	2.46 ± 1.13	2.25 ± 0.89	2.64 ± 1.03
Cooked Vegetables	4.00 ± 1.07	4.09 ± 0.90	3.88 ± 1.13	3.92 ± 1.08	4.00 ± 0.93	3.58 ± 1.24
Raw Vegetables	3.25 ± 1.28	3.50 ± 1.24	3.63 ± 0.92	3.58 ± 1.00	3.75 ± 0.89	3.67 ± 0.65

Note. Control  $\bar{N}$  = 9; Experimental  $\bar{N}$  = 12; Measures expressed as frequency of consumption determined by two-way analysis with

repeated measures. Items means reflect the following response choices: 1= /Month or less; 2= 2-3/month; 3= 1-2/per week; 4= 3-4/per week; 5= 5 or more/per week.

Table 9

*Adjusted Mean (M) and Standard Deviation (SD) Results for Starches*

	Week 0		Week 4		Week 8	
	Control	Exp	Control	Exp	Control	Exp
White Bread	2.25 ± 1.04	2.36 ± 1.21	1.50 ± 0.54	1.55 ± 1.04	1.75 ± 1.04	1.36 ± 0.81
Dinner Roll	1.50 ± 0.76	1.27 ± 0.47	1.63 ± 0.74	1.27 ± 0.65	1.50 ± 0.76	1.32 ± 0.67
Whole Wheat or Rye Bread	3.50 ± 0.76	3.33 ± 1.50	3.00 ± 1.07	5.00 ± 0.00	3.13 ± 1.25	4.75 ± 0.87
Pasta	2.50 ± 1.07	2.91 ± 0.83	2.13 ± 0.84	2.73 ± 0.65	2.13 ± 0.84	2.18 ± 0.98
Rice	2.22 ± 1.13	3.00 ± 0.63	2.00 ± 0.76	2.18 ± 0.87	1.75 ± 0.71	2.27 ± 1.01
Large Bagel	1.13 ± 0.35	1.36 ± 0.51	1.25 ± 0.46	1.09 ± 0.30	1.00 ± 0.00	1.09 ± 0.30
Small Bagel	1.12 ± 0.35	1.18 ± 0.41	1.13 ± 0.35	1.09 ± 0.30	1.50 ± 0.93	1.00 ± 0.00
Pretzels	1.62 ± 0.92	1.91 ± 1.04	1.50 ± 0.93	1.46 ± 0.93	1.50 ± 0.54	1.72 ± 0.91
Crackers	1.86 ± 0.90	2.58 ± 0.90	2.00 ± 0.82	2.00 ± 0.74	2.00 ± 1.00	2.25 ± 1.14
Hot Cereal	2.38 ± 1.30	1.80 ± 0.92	2.50 ± 1.51	1.40 ± 0.52	2.50 ± 1.41	1.80 ± 1.41
Cold Sweetened Cereal	1.25 ± 0.71	2.36 ± 1.12	1.13 ± 0.35	1.55 ± 0.69	1.13 ± 0.35	1.82 ± 1.17
Cold Cereal High in Fiber	2.00 ± 1.20	2.82 ± 1.33	2.00 ± 1.20	2.27 ± 1.19	2.13 ± 1.36	2.18 ± 1.36
Baked Mashed Potato	2.50 ± 0.93	2.58 ± 0.90	2.50 ± 0.93	2.58 ± 0.90	2.38 ± 0.92	2.25 ± 0.87

Note. Control N = 9; Experimental N=12; Measures expressed as frequency of consumption determined by two-way analysis with repeated measures. Items means reflect the following response choices: 1= /Month or less; 2= 2-3/month; 3= 1-2/per week; 4= 3-4/week; 5= 5 or more/week.

### *Summary*

The results of this chapter will now be summarized in items of the research objectives outlined in Chapter I.

*Research objective one.* To determine if overweight individuals who receive information on the benefits of high fiber diets and gradually increase their consumption of bread containing high fiber to six slices per day differ from overweight individuals who receive information on the benefits of high fiber diets after a period of eight weeks.

There was no significant difference between overweight individuals who received a handout indicating the benefits of high fiber diets and gradually increased their consumption of bread containing high fiber to six slices per day compared to overweight individuals who received only a handout indicating the benefits of high fiber diets over the eight week period of the study in any of the anthropometric or laboratory data collected at a significance factor of 0.05.

*Research objective two.* To determine if the consumption of bread containing high fiber decreased overweight individuals' risk factors specifically associated with heart disease.

There was no significant difference in any measured risk factor associated with heart disease in either the control or experimental groups. However, the experimental group did show improvements in mean cholesterol, triglycerides, HDL and LDL values. The control group also showed improvements in their mean blood glucose, cholesterol, triglycerides and LDL.

*Research objective three.* To determine if the increased consumption of high fiber breads changes the frequency of less nutritious foods consumed and reported by overweight individuals.

There were no significant differences in consumption in any foods indicated on the food frequency questionnaire, including foods that were less nutritious. Only butter or oils used in cooking and butter or margarine on bread had a mean that decreased more the one category over the eight week period in the control group with only the mean chocolate consumption decreasing by more than one category over the eight week period in the experimental group. However, there was a positive increase in the consumption of whole wheat bread over the course of the eight week test period for the experimental group indicating participants did follow the guidelines to increase their consumption of high fiber bread.

*Research objective four.* To determine if the increased consumption of high fiber bread would have a detrimental impact on liver function.

There was no significant change in any liver enzyme function test that was measured in either the experimental group or the control group in this study.

## Chapter V: Discussion

### *Limitations*

One of the limitations of this study was the smaller than anticipated number of participants. There were originally 39 participants, however, after each was emailed with details of the study, a consent form and a date for initial testing only (approximately) 30 attended their scheduled testing. During the initial briefing of the details and review of the consent form one participant no longer wished to participate in the study. Six more did not return for the week four follow up testing. One participant was removed from the study due to lack of continued bread consumption recommendations. The only male completing the study was removed to make the finding solely applicable to females.

Other limitations of the study were that subjects may not have accurately consumed the appropriate amounts of bread, inaccurately answered the food frequency questionnaire or did not follow the 12 hour fasting regulation before their testing times. A study over the course of a greater timeframe may have also produced more conclusive results.

Observations by the researcher also indicated that many of the participants admitted to supplementing their consumption of the bread with high fat and high calorie toppings such as peanut butter, processed lunch meats and gravies in order to meet consumption requirements. This in turn increased the overall calorie and fat consumptions by the participants decreasing the likelihood of improved weight, body composition and lipid profile.

## *Conclusions*

*Anthropometric Data* The results of this study indicated that the mean weight of participants in both the experimental and control groups were within plus or minus one pound throughout the entire eight week course of the study. The results also indicated that the mean BMI of both groups of participants decreased less than one half of a point and the body fat percentage of both groups of participants decreased less than 1% throughout the entire eight week course of the study. This stability in BMI and body fat percentage could have been anticipated as dietary restrictions were not apart of this study. Also, several participants in the experimental group indicated that they were supplementing their increased bread consumption with calorie-dense toppings such as butters, margarines, nut butters, jellies and gravies. Adding calorie-dense toppings decreased the possibility of lowered food consumption caused by an increase in satiety from increased bread and fiber consumption.

*Fasting Glucose* The results of this study indicated that the mean fasting blood glucose of the control group decreased 15.88 mg/dl, while the experimental group's mean fasting blood glucose only decreased 2.44 mg/dl over the course of the eight week study. The reason for this difference is unknown as it would have been anticipated there would have been a greater decrease in the fasting glucose of the experimental group as increasing fiber consumption has been shown to play an integral role in total diabetes care and management. In previous studies involving persons with type II diabetes mellitus, increasing fiber from 24 grams per day to 50 grams per day was reported to significantly improve glycemic control, and reduce hyperinsulinemia (Chandalia et al., 2000).

*Lipid Profile* The results of this study indicated that there were no significant differences found within each group or between groups for lipid profile in any comparison using a significance factor of 0.5. This was not anticipated as there is a clear body of evidence that supports fiber's effect on the body and its physiological effects on lowering plasma cholesterol levels ranging from 5%-10%, with decreases of up to 25% being reported. Also, almost invariably, increased fiber consumption leads to reductions reported to occur in triglycerides and LDL cholesterol with little or no change in HDL cholesterol (Bowman & Russell, 2001).

However, after examining the data more closely, the results did indicate a trend toward an improved lipid profile in all labs analyzed for the experimental group at what could have been anticipated levels. The mean week one cholesterol of the experimental group was 213.25 mg/dl with a 7.42 mg/dl decrease in mean cholesterol to 205.83 mg/dl during the course of the study. The week one triglyceride level of the experimental group was 113.5 mg/dl with an 11.92 mg/dl decrease in mean triglycerides to 121.58 mg/dl during the course of the study. The mean HDL of the experimental group was 49.58 mg/dl with a mean increase of 1.34 mg/dl to 50.92 mg/dl over the course of the study. The mean LDL level of the experimental group was 135 mg/dl during week one with a mean decrease of 3.17 mg/dl to 121.83 mg/dl during the course of the study.

Though not statistically significant, this data closely resembles previous reports on the effects of increasing fiber consumption and its effects on decreasing cholesterol levels by 5%-10% as the mean cholesterol of the experimental group decreased by 4%. It also supports previous reports with decreasing trends in triglycerides, LDL, and little to no change in HDL levels.



With large individual variations in all lipid values, the results of these studies were left with inherently large standard deviations and statistical significance was not achieved including standard deviations of: cholesterol - 39.53, triglycerides - 58.32, HDL - 10.31, and LDL - 49.42. This, in turn, diminishes the analyzed group results which overshadow many of the positive individual results such as the decreases in individuals' triglycerides from 133 mg/dl to 88 mg/dl (a 44% reduction), 174 mg/dl to 123 mg/dl (a 30% reduction), 138 mg/dl to 98 mg/dl (a 29% reduction), 145 mg/dl to 99 mg/dl (a 32% reduction), 127 mg/dl to 89 mg/dl (a 30% reduction), and 241 mg/dl to 157 mg/dl (a 35% reduction). There were also positive individual results in the lowering of cholesterol, with an individual decreasing from 265 mg/dl to 198 mg/dl (a 26% reduction). Positive improvements were also seen in LDL with an individual decreasing from 175mg/dl to 137 mg/dl (a 22% reduction) and in HDL with an individual increasing from 26 mg/dl to 46 mg/dl (a 45 % increase).

Though positive, these results are not comparable with the increased benefits from using common cholesterol-improving medications. Statins have reported a 20%- 60% reduction in cholesterol levels. The usual effect of bile acid sequestrants are a lowering of LDL-cholesterol by about 10%-20%. Nicotinic acid reduces LDL-cholesterol levels by 10%-20%, reduces triglycerides by 20%-50%, and raises HDL-cholesterol by 15%-35%. The cholesterol-lowering drugs called fibrates are primarily effective in lowering triglycerides and, to a lesser extent, in increasing HDL-cholesterol levels. The reductions in triglycerides generally are in the range of 20%-50% with increases in HDL-cholesterol of 10-15% (National Heart, Lung and Blood Institute, n.d.).

Though clearly not as effective as prescription medications, the results of this study do appear to be nearly as effective in increasing health benefits associated with heart disease as oatmeal has in clinical studies. Quaker Oats reports that eating a “good-sized” bowl of oatmeal daily for 30 days helps to lower cholesterol levels by an average of 6 mg/dl (Quaker Oats, 2002).

Regardless of the amount, any decrease in cholesterol helps to lower risks associated with heart disease. According to the National Cholesterol Education Program (NCEP), a 1% reduction in blood cholesterol translates into a 2-4% reduction in heart disease risk (as cited in NHLBI, 2006). With the mean cholesterol of the experimental group decreasing by 3.5%, this means that on average each participant in the experimental group decreased their chances of heart disease risk by 7%-14% over the course of the eight week study.

*Liver enzymes* The results of this study indicated that there were no significant differences found within each group or between groups in any comparison using a significance factor of 0.5. These findings were anticipated as this test was done as a safety precaution requested by the bread sponsor to monitor possible decreases in liver function due to the increase consumption of high fiber bread. No conclusions can be drawn from this data due to an inconsistency in trends and the high standard deviations of some values.

*Food frequency evaluation.* The results of this study indicated that there were no significant differences found within each group or between groups for any food frequency using a significance factor of 0.5. These findings were anticipated as this data

was gathered to research possible changes in food consumption due to the increase in high fiber bread consumption.

### *Major Findings*

There were no significant differences found within each group or between groups in any comparison due to increased high fiber whole grain bread consumption.

However, the findings did show an association with decreased mean cholesterol, triglycerides and LDL values and individuals given an information handout indicating the benefits of eating a high fiber diet.

### *Recommendations*

As a result of the findings of this study, the following recommendations are put forth:

- 1) To conduct a study assessing the effects of increasing the consumption of breads containing high fiber to an overweight population's diet conducted with a larger sample size over a larger timeframe to eliminate possible skewing of the data from individuals with abnormal anthropometric and laboratory results and attrition.
- 2) To conduct a study assessing the effects of increasing the consumption of breads containing high fiber to an overweight population's diet conducted with the individuals logging the amounts of bread they consumed each day and returning uneaten bread to insure participant cooperation with the consumption of bread.
- 3) To conduct a study assessing the effects of increasing the consumption of breads containing high fiber to an overweight population's diet conducted with an additional experimental group eating a whole wheat bread that was not high in fiber. The focus of the study would be to determine if there is a difference between the amount of increased

fiber consumption due to high fiber bread increase and laboratory values associated with cardiovascular diseases.

- 4) To conduct a study assessing the effects of increasing the consumption of breads containing high fiber to an overweight population's diet conducted with recommendations and limitations on ways participants should consume the required amounts of bread and food items that should be replace the increased consumption with.
- 5) To conduct a study assessing the effects of increasing the consumption of breads containing high fiber to an overweight population's diet with a participant support group implemented to assist in maintaining motivation and fostering behavior change strategies to help participants continue with the compliance and maintain suggested bread consumption.

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## Appendix A: Consent to Participate in UW-Stout Approved Research

Mitchel Holliday  
715-233-3499  
N3430 Hwy 25  
Menomoinie, WI 54751

Janice Coker  
715-232-2239  
Food/Nutrition Department  
College of Human Development  
Menomonie, WI 54751

The primary emphasis of this research is to provide supporting information that a diet including whole wheat bread which is high in fiber can help to reduce the risks of heart disease in an overweight population. You will be brought into the UW-Stout Nutrition Assessment Lab and after signing a consent form will be asked to complete a food frequency questionnaire and receive body weight and body composition testing along with having a standard blood sample drawn by a professional laboratory technician. After four and eight weeks you will be asked to return for follow-up testing of food frequency, body weight, body composition and again be asked for a blood sample.

There are no social or emotional risks associated with this study. The only potential physical risks are the discomfort associated with a blood draw that will be administered by the professional laboratory technician over each of the 3 visits. You must be 18 years of age or older, in good mental condition, have no preexisting health conditions (i.e. prediabetic, diabetes, celiac disease) or any other condition that may inhibit you from eating a diet including breads high in fiber. You can withdraw from the study at any time without penalty. In addition, all testing procedures including: tanita measurements, and blood draw will be administered by a professional laboratory technician.

Persons whose body mass index does not calculate over 25 will be informed they do not fit the desired qualifications for the experiment.

The research will take course over an eight week period. Laboratory testing will be done before week one and after weeks four and eight with an approximate time of ten minutes required per testing session. Participants will be awarded gift certificates upon completion of the eight week testing session.

Names and identification numbers from all participants will not be reported in the final paper. Only food frequency findings and laboratory data will be reported. Confidentiality will be confirmed thru email, in the written consent form, and in person at each of the three laboratory visits.

Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. Should you choose to not participate and later withdraw from the study, you may discontinue your participation at any time without incurring adverse consequences.

You agree to release the University of Wisconsin-Stout from any potential liability related to your voluntary involvement all portions of this study

This study has been reviewed and approved by the University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have any questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Questions or concerns about participation in the research or subsequent complaints should be addressed first to the investigator, Mitchel Holliday or research advisor, Dr. Janice Coker PhD, Food and Nutrition Department, College of Human Development, UW-Stout, Menomonie, WI 54751, phone 715-232-2239; and second to Sue Foxwell, Human Protection Administration, 152 Voc. Rehab. UW-Stout, Menomonie, WI 54751, phone 715-232-2477.

By signing this consent form you agree to participate in the project entitled, "The Beneficial Effects of a High Fiber Bread on an Overweight Population."

---

Signature

---

Date

## Appendix B: Letter to Participants

Dear Participant,

I would like to start by again thanking you for your participation in this research project. You have been scheduled for your initial evaluation on Friday April 1 at 7:00 a.m. in room 423 of the Home Economics Building at the University of Wisconsin-Stout. At this time you will be greeted by the researcher and asked to submit a completed Food Frequency and a Consent Form indicating your willingness to participate in the study (See attached forms). You will then be give information on the benefits of a high fiber diet and a variety of breads that are high in fiber that you will be asked to consume 2 slices of per day over the course of the following two weeks or advised to simply adhere to the recommendation give in the provided nutritional information. You will then be escorted into the Nutritional Assessment Laboratory and laboratory assistants will perform anthropometric evaluations and take a blood sample.

Due to the nature of the testing a 12 hour fast is required before your blood draw. Also, it is encouraged that no caffeine or additional fluids are consumed the morning of the testing. It is also advised that you wear a short sleeved shirt to help assist with the blood draw and do not participate in any physical activity as it may also change testing outcomes.

To adhere to confidential requirements it is asked that each participant arrive promptly at their scheduled time. It is also asked that you please come with the attached Food Frequency Questionnaire and Consent From completed as only 10 minutes will be given per participant for completion of their laboratory testing.

If you are not familiar with how to arrive at the UW-Stout campus or not familiar with the campus itself please go to the link below for additional information.  
<http://www.uwstout.edu/guide/>

Also, if you are having problems finding the facility the day of your evaluation, please contact the researcher at 232-1192.

Thank You

Mitchel Holliday

## Appendix C: Food Frequency Questionnaire



**JOHNS HOPKINS  
WEIGHT MANAGEMENT CENTER**

*An affiliate of the Johns Hopkins Bayview Medical Center*

### Food Frequency Questionnaire

Think about your most recent eating habits and how often you eat each of the following foods. Please mark one circle for each food.

Protein Sources	1 MONTH or less	2-3 times a MONTH	1-2 times a WEEK	3-4 times a WEEK	5+ times a WEEK
Beef, Veal (roast, steak, cubes)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pork	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ham	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lean lunch meat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poultry (chicken or turkey) not fried	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Salmon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fish, white	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shellfish (crab, lobster, shrimp or scallops)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soy protein meat substitute (ex. vegetarian burgers)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Beans, legumes (baked beans, pinto, kidney or black lentils)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Egg substitute	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eggs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ground beef, hamburgers, meatballs or tacos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ground turkey or chicken	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fried chicken	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot Dogs (regular), Polish or Italian	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
sausage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pepperoni, salami or bologna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bacon, breakfast sausage or scapple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peanut butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nuts (peanuts, cashews, almonds etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Starches	1 MONTH or less	2-3 times a MONTH	1-2 times a WEEK	3-4 times a WEEK	5+ times a WEEK
White bread	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dinner roll	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Whole wheat bread or rye	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pasta	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bagel, large	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bagel, small	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pretzels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Crackers, or snack crackers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot cereal (oatmeal, farina)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cold cereal, sweetened (ex. Frosted Flakes)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cold cereal, high fiber (ex. Shredded Wheat or Raisin Bran)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Baked, boiled or mashed potato	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pancakes or waffles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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<b>Fruits and Vegetables</b>	<b>1/MONTH or less</b>	<b>2-3 times a MONTH</b>	<b>1-2 times a WEEK</b>	<b>3-4 times a WEEK</b>	<b>5+ times a WEEK</b>
Raw fruit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
100% fruit juice, like apple or orange (frozen or canned)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Canned fruit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dried fruit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green salad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vegetable juice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vegetable soup or stew with vegetables	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tomato sauce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cooked vegetables	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Raw vegetables	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<b>Dairy Products</b>	<b>1/MONTH or less</b>	<b>2-3 times a MONTH</b>	<b>1-2 times a WEEK</b>	<b>3-4 times a WEEK</b>	<b>5+ times a WEEK</b>
Milk (Please circle skim, 1%, 2% or whole)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cheese	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cottage cheese	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yogurt (not frozen)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Combination Foods / Other</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pizza	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
French Fries, hash browns	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Frozen food entrée (ex. Stouffers, Lean Cuisine)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lasagna, Chili	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chinese Food	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<b>Fats, Oils and Sweets</b>	<b>1/MONTH or less</b>	<b>2-3 times a MONTH</b>	<b>1-2 times a WEEK</b>	<b>3-4 times a WEEK</b>	<b>5+ times a WEEK</b>
Ice cream (not low fat or fat free)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Potato chips, nacho chips, flavored popcorn, etc.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Donuts, pastries or danishes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muffins (not low fat or fat free)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cookies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cake or pie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chocolate or chocolate bar	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Salad dressing (fat free or light)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Salad dressing (regular)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mayonnaise (regular)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Butter, margarine or oil (in cooking)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Butter or margarine (on bread or as a condiment)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cream cheese or sour cream	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hard Candy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jelly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soda or sugar sweetened beverage (ex. Iced tea)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix D: Information Given to Focus Group



# Focus on Fiber

Patient Name: \_\_\_\_\_

Health Care Professional: \_\_\_\_\_

Date: \_\_\_\_\_

## A diet high in fiber may help:

- Maintain healthy blood glucose levels for people with diabetes;
- Lower blood cholesterol; reduce the risk of colon cancer;
- Prevent diverticulitis and constipation; and
- Aid in weight loss by adding bulk to the diet from low-calorie foods, like fruits and vegetables.

Fiber is the part of plant foods that cannot be digested. The major types of fiber are insoluble and soluble. Both are important for good health. Insoluble fiber, what your grandmother called roughage, helps with regularity and is found in wheat bran, whole grains and vegetables. Soluble fiber forms a thick gel when mixed with water. Bran, oatmeal, barley and beans are good sources of soluble fiber. Due to its soluble fiber content, daily consumption of a good-sized bowl of oatmeal has been proven to help lower cholesterol and reduce the risk of heart disease. Experts recommend getting 20 to 30 grams of total fiber each day for good health. For cholesterol reduction, at least half of that should come from soluble fiber.

## Fiber Tips

You can raise your fiber intake just by making a few small changes.

- Start the day with a cereal that's a good source of fiber, like oatmeal.
- Top it off with fresh or dried fruit and nuts.
- Add oat bran or wheat bran to pancakes, waffles and muffins.
- Use oatmeal in meat loaf and meatballs.
- Add sliced or shredded vegetables to spaghetti sauce and sandwich spreads.
- Use oat flour as thickening agents in sauces.
- Buy pre-cut vegetables to use for snacks.
- Use raisins and other dried fruit or bran in low-fat yogurt.
- Use whole-grain breads instead of white breads.
- When baking, substitute oatmeal (whirled in a blender to make oat flour) for up to one-third of the flour in a recipe.

## High-Fiber Substitutions

### Instead of:

White bread  
Cream of wheat  
White rice  
Pastines  
Instant mashed potatoes  
Apple juice  
Regular spaghetti  
Corn flakes  
Pretzels

### Eat:

Whole-grain bread  
Oatmeal  
Brown rice  
Rye crisp  
Baked potato  
Apple  
Whole-wheat spaghetti  
Bran flakes  
Popcorn

## For high fiber, include in your diet:

- Whole-grain cereals (like oatmeal), breads and pasta—at least 3 servings each day
- Dried or fresh fruits—4 to 5 servings each day
- Frozen or canned vegetables—4 to 5 servings each day
- Beans and peas—3 to 4 servings each week

## Fiber in Foods

Cereals and Grains	Serving Size	Total Fiber (grams)
Oatmeal, uncooked	1/2 cup	6.0
Oatmeal, uncooked (old-fashioned or quick cook)	1/2 cup	4.0
Pumpkin pie, bread	1 slice	2.7
Wheat	1/4 cup	6.1
<b>Fruit</b>		
Manicotti, dry only	1/2 small	2.9
Dried fruit	1 1/2	2.3
Pear, fresh, with skin	1 small	2.9
Plum	2 med	2.4
Apple, fresh, with skin	1 small	2.8
Apple, fresh	1 small	2.8
<b>Vegetables</b>		
Brussels sprouts, cooked	1/2 cup	3.8
Asparagus, cooked	1/2 cup	2.8
Turkey, ground	1/2 cup	4.8
Carrots, fresh, cooked	1/2 cup	2.0
Green beans, cooked	1/2 cup	2.8
<b>Beans</b>		
Kidney beans, cooked	1/2 cup	6.9
Black beans, cooked	1/2 cup	6.1
Navy beans, cooked	1/2 cup	6.5
Pinto beans, cooked	1/2 cup	5.9

Source: [www.fda.gov](http://www.fda.gov) and The Oatmeal Oats Company.