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Development and validation of short instruments to assess dietary risk for low intake of fiber and readiness to change fiber consumption

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Development and validation of short instruments to assess dietary risk for low intake of fiber and readiness to change fiber consumption

By

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ABSTRACT

Development and validation of short instruments to assess dietary risk for low intake of fiber and readiness to change fiber consumption

By

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In community-based health promotion there is an emerging need for dietary assessment tools to rapidly screen for nutritional risk. At the same time, the application of behavioral change models, such as the Stages of Change Theory, to dietary interventions has yielded promising results to help researchers understand a broad range of problematic behaviors. This study addressed the development of instruments to screen for dietary risk of low fiber intake and to assess stage of readiness to increase fiber intake in a sample of 99 middle-aged, predominantly female clerical workers of Michigan State University. Results showed the test checklist had high sensitivity (0.80) for distinguishing subjects with low fiber intake, and moderate correlation ($r=0.52$, $p<.01$) with 2-day food records. Subjects at Maintenance stage had higher average daily intake of fiber than those at Precontemplation and Action stages and received more social and environmental support than subjects at the other four stages. These findings: 1) support that the fiber checklist can feasibly identify a high risk population with low fiber intake; and 2) provide preliminary evidence that people at different stages of readiness for fiber consumption have somewhat different attitudes and beliefs.

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General Introduction

The importance of dietary fiber to health has emerged in the past two decades with advanced understanding of its role in human physiology. It has been well documented that low-fat, high-carbohydrate diets containing 20-35 g dietary fiber per day are beneficial for health promotion and disease risk reduction (ADA reports, 1993). Nevertheless, the U.S. public seems less concerned about fiber than about fat (Putnam, 1994), even though aware of the linkage between cancer and insufficient amount of fiber in diet (Glanz et al., 1994). Americans' dietary fiber intake has been reported as 11 g/day in NHANES II (Lanza et al., 1987) and 14.8 g/day in NHANES III (Alanio et al., 1994), both about half the goal for dietary fiber for the Year 2000 (Healthy People 2000, 1990). Possible explanations for people's low intake of fiber have included: 1) unclear expectations regarding the diet-disease linkage (Smith et al., 1992; Smallwood et al., 1994); 2) difficulty in making dietary change (Kristal et al., 1990); and 3) lack of knowledge for selecting high-fiber foods (Levy et al., 1993; Smallwood et al., 1994).

Assessing the dietary intake of free-living individuals remains among the most difficult measurement issues in epidemiological research and health promotion program evaluation (Kristal et al., 1990). The three generally accepted methods of dietary assessment—24-hour recalls, three-day food records, and food frequency questionnaires—have been problematic for respondent burden and validity in community-level interventions where measurement must be rapid, simple, and inexpensive (Kristal et al., 1990). In this research, we sought to develop instruments which could satisfy the need of community-level interventions with low respondent burden, while still maintaining acceptable validity and reliability.

Studies have shown that the efficacy of behavioral changes will be enhanced, if the intervention programs are based on appropriate psycho-theoretical models (Heimendinger, 1993; Glanz et al., 1994). A new theory, the Stages of Change Theory—originally

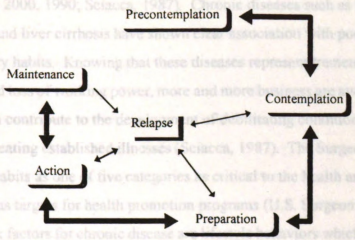


Figure 1. Diagram of Stages of Change Theory

developed for intervention programs on smoking cessation and substance abuse management—is rapidly being applied to food consumption (Prochaska et al., 1985; Sandoval et al., 1994). The Stages of Change Theory proposes that change is a measurable process through which people progress to achieve a certain desirable behavior, such as smoking cessation (Prochaska et al., 1988; DiClemente et al., 1991) or reduction of dietary fat (Curry et al., 1992; Greene et al., 1994; Sporny et al., 1995). The process of change consists of precontemplation, contemplation, preparation, action, and maintenance stages. The dynamic, cyclic-like relationship of these stages is shown in **Figure 1** (Prochaska et al., 1994; Sandoval et al., 1994; Sigman-Grant, 1996). The Stages of Change model can be beneficial for health professionals and program participants alike, because it allows demonstration of progress toward desirable change, even lapses, prior to actual change (Shelton, 1995). The early stages do not involve observable change of behaviors, but changes and attitudes or beliefs which can be measured. Lapses and relapses are anticipated as opportunities for improvement and not as absolute failure (Prochaska et al., 1994).

Because 85% of the U.S. adult population is employed, the worksite setting offers immense potential for health promotion efforts (Morbidity and Mortality Weekly Report, 1993). The fact that six of the ten leading causes of death in the U.S. are linked to diet has persuaded the industries to provide worksite health promotion programs to their employees (Healthy People 2000, 1990; Sciacca, 1987). Chronic diseases such as heart disease, cancer, stroke, and liver cirrhosis have shown clear association with poor lifestyle factors, especially dietary habits. Knowing that these diseases represent tremendous costs of medical care and loss of working power, more and more business are aware that modifying behaviors which contribute to the development of debilitating conditions is more cost effective than treating established illnesses (Sciacca, 1987). The Surgeon General singled out nutritional habits as one of five categories as critical to the health and well-being of Americans and as targets for health promotion programs (U.S. Surgeon General, 1986). Many health risk factors for chronic disease are lifestyle behaviors which are alterable, and dozens of worksite programs have been exclusively designed to cope with them (Pritchard et al., 1990; Chenoweth, 1987).

Programs to promote desirable eating habits are likely to be effective if based on an understanding of factors influencing food choices and at the stage at which the individual is (Sandoval et al., 1994; Laforge et al., 1994). Most interventions for dietary behavior change are designed for individuals at the action stage, while most people in the general population are at earlier stages (Glanz et al., 1993; Ockene et al., 1992). Theoretically, specific strategies should be planned for people at a specific stage of dietary change (Prochaska et al., 1994; Sandoval et al., 1994). So far few efforts have been made on applying the theory to increase dietary fiber intake (Glanz et al., 1994; Laforge et al., 1994).

To sum up, the purpose of this research is to classify a sample population into different stages of change relative to their consumption of fiber and find out the characteristics of attitudes and beliefs for each stage, which we believe will improve the design of future nutrition intervention. Thus, in this research we will: 1) develop and test a short checklist foods to estimate subjects' dietary fiber intake; 2) develop and test a stages of change questionnaire to categorize subjects into different stages for dietary fiber intake;

and 3) develop and test a questionnaire to examine individual beliefs and attitudes about dietary fiber intake.

The reasons follow for selecting the target population, members of Clerical Technical Worker's Union (CTU). 1) The majority are mid-aged females who tend to be the main food providers in family, thus their preference of foods and diets can influence other household members, especially young dependents. 2) CTU's are literate and have experienced questionnaire administration, allowing them to answer the test instruments without detailed interpretation by researchers. 3) An intramural health promotion program, MSU Healthy U, provides nutrition and health information routinely to its participants which are mainly female staff of MSU. The free dietary analysis offered is considered beneficial to the target population, because it is a costly health service. Another benefit for participants is that the importance of dietary fiber to health is reinforced. The results and instruments of this research will be available to the MSU Healthy U Committee to aid in future program design and evaluation.

Research Objectives

1. Develop a short checklist of foods to assess individual fiber intake and validate it with concurrently collected 2-day food records from members of Clerical Technical Worker's Union (CTU) of Michigan State University..
2. Develop a stage of change (SC) questionnaire for categorizing subjects into different stages by adapting the algorithm by Curry et al.
3. Develop a short questionnaire assessing individual attitudes and beliefs (AB questionnaire) related to dietary fiber by using components from Health Belief Model (HBM) that significantly correlate with dietary intake.
4. Determine the association of fiber intake with the different stages related to dietary fiber by analyzing the checklist and stages of change questionnaire.
5. Determine the association of subjects' attitudes and beliefs relative to dietary fiber intake and the stages at which they are.

6. Investigate the degree to which fiber intake can be predicted from fiber intake from checklist, stages of change, and the major constructs in AB questionnaire.

Hypotheses

1. There will be positive correlation between the gram amounts of dietary fiber intake assessed from the checklist and from the 2-day food records.
2. There will be no significant difference between the gram amounts of dietary fiber assessed from the checklist and the weighted 2-day food records.
3. The sensitivity of the checklist to detect high and low intake of dietary fiber will be $\geq .70$ when compared to weighted 2-day food records.
4. There will be a significant difference between the gram amounts of dietary fiber intake for different stages of change related to dietary fiber.
5. Subjects' responses to the attitudes and beliefs questionnaire will differ according to their different stages of readiness for fiber consumption.
6. Subjects' fiber intake from the weighted 2-day records can be predicted from 3 short instruments: the checklist, SC questionnaire, and the major constructs in the AB questionnaire.

Glossary

* Dietary fiber: the indigestible residue in food, composed of the carbohydrates cellulose, pectin, and hemicellulose; vegetable gums; and the noncarbohydrate lignin. (Dreher, 1987)

* Precontemplation: the stage in which that the individuals have no intention to make a dietary behavior change (e.g., increase dietary fiber intake or cut fat intake), at least not within the next six months. (Glanz et al., 1990)

* Contemplation: the stage in which that the individuals seriously think about changing a behavior within the next six months. (Glanz et al., 1990)
* Preparation: the time that serious commitment to change has been made. For example, the individuals in this stage are those who tried to change their dietary behavior in the past year and who plan to do it within next month. (Glanz et al., 1990)
* Action: the span of time ranging from zero to six months after the initiation of overt change toward a desired dietary behavior. (Glanz et al., 1990)
* Maintenance: the period beginning six months after the action has been started and continuing until the desired behavior change has been adopted. (Glanz et al., 1990)
* Criterion validity: the validity established on the agreement with a criterion measure or "gold standard" which might be found either concurrent with the instrument being validated or in the future. (Patrick et al., 1991)
* Content validity: the validity marked by the extent to which a measurement tool or instrument is consistent with a specific area of substantive content. (Patrick et al., 1991)
* Face validity: the validity marked by the extent to which a measurement tool or instrument is pertinent to a specific area. (Patrick et al., 1991)
* Predisposing factors: the factors affecting a specific dietary behavior utilization including: 1)belief in the diet-disease connection; 2)perceived benefits of healthy diet; and 3)knowledge about a healthy diet. (Glanz et al., 1993)
* Enabling factors: the factors affecting health services utilization including: 1)perceived barriers to healthy diet; 2)social support; and 3)perceived norms for healthy eating. (Glanz et al., 1993)

Review of Related Literature

This chapter reviews the literature related to the key concepts of this research. The literature review is divided into four sections: 1) health implications and food sources of dietary fiber; 2) factors associated with intake of dietary fiber; 3) modification of dietary behaviors using Stages of Change Theory; 4) the validity and reliability of dietary assessment instruments.

Health implications and food sources of dietary fiber

Health implications of dietary fiber

Three decades ago Burkitt and Trowell hypothesized that dietary fiber intake played a role in the etiology of colon cancer and other diseases (Burkitt et al., 1975) and stimulated subsequent research. Although interpretation is clouded in some case-control studies by confounding dietary parameters and the absence of reliable information on fiber content (Block et al., 1987), the role of dietary fiber has been promoted by nutrition and medical researches from simply a laxation facilitator to a potential preventive of several chronic diseases, such as diverticular disease (Brodribb, 1980), colorectal cancer (MacLennan et al., 1978, Modan et al., 1975; Kaaks et al., 1995), Type II diabetes (Comi et al., 1995; Anderson, 1985; Manhire et al., 1981; Nuttall et al., 1979), prostate cancer (Ross et al., 1990; Weisbruger, 1987), hypertension (Margetts et al., 1988; Schlamowitz et al, 1987; Wright et al., 1979), and hypercholesterolemia (Jenkin et al., 1995; Jenkin et al.,1980; Jenkin et al., 1979).

Despite the variety of health benefits associated with dietary fiber, however, many of the mechanisms in vivo remain unclear (Eastwood, 1992). **Table 1** summarizes the physiological effects of dietary fiber and proposed mechanisms. Some of the health benefits of dietary fiber components might be in part its ability to bind water and other factors such as bile acids and estrogens (Chenoweth et al., 1976; Key et al., 1979; Lindegarde et al., 1984). Other benefits might come from the increased transit time of fecal bulk, colonic fermentation of soluble fiber to butyric acid and slowed absorption of glucose. When fiber intake is increased, water and fluids must be increased as well to avoid digestive problems (ADA Reports, 1988). Excess dietary fiber intake may result in a decreased availability of bivalent metals (Frølich, 1995), however, consumption of a balanced diet from a variety of foods should not lead to overt vitamin/mineral deficiencies (ADA Reports, 1988).

Table 1
Physiological effects and proposed mechanisms in vivo of dietary fiber

Physiological Effects	Proposed Mechanisms	Authors
Anticarcinogenic effects	Reduce contact between carcinogenic substances and the intestinal mucosa by increasing the fecal bulk (i.e. decreasing the concentration of carcinogens within the lumen) and by shortening the transit time of bowel contents through the colon and rectum.	Cummings et al., 1982; Klurfeld, 1992
	Modify the metabolism of bile acid and the production of short-chain fatty acids by colonic fermentation of soluble fiber, which may lead to a decreased pH in the intestinal lumen and may decrease the enzymic activity of bacteria that transform bile acids into potent mutagens..	Hill et al., 1971
	During colonic fermentation, soluble fiber can produce butyric acid, which, in vitro, have antineoplastic properties and can reduce the mitotic rate of colon cancer cells.	Jacobs, 1987
	Influence the enterohepatic circulation by lowering the reabsorption of androgens and estrogens from the intestines. Excessive exposure of prostate tissue to the elevated sex hormones may cause prostate cancer in men.	Pusateri et al., 1990
Hypocholesterolemic/ Hypolipidemic effects	Increase bile acid losses due to impedance of bile acid absorption by soluble fiber in the terminal ileum. (e.g. oat bran, pectin)	Kritchevsky et al., 1974
	Alter small intestinal absorption of fat and flatten endocrine responses secondary to a reduced rate of carbohydrate absorption.	Schneeman et al., 1985; Jenkins et al., 1989
	Increase colonic fermentation of fiber and the colonically derived short-chain fatty acids propionate and acetate, which may inhibit hepatic cholesterol synthesis.	Anderson et al., 1984; Bridges et al., 1992
Hypoglycemic effects	Slow glucose intestinal absorption and reduce postprandial insulin level, which can modify the insulin binding and glucose transport in peripheral cells.	Hjollund et al.,1983
	Short-chain fatty acids, acetic, propionic and butyric acids produced by the fermentation of soluble fiber can improve glucose tolerance and the insulin sensitivity.	Venter et al., 1989 Anderson et al., 1991
Antihypertensive effects	Based on the premise of high blood pressure accompanies by high serum cholesterol, the hypolipidemic effects of fiber can subsequently lower blood pressure.	Wright et al., 1979
	Reduce insulin production and change the secretion of glucagon and glucocorticoids, which in turn may affect circulatory system.	Haber et al., 1977

Status and source of dietary fiber intake

Nutritionists, food and supplement manufacturers, and health promoters have made intensive efforts to spread the word about the virtues of dietary fiber, however, intakes remain far below the levels recommended by U.S. Department of Agriculture (USDA), the U.S. Department of Health and Human Service (DHHS), and other health authorities (Smallwood et al., 1994). The third National Health And Nutrition Examination Survey (NHANES III) revealed the mean and standard error of dietary fiber intake was 17.00±0.27 grams for males and 12.75±0.19. grams for females (Alaimo et al., 1994), while the recommended daily intake is 20 to 30 grams by the National Cancer Institute (NCI) (Pilch, 1987) or 25 grams per 2,000 kcal diet by Foods and Drugs Administration (FDA) on food labels (FDA, 1993). Surprisingly, data from USDA's 1989-90 Diet and Health Knowledge Survey (DHKS) and its associated Continuing Survey of Food Intakes by Individuals (CSFII) revealed that 51% of 2,880 respondents thought their diets were "about right" in fiber and those who thought they should lower their fiber intake consumed only 7.3 grams per day (Smallwood et al., 1994). These findings imply an need for nutrition education to educate people about their actual consumption of dietary fiber as well as the rich sources of dietary fiber and its benefits to health.

The development of dietary fiber analyses

Dietary fiber comes only from plant components and was first defined by Hipsley (Hipsley, 1953) to describe the plant cell wall components of food including insoluble lignin, cellulose, and hemicellulose. The definition of dietary fiber has been broadened by some to include soluble substances such as pectins, gums, and mucilages (Trowell, 1976). **Table 2** summarizes the general sources of dietary fiber. This current broad definition acknowledges the significance of fiber as a chemical and physiological component of the diet.

As a result of findings from medical research on the health benefits of fiber, the public policy on dietary fiber has been modified in the past three decades. Based on the definition

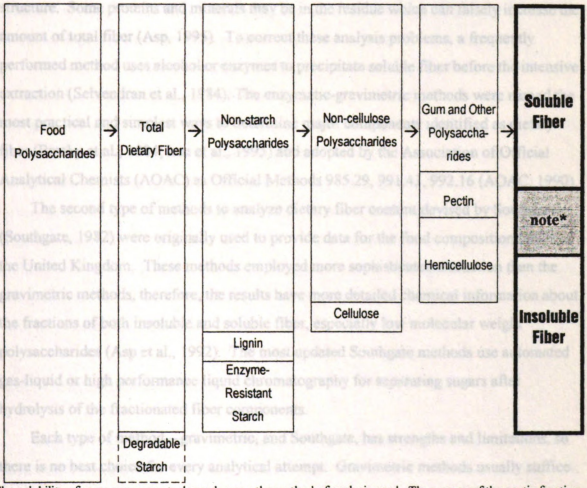
that fiber is 'the insoluble material remaining after severe acid and base hydrolysis', the U.S. Department of Agriculture (USDA) Handbook 8 provided the first comprehensive data on the amount of *crude* fiber in foods in 1963. As fiber analysis methods advanced, USDA released version 4 of the USDA nutrient database in November, 1990, which included both soluble and insoluble dietary fiber values of foods (USDA, 1990). Because this database is machine-readable, it is widely used for individual food intake surveys. In January, 1993, Food and Drug Administration (FDA) and USDA issued final food-labeling regulations including nutrition labeling and health claims for dietary fiber (Lee et al., 1995). However, there is no level set for dietary fiber in the current Recommended Dietary Allowances (National Research Council, 1989).

Table 2
Sources of five components of dietary fiber

Cellulose	Whole-wheat flour	Wax beans
	Bran	Broccoli
	Cabbage	Brussels sprouts
	Young peas	Cucumber Skins
	Green beans	Peppers
	Apples	Carrots
Hemicelluloses	Bran	Cereals
	Whole grains	Mustard greens
	Brussels sprouts	Beet root
Gums	Oat meals	Rolled-oat products
	Dried beans	
Lignin	Breakfast cereals	Eggplant
	Bran	Pears
	Older vegetables	Green beans
	Strawberries	Radishes
Pectin	Squash	Cabbage
	Apples	Dried peas
	Citrus fruits	Carrots
	Cauliflower	Strawberries
	Green beans	Potatoes

The sophisticated structures and physico-chemical properties of dietary fiber components have provoked much argument about how they should be classified. The

advance of analytical methods for these components and better understanding of their physiological effects on health has helped the development of an unanimous classification system. In 1995, an international survey was conducted to get the views of 147 professionals in the field on the definition of dietary fiber (Lee et al., 1995). The survey also solicited opinions on analytical methods for nutrition research. **Figure 2** shows the most updated classification system of dietary fiber components and its evolution.



*The solubility of some components depends upon the method of analysis used. Thus, some of the pectin fraction may be treated as "insoluble", or a part of hemicellulose may be treated as " soluble".

Figure 2. The evolution of the classification of dietary fiber components (ILSI, 1994)

Two types of analytical methods, gravimetric methods and the Southgate method, are commonly used to determine dietary fiber content of foods (Asp et al., 1992). The gravimetric methods, used over 130 years ago, weighed the insoluble residue (crude fiber) after extraction with boiling dilute acid, alkali and enzymes. Gravimetric methods can provide results varying from the amount of total fiber to its fractionated components, depending on the degree of sophistication of extraction. Soluble fiber is not included in the results of gravimetric methods, because the intensive extraction severely damages fiber structure. Some proteins and minerals may be in the residue which can falsely increase the amount of total fiber (Asp, 1995). To correct these analysis problems, a frequently performed method uses alcohol or enzymes to precipitate soluble fiber before the intensive extraction (Selvendran et al., 1984). The enzymatic-gravimetric methods were named the most practical and simplest ways to determine major components identified as dietary fiber (Prosky et al., 1984; Lee et al., 1995) and adopted by the Association of Official Analytical Chemists (AOAC) as Official Methods 985.29, 991.43, 992.16 (AOAC, 1990).

The second type of methods to analyze dietary fiber content devised by Southgate (Southgate, 1982) were originally used to provide data for the food composition tables in the United Kingdom. These methods employed more sophisticated extraction than the gravimetric methods, therefore, the results have more detailed chemical information about the fractions of both insoluble and soluble fiber, especially low molecular weight polysaccharides (Asp et al., 1992). The most updated Southgate methods use automated gas-liquid or high performance liquid chromatography for separating sugars after hydrolysis of the fractionated fiber components.

Each type of method—gravimetric, and Southgate, has strengths and limitations, so there is no best choice for every analytical attempt. Gravimetric methods usually suffice where information on dietary fiber is required for regulatory purposes. If the research emphasizes on the nature and physiological properties of dietary fiber polysaccharides, however, Southgate methods are more feasible and preferred (Asp, 1995; Asp et al., 1992).

Fiber is rich in foods such as whole grains, fruits, vegetables, and legumes (Anderson et al., 1994). A recent report stated most Americans fail to consume even one whole-grain food per day, much less than three, which might explain why the average daily intake of fiber is less than half of the recommended value (Alberton et al., 1995). From the 24-hour recalled dietary intakes of the NHANES II survey, Block and colleagues discovered the major single contributors of dietary fiber in the U.S. diet were vegetables, which provided 28% of daily fiber, breads provided 19% and fruits 7% (Block et al., 1987). Similar findings reported by Marlett and colleagues indicated that one third of the daily fiber intake of 200 college students was from grain products and legumes (Marlett et al., 1981).

A secondary analysis on specific food sources of fiber using data from the 1985 CSFII by Krebs-Smith and colleagues found that tomatoes, yeast breads, potatoes, green beans, soy products, and French fries contributed about 40% of total dietary fiber in diets of 1,459 women 19 through 50 years old (Krebs-Smith et al., 1992). The same analysis also revealed that subjects received an average of 42% of their dietary fiber from cereal and bakery products and 28% from vegetables and potatoes (Smallwood et al., 1994). In the Bogalusa Heart Study, conducted from 1976-1988 on three different age groups of 2,118 children and young adults, Nicklas and colleagues reported that vegetables, soups, breads, and grains accounted for 53% and 70% of the total fiber in the diets of 10- and 13-years-olds, respectively (Nicklas et al., 1995).

Remarks about literature reviewed

Over the last 30 years, the role of dietary fiber in nutrition has been changed from a "non-nutritive ingredient" to a factor "representative of healthy diet" as analytical methods and experimental dietary studies have progressed. Much has been written concerning the advantages of a high-fiber diet on various chronic diseases, however, the average daily intake of Americans still falls far behind the recommended value and people appear largely unaware of what foods are good source of fiber.

Factors associated with intake of dietary fiber

In the past two decades increasing concern and knowledge about the role of diet in the etiology of chronic disease have led to the development of dietary guidelines by health authorities in U.S. and other industrial countries. One major component these guidelines share is the emphasis on reduced fat intake and increased fiber consumption (National Research Council, 1989). To achieve the goals of these dietary guidelines, such as an increase in average consumption of fiber to 20-30 grams per day suggested by National Cancer Institute, an understanding of factors that strongly influence individual's food choice is indispensable for the development of intervention programs.

Determination of potential factors

A broad range of determinants contributing to dietary behavior has been recognized, including intrapersonal, interpersonal, institutional, community, and public policy influences (Glanz et al., 1990). Research examining dietary behavior has tended to concentrate on personal factors such as nutrition knowledge (Johnson et al., 1985); health and diet-related beliefs (Jensen et al., 1992); confidence of making dietary changes (Vega et al., 1988); and feelings of personal control over dietary behavior (Saltzer et al., 1978). Once potential determinants of specific dietary behavior are identified, these can provide a foundation for developing effective strategies for dietary change (Glanz et al., 1993). Additionally, measuring these variables might make it possible to evaluate change in mediating factors, in addition to the major endpoints, of food consumption (Kristal et al., 1990).

Demographic factors: Studies have found low socioeconomic status associated with lower dietary fiber intake (Baghurst et al., 1990; Smith et al., 1992; Kushi et al., 1988). Patterson and colleagues reported that people who had low-fat, high-fiber diets tended to be older women with high incomes and college education (Patterson et al., 1994). Specific dietary preference is another significant factor influencing dietary fiber intake. Vegetarians

typically consume a high levels of fiber—perhaps 40 grams or more daily—compared to non-vegetarians, while the historically carnivorous Eskimos eat virtually no fiber at all (Eastwood et al., 1983).

Personal knowledge: Correlated with low socioeconomic status, lack of knowledge may be another factor affecting fiber intake. A study using a telephone survey of foodservice specialists in 242 military installations found only 24% of the respondents, who nearly all perceived that they offered a whole-grain bread, actually did. Findings indicated brand names, misleading labels, and lack of knowledge in identifying real fiber-rich foods were associated with low fiber intake (Warber et al., 1996).

In a telephone survey on 407 adults residing in Providence, RI, Laforge and colleagues used psychosocial approaches to probe for factors associated with low fruit and vegetable consumption (Laforge et al., 1994). They found that education was directly related to fruit and vegetable intake, but was not correlated with those who usually consumed fewer than 5 servings and had no intention of adopting the national 5-A-Day program. Studies done by other researchers (Bunch, 1990; Subar et al., 1992) also confirmed that low educational level is likely to be associated with low fiber intake.

Attitudes and beliefs: Based on data from 1985 CSFII and 1989-90 DHKS, another psychosocial factor influencing dietary fiber consumption proposed by Frazao and Cleveland was the individual's assessment of the adequacy of his or her own intake (Frazao et al., 1994). They found people who regarded themselves as consuming enough dietary fiber in the diet, actually ate less dietary fiber than those who thought their fiber intake was not enough, even though both groups fell well below the recommended daily values for dietary fiber.

To acquire quantitative data for assessing abstract dietary attitudes and beliefs, numerous researchers have generated questions using concepts from the Health Belief Model (HBM) (Contento et al., 1990; Dittus et al., 1995; Patterson et al., 1995; Kristal et al., 1995; Trenkner et al., 1990). The HBM is one of the most commonly applied models in nutrition education (Contento, 1995) and a major organizing framework for explaining and

predicting acceptance of health recommendations (Glanz et al., 1990). For the concept of improving disease-related dietary behavior, the HBM would suggest that behavior is influenced by a readiness to take action and intervening beliefs about the behavior. Readiness to take action related to health could result from the perceived susceptibility to a disease state or concern about nutrition (Hayes et al., 1987; Dittus et al., 1995). The key components of the HBM are: 1) perceived threat; 2) outcome expectation; and 3) self-efficacy (Glanz et al., 1990). A list of recent studies using HBM and other psychosocial theories to measure individual's dietary attitudes and beliefs is tabulated in **Table 3**.

Table 3
Recent studies measuring individual's dietary attitudes and behaviors

Researchers	Subjects	Dietary behavior investigated	Psychosocial model(s) used in designing questionnaire
Cotugna et al., 1992	22,043 adults nationwide	cancer prevention diets	Not specified
Dittus et al., 1995	1,069 Washington State residents	fruits and vegetable intake	HBM
Contento et al., 1990	117 adult supermarket shoppers	comprehensive, positive dietary changes	HBM Theory of Reasoned Action Health Locus of Control
Smith et al., 1995	487 adult Australians	12345+ Food and Nutrition Plan diet	HBM Stages of Change Health Locus of Control
Kristal et al., 1995	16,287 participants of Working Well Trial	healthful diets including increase fiber, fruits and vegetable intake and decrease fat intake	HBM Stages of Change Social Learning Theory Diffusion of Innovation Social Support Theory

Remarks about the literature reviewed

Aside from the traditional advocacy focusing solely on the health virtues of fiber, an understanding of the psychological, socioeconomic, and other potential attitudinal factors that influence intake of dietary fiber may be helpful for nutrition educators and health promoters to screen for those with low intake and design effective interventions. The concepts of the HBM offer comprehensive perspectives on individual's perceived barriers and motivations for desired dietary change. However, for dietary fiber, more efforts are needed to clarify the contribution of these psychosocial factors to tangible change of dietary behaviors such as attitudes, beliefs, and self-efficacy. The research does suggest that some of these psychosocial factors might predict those at risk for low intakes of dietary fiber.

Modification of dietary behaviors using Stage of Change theory

Components of Stages of Change theory

Stages of Change theory (SCT) was developed by Prochaska, Diclemente and colleagues in the early eighties (Prochaska et al., 1982; McConnaughy et al., 1983) in an attempt to understand how and why people make health related changes. They proposed that change occurs through a series of stages and processes shown in **Figure 3**.

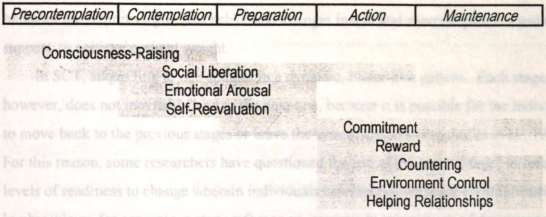


Figure 3. Change processes most useful in particular Stages of Change (Prochaska et al., 1992; Prochaska et al., 1994)

The definitions of these stages are: precontemplation—unaware or not thinking about making a change; contemplation—seriously thinking about changing; preparation—making definite plans to change; action—actively modifying an undesired behavior; and maintenance—maintaining the new, favorable behavior for certain length of time which might be from three months to one or two year. **Figure 3** also shows the types of intervention efforts thought to be appropriate at each stage to lead people to the next stage of readiness to change.

The SCT initially was designed for psychotherapy intervention programs such as smoking cessation (Prochaska et al., 1983; Prochaska et al., 1985; Prochaska et al., 1988; DiClemente et al., 1991); alcohol intake reduction (DiClemente et al., 1990; Norcross et al., 1991); adoption of physical activity (Marcus et al., 1992); and prevention of coronary heart disease (Ockene et al., 1990). Some claim that the SCT might be an integrative theme for understanding and accelerating change in a wide range of problem behaviors, including dietary ones (Prochaska et al., 1992). Several researches have applied SCT to promote fat intake reduction (Curry et al., 1992; Greene et al., 1994; Sporny et al., 1995); cholesterol reduction (Southard et al., 1992); fiber intake increase (Brinberg et al., 1990); and adoption of healthy diets (Glanz et al., 1994). Broader applications have used SCT for weight management (O'Connell et al., 1988; Prochaska et al., 1992), which is not really a behavior but requires a group of behavioral changes in diet and exercise patterns and social support, to achieve optimal weight.

In SCT, stages link to one another in a dynamic, linear-like pattern. Each stage, however, does not inevitably lead to the next one, because it is possible for the individual to move back to the previous stages or leave the system entirely (Prochaska et al., 1992). For this reason, some researchers have questioned the use of the term "Stage" to refer to levels of readiness to change wherein individuals can regress (personal communication). In physiology, for example, a stage refers to an immutable progression of development towards maturity (Rhoades and Pflanzer, 1992). Perhaps "state of change" would be more appropriate term to use than "stage of change" for this model.

In the maintenance stage, there is no *a priori* reason for a particular time span for a particular dietary behavior and this is an area which could benefit from research. Researchers customarily have decided the length of time span for the maintenance stage based on that in previously related studies (Sporny et al., 1995). The time lengths used for maintaining desired dietary behaviors in some related studies are listed in **Table 4** and vary from "made the change" to "longer than 2 years". "Longer than 6 months" has been the length of time used most frequently and by researchers funded by National Cancer Institute to study intake of fat and fruits and vegetables (Glanz et al., 1994).

Table 4
Summary of various lengths of time for maintenance used for selected dietary behaviors in recent researches

Desired dietary behavior	Time length for maintenance	Source
Low-fat and high-fruit and vegetable diet	presently trying	Campbell et al., 1994
Low-fat diet	longer than 6 months	Curry et al., 1992
Low-fat and high-fiber diet	longer than 6 months	Glanz et al., 1994
Low-fat diet	longer than 6 months	Greene et al., 1995
5 servings of fruits and vegetables	longer than 6 months	Laforge et al., 1994
Overall dietary change	already made change	Smith et al., 1995
Low-fat and high-fiber diet	longer than 2 years	Sporny et al., 1995

The applicability of SCT in dietary behavior change

Because most diet-related health problems develop gradually and do not present immediate symptoms, to be effective, programs promoting healthy dietary behaviors must reach large segments of the population and influence the diverse factors which determine eating patterns (Glanz et al., 1988). The first use of SCT in programs promoting healthy eating habits was regarded as a conceptual and methodological challenge (Glanz et al., 1993). Glanz and Mullis explained that the attempt to clearly and correctly categorize a person into a specific stage for dietary behavior change required attention to the unique characteristics of eating patterns and practical issues about the eating environment which were barely researched at that time (Glanz et al., 1988). Subsequently, some algorithms and instruments were tested and validated for their effectiveness on categorizing individuals into different stages of behavioral change (Curry et al., 1992; Glanz et al., 1994).

For healthy people of normal weight, most diet-related health problems do not present immediate or dramatic symptoms, and are not the targets of social stigma compared to alcohol or drug abuse or obesity. Without a provocative psychological reasons, most healthy people are not motivated to make dietary behavior change, even if their diets are inadequate (Glanz et al., 1994). Researchers have found that traditional health education messages and action-oriented interventions may be counterproductive for people at the Precontemplation stage, because people in this stage are highly resistant to change and do not believe any change is necessary or that their current behavior threatens their well-being (Ockene et al., 1992; Ershoff et al., 1989). Because the SCT underscores the need and strategies to move from precontemplation to contemplation, its concepts offer individuals promise of future change in dietary behaviors (Brownell et al., 1995) and are considered as effective ways to decrease early dropouts (Prochaska et al., 1986).

A few studies have reported the applicability of the SCT used in promoting dietary change in healthy populations. A summary of several reviewed studies is in **Table 5**. Curry and colleagues assessed stage of dietary fat reduction and its association with fat intake using telephone interviews with two predominantly white samples in Washington state. They found consistent results across the two samples indicating more women than men in action and maintenance stages, and significant associations between stage of readiness for dietary fat reduction and percent of calories from fat (Curry et al., 1992). Rossi and colleagues evaluated distributions for four different staging algorithms for dietary fat reduction and compared the findings across three samples in New England using in person, mail, and telephone methods. The distributions differed between the algorithms and, with all four algorithms, dietary fat consumption levels decreased with successive stages of change (Rossi et al., 1993).

Glanz and colleagues assessed the psychological stages of change in relation to both dietary fat and fiber intake on two samples— predominantly middle-aged, white males— using food frequency and questionnaires about psychosocial factors. Findings indicated that a greater proportion of the population had actively tried to reduce fat intake than to consume more fiber; and intake of fiber and vegetables was significantly lower in Precontemplation, Contemplation, and Preparation stages than that in Action and

Maintenance stages (Glanz et al., 1994). In a national 5-A-Day campaign, Laforge and colleagues studied 405 adult respondents to investigate psychosocial factors related to fruit and vegetable consumption using the SCT. Results show that education was positively related to fruit and vegetable intake and inversely related to being in the Precontemplation stage. Males were twice as likely as females to be in the Precontemplation stage and eat fewer than 2 servings of fruits and vegetables a day. Such findings imply that stage of readiness to change should be considered as well as other factors in planning interventions for increasing fruit and vegetable consumption. Targeting precontemplators with information about the health benefits of consuming more servings of fruits and vegetables daily, will likely be more effective than giving these people ways to meet the 5-A-Day objective (Laforge et al., 1994).

Table 5
Studies that applied SCT in dietary behavior change

Author	Subjects	Dietary Behavior Investigated	Results
Curry et al., 1992	two samples were studied. Sample A was a random sample of 158 adults enrollees in a large health maintenance organization. Sample B consisted of 1,083 adults who participated in a random-digit dial telephone survey of health behavior in Washington State residents.	dietary fat reduction	more males than females in a precontemplation stage and more females than males in a maintenance stage. age, education, BMI, and number of chronic conditions had positive correlation with stage for men and women. stage of dietary fat reduction was significantly associated with percent of calories from fat.
Glanz et al., 1994	20,801 participants of Working Well baseline survey.	percent energy form fat grams of fiber per 1,000 kilocalories daily servings of fruits and vegetables	subjects in action/maintenance stages for both fat and fiber tend to be older, female, and better educated. stage of change was significantly associated with fat, fiber, and fruits and vegetable intake in a stepwise manner.
Laforge et al., 1994	405 adult respondents of a random-digit telephone survey in Providence, RI.	fruits and vegetables consumption	males were twice as likely as females to be in the precontemplation stage and eat fewer than 2 servings a day. less educated subjects (< 12 years of education) were more likely to eat 2 or fewer servings of fruits and vegetables daily.
Sporny et al., 1995	615 government employees in northeast.	dietary fat reduction	difference between people in the precontemplation and contemplation stage is in their thoughts about changing their behavior, not in their actual behavior. significant reduction of perceived barriers were associated with taking action and maintaining the behavior change.

Remarks about the literature reviewed

Nutrition interventions implemented using psychosocial theories can intensify the credibility of program design, and improve effectiveness of interventions (Sigman-Grant, 1996). Instead of relying on traditional dichotomous outcomes of success or failure to change diet, the alternative measures of success for nutrition interventions offered by the SCT such as movement from precontemplation to contemplation stage are considered as needed elements often missing from other theoretical models of health behavior (Sporny et al., 1995). Additionally, the adoption of stage-appropriate interventions has the potential to diminish the demoralization and frustration frequently expressed by nutrition and health professionals as well as program participants (Shelton, 1995). Given the potential values of using the SCT in designing nutrition intervention, further research, including an exploration of dietary habits, processes of change and length of maintained behavior associated with each stage, is clearly warranted (Curry et al., 1992). The finding that dietary intake of fat, fiber, fruits and vegetables parallels stages of readiness to consume these dietary components and foods suggests that SCT might be useful in predicting people at risk for low intake of dietary fiber.

The validity and reliability of dietary assessment

Reliability and validity, the concepts

A new test or measurement is generally accepted by the scientific community when its reliability and validity have been established, otherwise results from the new measurement are open to criticism (Patrick et at., 1991; Guyatt et al., 1987). Reliability is often thought of as the extent to which concepts and their measures are defined precisely and replicably, that is, the ability of the measurements to produce the same result repeatedly. The definition of validity can be described as the accuracy of measurements, or the extent of the closeness for the new tool to measure what it is supposed to measure (Patrick et al., 1991; Block et al., 1989).

The assessment of reliability and validity of the measurement is crucial in the evaluation of health promotion programs, although the process is regarded elusive by many program designers, possibly because they are not familiar with the statistical methods involved (Patrick et al., 1991; Patrick et al., 1979). Commonly used methods for reliability analysis including: split-half reliability test; test-retest reliability test; and the calculation of Cronbach's alpha (Patrick et al., 1991). For validity analysis, there are three types of tests which are particularly important in the design of questionnaires for health promotion including: content validity; criterion validity; and construct validity (Carmines et al., 1979; Baranowski et al., 1991). Examples of how these analyses apply in development of new instruments are given later in this Section under "Validation of new short instruments in dietary assessment".

Methods of dietary assessment in community-level programs

Diet has an important impact not only on health but also on daily functioning, cognitive performance, and probably psychological well-being. Data collected from dietary assessment therefore can serve as an early indicator of individual nutrition risk as well as be useful for implementing desirable dietary changes (Brownell et al., 1995).

There are four methods traditionally used by researchers to conduct dietary assessment: 24-hour recall, multiple days food record, lengthy food frequency questionnaire (FFQ) or checklist, and diet history (Block, 1988; Lee et al., 1993). Each technique has particular strengths and limitations, but all place considerable demands on participants for interview time, careful completion of lengthy questionnaire, and detailed record keeping (Glasgow et al., 1996). As demands have emerged for health promotion and public health researchers to conduct research and intervention in less constrained locations and in original field settings—such as worksites or homes, the traditionally time-, cost-, and labor-intensive dietary assessments such as 24-hour recalls and food records have become less practical (Kristal et al., 1990; Glasgow et al., 1996).

Kristal and colleagues have argued that assessing patterns of dietary behavior instead of, or in addition to, traditional measures of nutrient intake, may be useful for designing and measuring the effects of community-level dietary interventions (Kristal et al., 1990). Based on this premise, several studies have focused on the development and validation of short food checklists as new dietary assessment techniques using behavioral approaches, such as the psychosocial factors that influence specific food and nutrient intake (Glanz et al., 1993; Kristal et al., 1990; Kristal et al., 1990; Kristal et al., 1990).

The FFQ, or increasingly a short checklist, has become the primary tool of dietary assessment in epidemiological research (Willett, 1990; Block 1989; Block et al., 1989). Additionally, the short FFQ or checklist is considered as an appropriate tool to collect dietary information from all survey participants in large prospective cohort studies under constraints of time and limited resources (Willett et al., 1995; Boeing et al., 1989).

The two most widely used FFQ seen in nutrition research are those developed by Willett et al.(Willett et al., 1985) and Block et al. (Block et al., 1986). Both consist of lists of about 100 or fewer individual foods or food groups that are important contributors to the population's intake of energy and selected nutrients with space for subjects to indicate the frequency they usually consume of the foods (Lee et al., 1993). The Willett-type FFQ was developed through stepwise regression analysis of data obtained by questionnaires from nearly 100,000 women (Willett et al., 1985). Willett selected foods based on their ability to distinguish between women with high, moderate or low consumption of fat and fiber,

and other nutrients selected for their suspected role in cancer. The Willett FFQ was cross-validated in a small sample (n=27) comparing data from the FFQ to 1-year diet records over the same period (Willett et al., 1987). The Willett-type FFQ specifies one "standard" portion size for each food and does not provide subjects' choice of portion size, because Willett believed that frequency of food consumption, rather than difference in portion size, could potentially influence the results of sorting individuals into groups of high or low intake of nutrients (Willett, 1990). See **Figure 4** for an example used in a study conducted on 27 men and women living in Beltsville, MD, area (Willett et al., 1987).

		Average Use Last Year								
	Foods and Amounts	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-5 per day	6+ per day
Dairy Foods	**Skim or low fat milk (8 oz. glass)**									
	Whole milk (8 oz. glass)									
	Sour cream (1 T)									

Figure 4 A section of Willett-type food frequency questionnaire (Willett et al., 1987)

The Block-type FFQ allows subjects to indicate whether their usual portion sizes are small, medium, or large with respect to a stated medium or "standard" portion for certain age/sex groups. The food items in Block-type FFQ were selected on the basis of their contribution to total population intake of energy and each of 17 nutrients in the NHANES II data, and represent over 90% of each of those nutrients. Block believed that difference in portion size had significant influence on total intake of nutrients and need to be specified in dietary assessments. Portion sizes on Block-type FFQ were derived from median amounts reported in 24-hour dietary recalls obtained form nearly 12,000 adults during NHANES II in 1976-1980 (Block et al., 1986). See **Figure 5** for a section of 13-item

Block-type questionnaire developed by researchers at the National Cancer Institute to identify groups whose mean percent fat intake is high or low (Block et al., 1989).

Foods	Medium serving	Your serving size			How often ?				
		S	M	L	Day	Week	Month	Year	Never
Hamburger, meat loaf	1 medium								
Beef steaks, roasts	4 oz.								
Pork, including chops, roast	2 chops/4 oz.								
Hot dogs	2 dogs								
Ham, lunch meats	2 slices								

Figure 5 A section of 13-item Block-type screening questionnaire for fat intake (Block et al., 1989)

Validation of new, short instruments in dietary assessment

Patrick and Beery suggested that the emphasis with development of new dietary assessment tools for health promotion programs should be on the tools' validity, rather than reliability. Validity is thought to be more important than reliability because most assessments and health promotion campaigns are cross-sectional and investigators are not likely to administer the same instrument to the same subjects (Patrick et al., 1991). Also respondents' desire to provide information he/she feels the questioner wants to obtain, instead of what the respondent really eats, can substantially bias the validity of testing instruments (Patrick et al., 1991). These reasons explain why the importance of validity of new dietary assessment instruments for health promotion outweighs the need for reliability.

Some recent studies have documented how to establish validity and, when possible, the reliability, of new instruments for dietary assessment. A summary of these studies is shown in **Table 6**.

Table 6
Summary of studies developing new dietary instruments using a behavioral approach

Researchers	Subjects	Testing Instruments	Validation methods	Results
Kristal et al., 1990.	99 mid-aged Washington women with a wide range of fat intakes	18-item food checklist assessing four relevant dimensions of dietary behaviors related low-fat diet	the correlation between testing instrument and two 4-day food records and one Block-type FFQ the internal consistency of scales of dietary fat use patterns.	the sum of correlations was 0.68 ($p<.001$) for 5 scales related to percentage of calories from fat. total internal consistency of testing instrument was 0.62
Kristal et al., 1990.	97 mid-aged disclaimers of Women's Health Trial	a short dietary questionnaire, which has self- and telephone-administered version, to assess total fat , saturated fat, percent calories from fat, and dietary fiber	the correlation between the testing instrument and mean of two 4-day food records the correlation between testing instrument and mean of one Block-type FFQ and two 4-day food records.	correlations between self-administered short questionnaires and two 4-day food records were .52,.53,.61,.40 for total fat, % of calories from fat, saturated fat, and dietary fiber.
Kristal et al., 1990.	96 mid-aged women who are HMO members	a Food Behavior Checklist (FBC) containing 19 yes/no . questions about the foods consuming during the previous day	the agreement (kappa statistic) between FBC and 24-hour recall for food groups	11 items out of 19 had kappa>0.80 and 5 of the rest had kappa>0.60
Glanz et al., 1993	652 participants of Working Well Project	a 12-construct, 24-item questionnaire measuring psychosocial factors influencing fat- and fiber-related dietary behavior	the correlations between testing instrument and one 22-, one 88-item Block-type FFQ the internal consistency of behavioral questions within constructs	3 constructs have significant correlations with data from FFQs ranging from r=0.31 to r=0.35 3 constructs have internal consistency greater than desired 0.50

In a research funded by the National Cancer Institute (NCI), Kristal and colleagues developed an 18-item food checklist assessing dietary pattern of fat intake on 99 mid-aged women (Kristal et al., 1990). Researchers tested the criterion validity of the new checklist by comparing results from the checklist with those from two 4-day diet records and one modified Block FFQ, which served as criterion measurements. For the estimation of percentage of calories from fat, the correlation between the test instrument and criterion measurements was 0.68 ($p<.001$). The new instrument also had adequate test-retest and internal consistency reliabilities ranging from $r=0.67$-0.90 and $r=0.54$-0.76 for percentage of calories from fat and for its five scales of dietary behavior related to fat. The five scales were: 1) avoid fat as seasoning; 2) avoid meat; 3) modify high-fat food; 4) substitute high-fat foods with specially manufactured lower-fat foods; 5) replace high-fat foods with low-fat alternatives.

Similar validation procedures were followed with another short checklist administered to 97 disclaimers of the Women's Health Trial to assess their intake of total fat, fiber, and saturated fat (Kristal et al., 1990). These women were disclaimed from the randomized clinical trial of low fat diet and breast cancer, because the screening showed they already consumed low fat diets. The researchers found the correlations between the test questionnaire and criterion measurement, which was a mean of two 4-day food records, were $r=0.52$, 0.40, and 0.61 for total fat, dietary fiber, and saturated fat, respectively. These correlations were similar to those observed between a modified Block FFQ administered concurrently and 4-day food records ($r=0.57$, 0.48, 0.63, respectively), suggesting the development of short dietary questionnaires with acceptable validity, as assessed by moderate correlations, was a feasible approach.

In the development of the Food Behavior Checklist (FBC) , a simplification of a 24-hour diet recall consisting of 19 simple yes/no questions about foods consumed during the previous day (Kristal et al., 1990), researchers established validity by comparing the responses of 96 women on the FBC to information collected during a professionally administered 24-hour diet recall. For the agreement between the checklist and 24-hour

recall, 11 items out of 19 had kappa values greater than 0.80 and five of the rest had kappa values greater than 0.60. The authors concluded that data collected by FBC were similar to those obtained from a 24-hour recall, and the FBC could be an inexpensive and technically simple dietary assessment tool for community-level use. The authors assumed that the 24-hour recall was appropriate for criterion validity, however, the validity of 24-hour recall for typical food intake has been highly questioned by other researchers (Block, 1982).

A questionnaire developed by Glanz and colleagues used 24 Likert-scale items for 12 constructs to measure psychosocial factors influencing fat- and fiber- related dietary behavior on 652 participants of the Working Well project -- a National Cancer Institute funded, multicenter controlled trial of worksite health promotion interventions (Glanz et al., 1993). Researchers tried to establish criterion validity of their test questionnaire by correlating the responses with the information collected from a 22-item and a 88-item Block FFQ and then examining the partial correlations between psychosocial items and fat and fiber intake. Among 12 constructs, the constructs of self-rated diet, past success at change, and motivation to eat low-fat foods were found to have significant correlations with fat and fiber data from the FFQs ranging from $r=0.31$ to $r=0.35$ ($p<0.0001$). The constructs of intentions to change, self-efficacy for change, and success at changing had internal consistency greater than 0.50, which is desirable for scale construction in behavioral research (Glanz et al., 1993). Thus, a new dietary questionnaire with the questions designed from those three constructs might have similar correlations with subjects' actual nutrient intake.

Remarks about the literature reviewed

An understanding of the factors that influence people to change their diets in a positive direction may provide us with some insights useful for the design of effective nutrition education and counseling programs (Contento et al., 1990). As the demand increases for simple, rapid, and accurate dietary assessments in low-intensity community-based

intervention trials, measuring dietary behavior seems like a promising approach to meet these needs (Kristal et al., 1990). Nevertheless, further research efforts in behavioral science and psychology are indispensable to assure the validity and reliability of developing instruments. Several short checklists for fat intake have been developed and validated primarily by correlation coefficients exceeding >0.50. Food checklists do not exist specifically for fiber. Also, one might question whether a correlation coefficient of 0.50 is adequate to establish validity, or whether it is even the appropriate technique for validation of such tools. Perhaps the sensitivity, or ability of a tool to detect who is at dietary risk would be more meaningful for establishing the validity of a rapid community-level screening tool.

Insight of the research from the reviewed literature

Knowing that increased dietary fiber intake helps reduce the risks of several chronic diseases and peoples' average daily intake is still far below the recommended amounts, more efforts on promoting the public awareness and recognition of benefits of fiber seem necessary. Nutrition interventions combining the information of *what* changes to make and *how* to make changes might be useful to achieve this goal. The thesis research serves as a prologue for the development of such intervention.

Validating a short checklist of foods for fiber intake examines the feasibility of a rapid method to collect dietary intake data, or a food component of interest. Developing a SCT flowchart provides a simple way to stratify subjects into different stages of readiness for different intervention strategies. Composing a questionnaire of attitudes and beliefs toward dietary fiber intake reveals the characteristics of subjects at different stages, which might be used as intervention points in program design as well as to validate the SCT paradigm for dietary change. The aggregation of such instruments as these three might be an integral piece for screening subjects at risk for low intake of dietary fiber before the onset of core intervention, and providing baseline information for evaluating the efficacy of intervention.

Methods

Subjects

Subjects were the 99 respondents from a random sample of 401 adults selected from the members of Clerical Technical Worker's Union (CTU) of Michigan State University (MSU), currently 1,891 members. The average age for this population was 42 years old and nearly 92% of them are female. The name list and mailing labels for subjects were obtained for $25.00 from MSU Human Resource Information Data Service in September, 1996.

The reasons follow for selecting this target population. 1) The majority of CTU's are mid-aged females who tend to be the main food providers in family, thus their preference of foods and diets can influence other household members, especially young dependents. 2) CTU's are literate and have experienced questionnaire administration, allowing them to answer the test instruments without detailed interpretation by researchers. 3) An intramural health promotion program, MSU Healthy U, provides nutrition and health information routinely to its participants which are mainly female staff of MSU. We expected the research to be mutually beneficial to CTUs (increased awareness of dietary fiber) and Healthy U program (provide information for future program design and screening those at risk for low intake).

Procedures

Data collection began after permission from the University Committee on Research Involving Human Subjects (UCRIHS) **(Appendix A)** and the MSU Healthy U Committee. A pilot test was conducted on the secretaries (n=10) of Food Science and Human Nutrition (FSHN) Department after the permission from chairperson of FSHN was obtained. Preliminary support from the MSU Clerical Technical Worker's Union (CTU) was sought, and at first granted, by the President of the CTU. Unfortunately after all questionnaires

were developed and prepared, the CTU President found, after extensive discussions with her advisory board, that the CTU could not officially support the survey with a letter of recommendation. This was because the Union was initiating formal health-benefit contract negotiations with the university. Eventually, the test instruments were mailed without the support letter from the CTU President. A brief explanatory letter was sent to all 1,891 CTU members regarding the purpose of the research before the sample selection occurred **(Appendix B)**.

The sample of 401 people received the consent form **(Appendix C)**, the test instruments, and an incentive. The test instruments, which include one food checklist, one Stages of Change (SC) questionnaire, a one attitudes and beliefs (AB) questionnaire and food record forms for one weekday and one weekend day, were mailed to selected subjects in October, 1996. As an incentive, one dollar coupon to the campus Dairy Store and an offer of free dietary analysis was provided. Interested subjects provided their age, height, weight, and exercise pattern for a free dietary assessment. The test instruments were self-administered with brief directions. It took about 10 minutes to complete the food checklist and two questionnaires. More time, about 30 minutes, was needed for recording 2-day's food intake. Due to the poor response rate (16%) for this first mailing, a second mailing of test instruments was mailed again with a cover memo **(Appendix D)** to subjects that did not return. The final response rate reached 25%. All survey responses were collected by researchers and kept in a file cabinet to ensure confidentiality of subjects.

The fiber content of foods on the checklist was extracted from the MSU NutriGuide 2.0 program (Song W.O., Nutritional Analysis Computer Program, Michigan State University, 1990) and entered into an IBM-compatible computer using Microsoft Excel 7.0 program (Microsoft Inc., Seattle, WA, 1995). Results served as the database to calculate subjects' fiber intake assessed by the checklist.

To judge the validity of the test checklist, results were compared to the fiber intake computed from the concurrently-collected 2-day food records analyzed by using MSU NutriGuide 2.0. MSU NutriGuide analyzes diets for 27 nutrients in 953 different foods.

Ninety-nine percent of the foods in the software are complete for fiber composition. Its nutrient composition data originally came from Michigan State University main-frame database and USDA Handbook-8 (USDA, 1990). However, sources like food manufacturer's information, McCance and Widdowson (Holland et al., 1991), and Pennington (Pennington, 1989) were also included in the database.

Before the primary data collection on CTUs, both the checklist and the questionnaires were pilot-tested on all secretaries in the Food Science and Human Nutrition Department (n=10). The draft test instruments were modified slightly based on response to the pilot test. In the checklist, not-selected food items were omitted, such as cowpeas. Standard portion size was added to each food for better accuracy in estimating actual consumption. In the Stages of Change questionnaire, a slight change in wording was made to include people already on a high-fiber diet in the maintenance stage. For the attitudes and beliefs questionnaire, one question was eliminated because of similar wording to another question. Two open-ended questions were added to acquire subjects' detailed description of motivation and barriers for increasing dietary fiber intake. The summarized responses will be made available to Healthy U for improving future program design.

Instruments

One checklist of food sources of fiber and two questionnaires related to changing dietary behavior related to fiber were developed for administration by mail. It was hypothesized that these three short instruments, taking less than 10 minutes to complete would be able to identify people at risk for low intake of fiber as well as the more lengthy 2-day food records.

Checklist

The purpose of developing the checklist was to establish a valid tool for ranking people by their dietary fiber intake. Establishing criterion validity of this checklist was one of this study's goals.

The 2-day food records from Healthy U participants in three previous projects were used to develop a list of food items contributing to 95% of the fiber intake in participants' diets. The computer program written in Turbo Pascal (Borland International Inc., Scott Valley, CA, 1987) language developed by Huang and colleagues (Huang et al., 1994) was used to accomplish the sorting job. The "top 40" foods contributing fiber were assumed to reflect the fiber consumption of our target population. The amount of dietary fiber intake was determined by the following formula:

Fiber (g/day) = Quantity of serving X Frequency (daily) X Fiber content of the food (g)

Further selection of food items for the checklist were from two sources: 1) the food sources of dietary fiber in diets of 1,032 women 19 through 50 years old in 1985 Continuing Survey of Food Intakes of Individuals (CSFII) data, which lists the food items contributing to 70% of dietary fiber resources (Krebs-Smith et al., 1992); 2) the dietary checklist formed by Kristal and colleagues, because it has fair criterion validity ($r = 0.57$) with two 4-day food records and one Block-type FFQ and fair test-retest reliability (weighted Kappa= 0.48) (Kristal et al., 1990; Laforge et al., 1994). See **Table 7** for sources of foods in the checklist developed for this study.

The final edition of the checklist used in this study (**Appendix E**) contained 47 foods divided into 7 groups: Fruits, Vegetables, Beans/Legumes, Breads/Grains/Pasta, Nuts, Snack foods, and Cereals. A few foods were kept on the checklist which did not come from the sources in **Table 7**, because these foods might be "indicator" foods for people who consume high fiber diets. A blank for one food item in each group was also included to allow subjects to add foods not on the checklist. A standard portion size, closest to usually consumed amounts, was selected for use on the checklist to keep the format concise. The

small, medium, and large serving sizes in the Block-type FFQ were not included, because studies suggested the variations in food intake are mainly determined by frequency of consumption rather than by portion sizes (Samet et al., 1984). Also, subjects tend to pay very little attention to the serving size information on FFQ without the presence of instructor (Smith et al., 1991; Subar et al., 1995).

Table 7
The sources and foods selected for the Checklist

Diets of Healthy U participants by Huang et al., 1994	CSFII data, 1985	Dietary checklist by Kristal et al.,1990	Fiber-rich, "Indicator" foods
apple	apple	baked beans	berries
bagel	broccoli	broccoli	celery
banana	corn	brown rice	granola
bran flakes	crackers	Brussels sprouts	grape
broccoli	French fries	cauliflower	nectarine
carrots	green beans	kidney beans	peach
French fries	lettuce	lima beans	popcorn
green beans	lima beans	melon	spinach
green peas	noodles	orange	
noodles	pasta/spaghetti	peanut butter	
oat bran	peanut butter	peanuts	
oatmeal	peanuts	potato chips	
orange	potato	prunes	
pasta/spaghetti	potato chips	raisins	
peanut butter	ready-to-eat cereals	ready-to-eat cereals	
pear	tomato	walnuts	
pizza	tortillas	whole-wheat bread	
potato	white bread	zucchini	
potato chips	whole-wheat bread		
prunes			
raisin bran			
raisins			
tomato			
tortillas			
tossed salad			
white bread			
whole-wheat bread			

Stages of Change Questionnaire

One Stages of Change (SC) questionnaire was designed to categorize subjects into one distinct stage of readiness to eat fiber-rich foods, based on the work of Curry and colleagues. Curry and colleagues developed an algorithm and set of questions to determine at which stage individuals were for dietary fat reduction (Curry et al., 1992)**(Table 8)**. Their results suggested that individuals could be clearly classified into one of five stages of dietary fat reduction, which were inversely associated with self-reported intake of fat (-0.93 for men, -0.73 for women in Sample B, $p<0.001$). Therefore, their algorithm was modified to readiness to consume adequate fiber, for the purpose of stratifying subjects in this study. The subjects' stage of change relative to fiber intake was determined by their responses according to the algorithm. Although there was no *a priori* reason for a particular time span for a particular dietary behavior (Sporny et al., 1995), and no study has addressed stage of change for fiber intake (Glanz et al., 1994), we chose six months to be the time span for maintaining high fiber diet. Six months was selected based on the remarks by Prochaska and colleagues, "Being able to consistently engage in a new incompatible behavior for more than six months are the criteria for considering someone to be in the maintenance stage" (Prochaska et al., 1992).

The SC questionnaire was modified from multiple-choice questions into a flowchart **(Appendix F)** for several reasons. 1) The flowchart appeared to be easier and quicker for subjects to answer than a multiple choice format. 2) The format is shorter and clearer, thus subjects' interest of answering should be enhanced. 3) The original questions and algorithm by Curry et al. left some people between stages; the flowchart format avoids this problem entirely. By using the flowchart-style Stages of Change questionnaire adapted from Curry's algorithm (Curry et al., 1992), each subject can be categorized into one stage of change related to his/her attitude and consumption of dietary fiber.

Table 8

Staging questions and algorithm for dietary fat reduction used by Curry et al.,1992

Questions

1. Have you ever changed your eating habits to decrease the amount of fat in your diet?

Yes 1; No 2 (Skip to #2)

1A. If Yes, are you currently limiting the amount of fat in your diet?

Yes 1; No 2 (Skip to #2)

1B1. If Yes, how long have you been limiting the amount of fat in your diet?

Less than 30 days 1; 1-6 months 2; 7-12 months 3; Over 1 year 4

1B2. If Yes, would you say your are now eating a low-fat diet?

Yes 1; No 2

2. In the past month, have you though about changes you could make to decrease the amount of fat in your diet?

Yes 1; No 2

2A. How confident are you that you will make some of these change during the next month?

Very confident 1; Somewhat confident 2; Mildly confident 3; Not at all confident 4

Algorithm

Stage	Question(s)	Answer(s)
Precontemplation	1 or 1A	No
	2	No
Contemplation	1 or 1A	No
	2	Yes
	2A	Mildly or not at all confident
Decision/Preparation	1 or 1A	No
	2	Yes
	2A	Somewhat or very confident
Action	1 and 1A	Yes
	1B	6 months or less
Maintenance	1 and 1A	Yes
	1B	7 months or more

Attitudes and Beliefs Questionnaire

The Attitudes and Beliefs (AB) questionnaire was designed for assessing subjects' attitudes and beliefs related to dietary fiber intake. Carruth and Anderson proposed that scaling criteria for developing and evaluating an attitude instrument should include determination of content validity, test-retest reliability (stability), and internal consistency reliability (unidimensionality) (Carruth et al., 1977). In this cross-sectional research, only content validity and internal consistency reliability were examined.

Glanz and colleagues defined three domains of psychosocial factors as sensitive indicators of dietary behavior improvement which are : predisposing, enabling, and change-related factors (Glanz et al., 1993). A 12-construct, 24-item questionnaire based on these three domains was developed and tested on the 652 participants of worksite health promotion intervention. Results showed that self-rated diet, past success at change, and motivation to eat low-fat foods were factors most strongly associated with dietary intake. Adopting these three constructs and building on the work of Glanz and colleagues, we designed our questions to assess subjects' dietary attitudes and beliefs related to fiber consumption.

Other researchers have used the Health Belief Model (Rosenstock, 1974) for constructs related to attitudes and beliefs important for dietary behaviors. Contento and Murphy found dietary self-changers were differentiated from non-changers primarily on the basis of perceived susceptibility to diet-related diseases, perceived benefits of changing their diets, normative beliefs, overall health concern, cues to action, chance locus of control, and self-efficacy (Contento et al., 1990). Likewise, Schwarzer proposed that self-efficacy was a major determinant of behavioral intention in both the decision-making phase and the action phase (Schwarzer, 1992). Therefore, questions related to these factors were added to the AB questionnaire in order to increase its content validity and to relate responses to appropriate Stages of Change.

Several questions on the AB questionnaire were adapted for fiber from the original questionnaire developed by Glanz and colleagues (Glanz et al., 1993). Most questions were

designed according to appropriate constructs of the HBM (Rosenstock, 1974) to reflect stages of readiness to consume foods high in fiber. At first the questions were grouped into four constructs for the pilot study: 1) predisposing factors; 2) enabling factors; 3) change-related factors; and 4) self-efficacy, but later the titles of these constructs were removed for conciseness. Expert reviewers determined the soundness of the questions for assessing the fiber-related attitudes and beliefs to assure the content validity. For conciseness, items with less face validity and complex wording were eliminated. The final edition of the AB questionnaire **(Appendix G)** contained 13 questions, each question with a numeric Likert response scale answers ranging from 1 = strongly disagree to 5 = strongly agree.

Statistical analyses

The collected data were analyzed with the use of MSU NutriGuide 2.0 (Song W.O., Nutritional Analysis Computer Program, Michigan State University, 1990), SPSS 6.1 for Windows (SPSS Inc., Chicago, IL, 1995) and Excel 7.0 (Microsoft Inc., Seattle, WA, 1995). The descriptive statistics of subjects' demographic characteristics including age, sex, height, weight, and BMI were analyzed. From the checklist, each subject's gram amount of fiber intake was determined from the fiber content of each food in a standard portion multiplied the frequency of consumption, then summed for all foods selected. From the 2-day food record, the average daily intake of fiber was the sum of 5/7's of the weekday intake plus 2/7's of the weekend intake. Different weights were applied to reflect subjects' different eating pattern during the weekday and weekend. The size, mean, and standard deviation of fiber intake assessed from checklists and weighted 2-day food records of each subgroup were calculated.

Validity of the checklist was examined by three methods: 1) Pearson's correlations of gram amount of fiber intake between checklist and weighted 2-day food records; 2) paired t-tests conducted on the gram amount of fiber intake assessed by the checklist and

weighted 2-day food records; and 3) the extent of sensitivity of the checklist to predict those at risk for low intakes of fiber.

Low intake of fiber was defined two ways: 1) as $\leq$ 10 g/day based on findings by Smallwood and Blaylock using data from CSFII (Smallwood et al., 1994) where people not aware of health problems consumed less than this amount; and 2) as less than adequate or 20 g/day. High intake of fiber was $\geq$ 20 g/day because NCI recommends 20-30 g fiber intake per day. The definition of sensitivity in this study is the percentage of subjects whose actual fiber intake is defined as low ($\leq$20 g/day) confirmed by checklist (Greenberg et al., 1993).

Subjects' responses to SC questionnaire were coded 1 through 5, corresponding to precontemplation through maintenance, for statistical analysis. In each stage, the distribution of subjects and average daily intake of fiber assessed from the checklist and weighted 2-day food record were calculated. ANOVA (Duncan's multiple range test) was used to test the significant difference of fiber intake among these subgroups. The distribution of subjects in each stage combining with the results of exploratory factor analysis from AB questionnaire were used to explain the characteristics of attitudes and beliefs related to fiber intake.

The mode and mean ($\pm$SD) of each question on AB questionnaire for each stage was determined to reveal particular characteristics of attitudes and beliefs related to fiber consumption. Exploratory factor analysis was performed to determine how many constructs really existed in the AB questionnaire and then appropriate construct titles were given. The internal consistency of each construct was examined and the specific attitudes and beliefs at each stage of change were determined by subject's response to each construct. Responses to AB questionnaire were cross-tabulated by distribution of Stages of Change to see whether responses made sense conceptually according to stage of readiness to consume fiber-rich foods.

In additional analyses, the rank of foods from the checklist was calculated based on the contribution to the weekly number of portions and grams of fiber. The qualitative

responses to the barriers and suggestions to increase fiber intake were tabulated. Results and implications of this research will be provided to the Healthy U Program to aid in future evaluation and program design.

Schedule

Spring/95	*Started proposal writing
Summer/95	*Finished draft questionnaire and checklist *Had 2nd committee meeting *Acquired UCHRIS approval
Fall/95	*Examined 3-day food records from previous Healthy U results *Designed the format of checklist and questionnaires
Spring/96	*Finished preliminary data analysis of foods selection for the checklist *Finished questions wording for the AB questionnaire *Had 3rd committee meeting *Made the checklist and questionnaires ready
Summer/96	*Started literature review *Completed pilot test on secretaries of FSHN Dept.
Fall/96	*Obtained the permission from MSU CTU *Mailed out the test instruments and started data collection from MSU CTUs. *Had 4th committee meeting *Started thesis and manuscript writing
Spring/97	*Submit manuscript to the Journal of American Dietetic Association *Finish all research works

Results

Of the 401 subjects contacted, 74 (18%) returned refusals to participate. In total, 99 (25%) subjects responded: 96 completed food frequency checklists; 67 completed 2-day food records; and, most of the subjects were female (90%). The gender distribution was similar between subjects who responded (n=99) and total subjects contacted (n=401). There appeared to be a slightly higher percentage of men than women who refused to participate. See **Table 9** for the distribution of respondents by gender. The mean (±SD) age for all respondents was 42.8±17.1 years. See **Table 10** for detailed demographic statistics. The demographics for gender and age of the respondents was identical to those of the total CTU pool (n=1891).

Table 9
Response rate and demographics of subjects

	Male	Female	All
Total subjects contacted:	36	365	401
number of responders:	9	90	99
number of returned refusal:	10	64	74
number of non-respondents:	17	214	231
Subjects completing Checklists:	8	88	96
Subjects completing 2-day Food Records:	7	60	67
Subjects completing both instruments	7	57	64

Table 10
Mean (±SD) of age, height, weight, and BMI of subjects by gender

	Male (n=7)	Female (n=60)	All (n=67)
Mean Age: (yr)	42.1±11.8	41.3±10.3	42.8±17.1
Mean Height: (in)	71.3±6.4	65.5±3.2	66.1±4.0
Mean Weight: (lb)	184.1±45.2	147.2±27.6	151.0±31.6
Mean BMI: (kg/m^2)	25.3±3.9	24.1±3.7	24.2±3.7

Figure 6 shows the scatterplot of fiber intake data from the two dietary assessment tools. **Figure 6a, 6c** show the distribution of the original fiber intake data collected from checklists and weighted 2-day food records, respectively. Distributions were skewed and needed to be normalized for correlational analyses. **Figures 6b, 6d** show the logarithmic distribution of the original data. All following statistical analyses were performed without the subject who reported 95 g/day of fiber intake **(Figure 6a)**, a physiologically impossible intake, because this abnormal value would be a cause of significant bias.

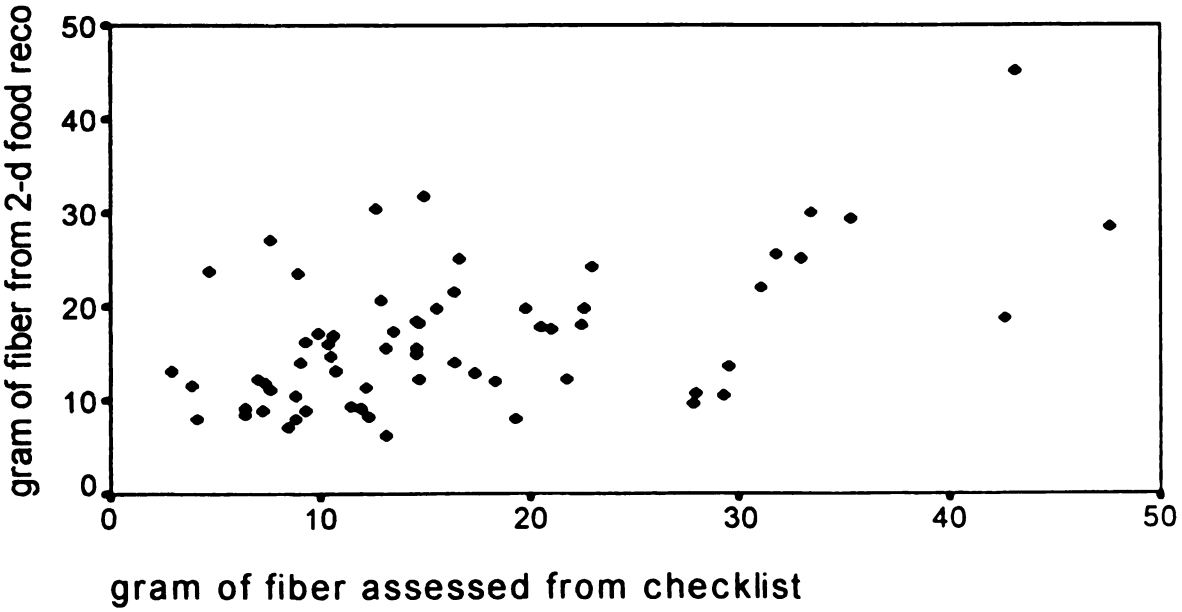


Figure 6: Distribution of daily fiber intake from checklist vs. weighted 2-day food records

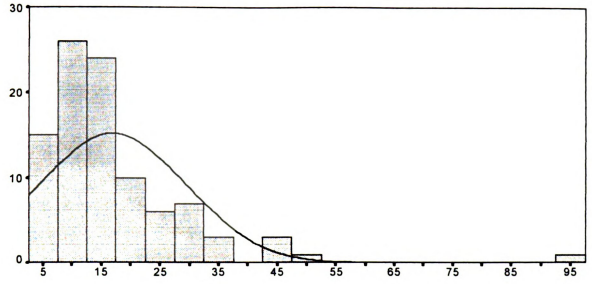


Figure 6a. Original distribution of fiber intake (g) from checklist (n=96)

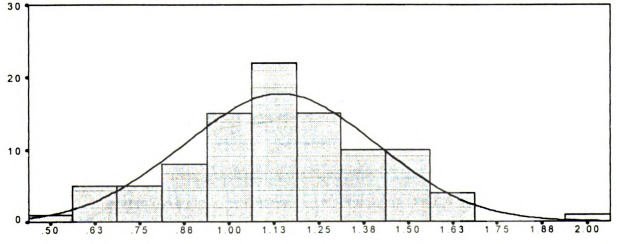


Figure 6b. Logarithmic distribution of fiber intake (g) from checklist (n=96)

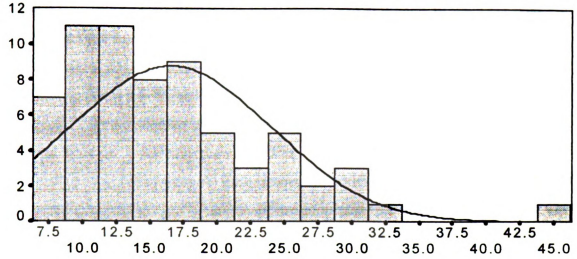


Figure 6c. Original distribution of fiber intake (g) from weighted 2-day food records (n=67)

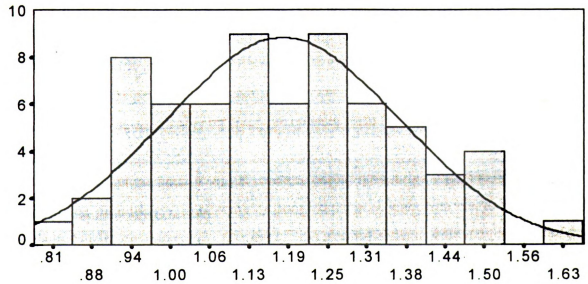


Figure 6d. Logarithmic distribution of fiber intake (g) from weighted 2-day food records (n=67)

Although the fiber intake data appeared to be normally distributed after log transformation, the log values were only used in the calculation of correlation coefficients because it is not appropriate to describe if the subject was at the risk of low fiber intake or not using log values.

Hypothesis 1. There will be positive correlation between the gram amounts of dietary fiber intake assessed from the checklist and from the 2-day food records.

The daily fiber intake assessed from checklists was 16.9±12.5 g/day, ranging from 3 to an abnormally high intake of 95.5 g/day. After the subject with abnormal fiber intake was excluded, the daily intake became 16.1±9.6 g/day, ranging from 3 to 47.6 g/day. The daily fiber intake assessed from weighted 2-day food records was 16.1±7.3 g/day, ranging from 6.3 to 45.1 g/day.

Both original and logarithmic data showed significant correlation between the checklist with the 1st day and the average of the weighted 2-day food records (**Table 11**), suggesting that the eating pattern of subjects might have a larger fluctuation on weekend days than that on weekdays. Although the fiber intake appeared higher on weekdays than on the weekend, there was no significant difference ($p=0.12$) The range of Pearson's correlation coefficiences were lower ($r=0.48$ to 0.55, $p<0.01$) than those expected and desired ($r=0.60$ to 0.80).

Table 11
Median and mean (±SD) of average daily fiber intakes form checklist and weighted 2-day food record and log transformed correlation

Instrument	N[a]	Median(g)	Mean±SD(g)	Correlation (r)	
Checklist	95	13.6	16.1±9.6	—	
weighted 2-day food record:	66				Log
1st day (weekday)		15.0	17.0±8.5	.545*	.479*
2nd day (weekend)		14.0	15.4±8.6	.233	.198
average		14.9	16.5±7.4	.519*	.481*

[a] number of paired t-test performed: 64
* $p<.01$

The range of "limits of agreement" , which indicated how the difference in grams of fiber intake between two measurements distributes, was calculated by following formula (Saba et al., 1995) :

mean difference (0.339) ± 1.96 × standard deviation of the differences (9.42)

The large range of "limits of agreement" (-18.12, 18.80) also confirmed the moderate correlation between these two measurements.

Based on these results, the *Hypothesis 1* was weakly supported.

Hypothesis 2. There will be no significant difference between the gram amounts of dietary fiber assessed from the checklist and the 2-day food records.

The paired t-value between the fiber intake from these two measurements was 0.29 (df=63, 95% CI= -2.015 to 2.693). Because the 95% confidence interval includes 0 in this range, no significant difference was detected in gram amounts of dietary fiber assessed from both measurements. Thus, the *Hypothesis 2* was supported.

Hypothesis 3. The sensitivity of the checklist to detect high and low intake of dietary fiber will be _.70 when compared to 2-day food records.

The distribution of subgroups for high, medium, and low fiber intake is shown in

Table 12. The number of subjects being classified in the same subgroups by the two dietary assessments is 32 (7+17+8), which divided by total valid subjects (n=66) is defined as the percentage of agreement (0.48) between the checklist and weighted 2-day food record.

To calculate sensitivity, subjects in **Table 12** with fiber intake < 20 g/day from both dietary assessments were grouped (n=40) as well as the subjects with fiber intake < 20 g/day from the weighted 2-day food record but ≥ 20 g/day from checklist (n=10). The sensitivity, or the ability to detect subjects who actually had low fiber intake, of the checklist was 0.80, is higher than the expected value (0.70). Therefore, the *Hypothesis 3* was supported.

Table 12
The distribution of subjects (n=66) in high, medium, and low subgroups of fiber intake assessed by checklist and weighted 2-day food record

	weighted 2-day food record		
Checklist	Low (<10 g/d)	Medium (10 to <20 g/d)	High (≥20 g/d)
Low (<10 g/d)	7	11	3
Medium (10 to <20 g/d)	5	17	5
High (≥20 g/d)	1	9	8

Hypothesis 4. There will be a significant difference between the gram amounts of dietary fiber intake for different stages of change related to dietary fiber.

To address this hypothesis, subjects were classified into stages of readiness to consume adequate dietary fiber as assessed by the SC questionnaire. **Figure 7** shows the distribution of subjects by stage of change, with number of cases on the tips of the bars. The largest group was people at the Maintenance stage, claimed by 35% of all subjects. Eighteen subjects did not indicate their stages on the flowchart, a surprisingly large number.

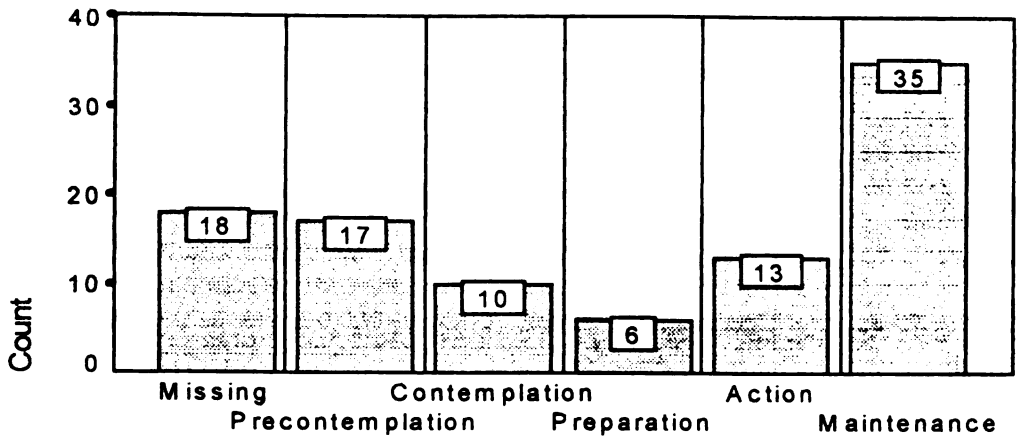


Figure 7. Distribution of subjects in five stages of readiness to change fiber intake (n=99) (number of subjects are shown at the tip of bars)

The results for mean (±SD) fiber intake at each stage assessed by both instruments are shown in **Table 13**. Duncan's multiple range t-test revealed that the fiber intake assessed by the checklist at the Maintenance stage was significantly higher than that at the Precontemplation and Action stages. No significant differences were found between stages for the fiber intake assessed from weighted 2-day food records. Although people at the Preparation stage appeared to have highest amount of fiber intake from both measurements, the differences were not significant by either dietary assessment measure, perhaps due to the small number in this stage.

Table 13
Fiber (g) assessed from the checklists and weighted 2-day food records at each stage of change

Stage	Checklist[a]	weighted 2-d Food Record[a]
Precontemplation	12.5±9.0 (17)*[b]	14.9±9.6 (14)
Contemplation	14.7±10.6 (11)	13.8±3.9 (6)
Preparation	20.4±13.8 (6)	18.4±7.1 (5)
Action	13.1±7.2 (13)*	15.8±3.7 (7)
Maintenance	19.8±9.3 (34)	17.0±7.9 (23)
All valid cases	16.5±9.9 (81)	16.1±7.5 (55)

[a] Mean±SD (n)
[b] Duncan's multiple range test, Precontemplation, Action vs Maintenance
* $p<.05$

Table 14 shows the Spearman's rank order correlation between stage of change with estimated grams of fiber intake from checklist and weighted 2-day food record. We found a positive, significant correlation between the checklist and stage of change, not too surprisingly because both are based on people's self-perception of their diet and attitudes. However, there was no correlation between stage of change and estimated fiber intake from weighted food records which reported foods actually consumed for 2 days (a weekday plus a weekend).

Table 14
Spearman's rank order correlation between stage of change and estimated grams fiber intake from two instruments

Instrument	N	Spearman's r
Checklist	81	.367*
weighted 2-day food record	55	.176

* $p<.005$

The *Hypothesis 4* was supported in part for the checklist. The fiber intake at Precontemplation stage is the lowest and was the highest at Maintenance stage. However, a clear stepwise progression from low to high intake by stage of readiness to eat fiber-rich foods was not observed, although there was a low but significant correlation for the checklist. The low intake for the Action stage is puzzling.

Hypothesis 5. Subjects' responses to the attitudes and beliefs questionnaire will differ according to their different stages of readiness for dietary fiber.

Table 15 shows subjects' responses to the 13 questions on attitudes and beliefs related to fiber intake and the original constructs. In general, subjects knew about the health benefits of fiber (Q1, Q2, Q9, Q13) and showed interest on fiber-rich foods (Q3, Q10, Q12). Subjects' responses were neutral to environmental factors (Q8, Q11) and childhood history of high fiber intake (Q4). However, subjects reported overall a lack of social and family support for eating fiber-rich foods (Q5, Q6, Q7).

Table 15
Mode[a], mean, and standard deviation of subjects' (n=95) responses to Attitudes and Beliefs questions

		Mode	Mean	SD
Q1	Eating a lot of fiber-rich foods decreases my chances of getting serious diseases such as cancer and heart disease.	4	4.0	0.94
Q2	What I eat is important for my health	5	4.6	0.74
Q3	Fiber-rich foods taste good	4	3.9	0.96
Q4	I ate a lot of fiber-rich foods when I was growing up.	3	3.1	1.08
Q5	I've gotten a lot of advice about how to eat fiber-rich foods.	1	2.9	1.18
Q6	My friends encourage me to eat fiber-rich foods	1	2.0	1.06
Q7	My family encourages me to eat fiber-rich foods.	1	2.3	1.18
Q8	It is easy to select fiber-rich foods when I eat out	3	2.8	1.09
Q9	Eating fiber-rich foods is important	5	4.4	0.85
Q10	I'm willing to try a new food if it is fiber-rich	4	3.7	1.05
Q11	It is hard to increase my intake of fiber-rich foods	3	3.0	1.10
Q12	I can increase intake of fiber-rich foods in next 6 months	4	3.8	0.88
Q13	I can be healthy, if I eat fiber-rich foods	4	4.0	0.98

[a] Likert scale from 1=Strongly Disagree to 5=Strongly Agree

When exploratory factor analysis was performed, the five constructs emerging from these questions were: Health benefits of fiber; Social and environmental support; Interest in fiber-rich foods; Childhood intake; Difficulty of increasing intake. These five constructs accounted for 73.1% of the total variance of responses. **Table 16** shows the percentage of variance for which each construct accounts.

Table 16
The percentage of variance of responses to AB questionnaire for which each construct accounts

Construct	Percentage	Cumulative Percentage
Health benefits of fiber	28.5	28.5
Social and environmental support	17.2	45.6
Interest in fiber-rich foods	10.7	56.3
Childhood intake	9.0	65.4
Difficulty of increasing intake	7.7	73.1

Questions were put together which had correlation coefficients ≥ 0.60 for a specific construct. **Table 17** shows the correlations between the 13 questions for the five constructs. Confirmatory factor analyses were performed for the questions with correlations < 0.60 and linked to more than one construct, e.g. Q7 and Q13, to decide to which constructs the questions belong (Hunter, 1977).

As a result, the construct of "Health benefits of fiber" included Q1, Q2, Q3, Q9, and the less dominant Q13. Construct of "Social and environmental support" included Q5, Q6, Q7, Q8. Construct of "Interest in fiber-rich foods" included Q10 and Q12. Both the constructs of "Childhood intake"and of "Difficult of increasing intake" had only one question each which were Q4 and Q11, respectively. The α reliability of the three constructs with more than one question ranged from 0.61 to 0.83 as shown in **Table 17**.

Table 17
Correlations[a] of each question with five constructs and α of three constructs with more than one question

	Health benefits of fiber	Social and environmental support	Interest in fiber-rich foods	Childhood intake	Difficulty of increasing intake
Q1	.80				
Q2	.86				
Q3	.66				
Q9	.84				
Q13	.42				.52
Q5		.78			
Q6		.81			
Q7		.64		.42	
Q8		.68			
Q10			.72		
Q12			.83		
Q4				.93	
Q11					.89
α	.83	.73	.61	—	—

[a] only correlations > .40 are shown

Table 18 shows the responses to the 13 questions within the five new constructs by subjects at different stages of readiness to consume fiber-rich foods. For the construct of "Health benefits of fiber", subjects across all five stages thought fiber in the diet was important to health. People at Preparation stage, however, did not seem to like the taste of fiber-rich foods (Q3). This finding was interesting given that subjects at the Preparation stage reported high intakes of fiber. These people were probably at the transition of adopting new foods and perhaps experiencing difficulty in the interim.

Responses to the construct of "Social and environmental support" was low for all stages. People at Preparation and Maintenance stages appeared to be getting the most advice. The highest scores overall for "Social and Environmental support" were at the

Maintenance stage, as expected in SCT. Unfortunately average support from friends (Q6) and family (Q7) was still low or neutral, even at the Maintenance stage.

Subjects at all stages above Precontemplation showed moderate self-efficacy (Q10, Q12) in the response to the construct of "Interest in fiber-rich foods". There was no apparent relation between stages of change for fiber and the two one-question constructs—"Childhood intake of fiber rich foods" and "difficulty of increasing intake". Because a one-question construct is inadequate to contribute to a scaled score—these two single question constructs were dropped from further analyses.

Table 18

The mode[a] of responses to Attitudes and Beliefs questions and their distribution by five stages of change

	Health benefits of fiber					Social and environmental support				Interest in fiber-rich foods		Childhood intake	Difficulty of increasing intake
Stage[b] (n)	Q1	Q2	Q3	Q9	Q13	Q5	Q6	Q7	Q8	Q10	Q12	Q4	Q11
P (17)	4	5	4	4	3	2	1	1	3	3	3	3	4
C (10)	4	5	4	5	4	1	1	1	3	4	4	2	2
D (6)	4	5	2	5	3	4	1	1	3	4	4	3	3
A (13)	4	5	4	5	5	3	1	2	3	4	4	3	4
M (35)	5	5	4	5	5	4	2	3	4	5	4	3	3

[a] Likert scale from 1= Strongly Disagree to 5 = Strongly Agree

[b] P= Precontemplation, C= Contemplation, D= Preparation, A= Action, M= Maintenance

To examine if subjects' responses to first three constructs (with two to five questions each) would demonstrate significant difference by stage, the "score" of each construct was calculated. The score of a construct was defined as the sum of subjects' response, based on the Likert scale, to all questions within the construct. **Table 19** shows the mean ($\pm$SD) of the scores for each construct at different stages. Subjects at the Maintenance stage had the highest scores ($p<.05$) for the construct of "Health benefits of fiber" compared to those at

other four stages. The social and environmental support that precontemplators and contemplators perceived for consumption of fiber-rich foods was significantly less than what people at the Maintenance stage perceived. Precontemplators also had significantly less interest in fiber-rich foods than people at other stages, except for Preparation, confirming the concepts of SCT. These three constructs only accounted for 56.3% of total variance of responses, indicating they did not completely reveal all attitudes and beliefs related to fiber consumption. Thus, *Hypothesis 5* was particially supported.

Table 19
Mean (±SD) of the scores for three major constructs at the subjects' different stages of readiness to consume fiber

	Health benefits of fiber (5)[a]	Social and environmental support (4)	Interest in fiber-rich foods (2)
Precontemplation (17)[b]	19.9±2.4*[c]	8.3±2.6*[c]	6.4±2.0
Contemplation (10)	20.9±2.6*	8.4±3.1*	7.7±1.1*[d]
Preparation (6)	18.8±2.8*	9.2±2.9	7.8±1.7
Action (13)	21.2±2.6*	10.2±3.9	8.1±1.5*
Maintenance (35)	22.8±2.1	11.3±2.9	7.8±1.5*

[a] number of questions in the construct
[b] number of subjects at the stage
[c] Duncan's multiple range test, stages vs Maintenance
[d] Duncan's multiple range test, stages vs Precontemplation
* $p<.05$

Hypothesis 6. Subjects' fiber intake from the 2-day food records can be predicted from 3 short instruments: the checklist, SC questionnaire, and the major constructs from the AB questionnaire

Multiple regression (enter) was used to determine if fiber intake from the weighted 2-day food records (dependent variable) could be predicted from the fiber intake from

checklist, the subject's stage of change, and scores of the three major constructs in AB quesitonnaire (independent variables). **Table 20** shows the hierarchical and stepwise prediction of dependent variable from five independent variables.

Table 20

Stepwise prediction of fiber intake from weighted 2-day food record using fiber intake from checklist, the subject's stage of change, and subject's scores of the three major constructs in AB quesitonnaire

Step	Variable	r	R^2	p
1	Gram amounts of fiber intake from checklist	.52	.27	<.001
2	Stages of Change	.13	.02	.35
3	Construct of "Health benefits of fiber"	.17	.03	.20
4	Construct of "Social and environmental support"	.25	.06	.06
5	Construct of "Interest in fiber-rich foods"	.19	.03	.17

The regression equation was:

$$\mathbf{Y = 0.46\ X1 + 8.54} \qquad (n = 64;\ F = 29.43;\ df = 1;\ p < .0001)$$

Y : gram amounts of fiber assessed from the weighted 2-day food record

X1 : gram amounts of fiber assessed from the checklist

Other independent variables (step 2-5) are not shown in the equation because their correlations with the dependent variable are not significant, although the construct of "Soical and environmental support" showed a low correlation that approaches significance (p=0.06). The five independent variables predicted a total of 44% of the variance in fiber intake—suggesting that the relationship is not likely linear. Therefore, *hypothesis 6* was not supported for this population of predominatly women.

Additional Analysis

From the checklist, the rank of foods for their contribution to total fiber intake was calculated based on two factors: the weekly number of portions consumed; and the grams of fiber consumed per week by an individual. **Table 21** shows the top 20 foods for each of these two factors. Wheat bread was the food with the largest weekly consumption and apple was the food providing largest amount of fiber in the subjects' diet.

Table 21
Ranking of foods from the checklist for their contribution to total fiber intake based on the average weekly number of portions consumed and grams of fiber consumed from that food per week by each subject

Food	no. of portion/wk/person	Food	grams of fiber/wk/person
wheat bread	4.50	apple	8.32
apple	3.18	whole grain cereal	7.95
white bread	2.85	wheat bread	7.16
lettuce	2.74	bran cereals	7.05
tossed salad	2.57	potato	5.38
potato	2.56	banana	5.38
banana	2.48	prunes	5.01
tomato	2.28	refried beans	5.00
carrots	2.25	tomato	4.88
bagel	1.96	oatmeal	4.37
whole grain cereal	1.91	peanut butter	4.36
pasta	1.45	carrots	3.96
crackers	1.42	baked beans	3.65
broccoli	1.40	green peas	3.16
green beans	1.34	green beans	2.92
peanut butter	1.07	broccoli	2.83
corn	1.05	pasta	2.72
tortillas	0.99	bagel	2.45
oatmeal	0.96	orange	2.30
bran cereals	0.94	pear	2.08
popcorn	0.91	tossed salad	2.01

Shown in **Table 22** are foods that subjects in this study ate frequently, but were not listed on the checklist. The foods selected more than three times (white rice, cabbage, pepper, grapefruit) might be necessary to be included in the checklist in the future to decrease the inaccuracy between the data from the checklist and actual intake.

Table 22
Foods not listed on the checklist but were selected by subjects more than once

Food	Times being selected
White rice	5
Cabbage	4
Pepper (green, red)	4
Grapefruit	4
Pretzel	3
Lentil	3
Pinto bean	3
Kiwi fruit	3
Black bean	3
Sunflower	3
Cucumber	2
Almond	2
Onion	2
Gabanza bean	2
Sesame seed	2
Bulgar	2
Pecan	2
Radish	2

Subjects' responses were tabulated in **Table 23** to the two open-ended questions "What could you do to increase your intake of dietary fiber ?" and "What keeps you from eating more fiber-rich foods ?" in the AB questionnaire. Generally, subjects thought the best way to increase intake of dietary fiber was to consume more fiber-rich cereal, fruits, and vegetables. It is noticable that two subjects reported use of fiber supplements was a way they would increase their fiber intake. The major factors for avoidance of fiber-rich foods were lack of convenience, not enough time to cook, difficulty in having fiber-rich foods on the go or when eating out. Concerns about the gas production and unpaltable taste of fiber-rich diet were also significant reasons for not eating fiber-rich foods.

Table 23
Subjects' response to suggestions for and barriers to increasing fiber intake (n=95)

What could you do to increase your intake of dietary fiber ?	
	Counts [a]
Eat more fiber-rich cereals, fruits, and vegetables	40
Improve meal planning	7
Avoid empty calorie snacks	7
Increase availability of fiber-rich foods	5
Learn how to select fiber-rich foods	3
Use fiber supplements	2
What keep you from eating fiber-rich foods ?	
Lack of convenience (time to prepare, availability)	30
Health concerns (on special diet, avoid gas production)	13
Lack of interest to change	11
Unpalatable taste of fiber-rich foods	8
Feelings of enough consumption	6
Influence from family or spouse	4
Cost	4
Strict dietary preference (small appetite)	3
Lack of knowledge for selecting fiber-rich foods	3
Lack of recipes	1

[a] based on number of opinions generated from open-ended questions, not number of subjects

Discussion

The high sensitivity (80%) of the checklist demonstrated its ability to distinguish subjects who actually ate low fiber diets from those who reportedly ate low fiber diet. High sensitivity of a dietary assessment instrument is required for intervention programs to ensure the strategies are targeted to those who actually are at dietary risk, even though they might regard their diets as adequate. The good sensitivity of the checklist supports its feasibility and effectiveness of use as a screening tool for a population similar to this sample at high risk for insufficient intake of dietary fiber.

Checklist Validation

The correlation between the test checklist and the criterion measure of weighted 2-day food records was 0.52, which was identical to the result of a similar study by Saba et al (1995). Low to moderate correlation (r =0.30-0.50) in measuring dietary fiber intake between the test instrument and criterion measurement seemed prevalent in the studies reviewed. The short checklist developed by Kristal et al. had a correlation of 0.40 with mean of two 4-day food records (Kristal et al., 1990). The FFQ developed by Willett et al. had a correlation of 0.46 with mean of four 7-day food records (Willett et al., 1985). The FFQ developed by Jain et al. had correlations of 0.39 for men and 0.52 for women with one 7-day food record (Jain et al., 1996).

Moderate correlations between two dietary assessment techniques might be caused by random errors incurred in measurement of the diet by both methods. Sources of random errors include: 1) subjects forgetting to record what they ate; and 2) over- or underestimate of actual consumption. Other sources of error include: 1) checklist or FFQ design does not match subject's ordinary food choices; 2) the foods not included in the database of the

analytical software were mistakenly substituted by researcher's subjective interpretation; and 3) incorrect portion size transformation by researchers.

All methods of dietary intake measurement require either a direct probe of portion size or referral to a standard size in order to estimate energy or nutrient content. If portion sizes are estimated incorrectly, this source of error itself might be sufficient to explain the discrepancy between self-reported caloric intakes and rates of obesity in the U.S. (Young et al., 1995) Moreover, studies have shown that in fact subjects pay little attention to portion size information on FFQ (Subar et al., 1995). The moderate correlation between the checklist and the weighted 2-day food record in this study might largely result from this reason.

Another reason for the moderate correlation might be subjects' confusion on filling out the checklist. It was quite common to find subjects entering self-contradictory responses (> 80%), e.g., filling in 1 time daily and 3 times a week for the same food. This problem was addressed by uniformly choosing the answer with largest frequency, which might have led the checklist to overestimate actual fiber intake. A third reason for the moderate correlation might be that foods were not on the checklist, but were selected by the subjects, forming a missing source of fiber intake. There were 36 subjects (36%) who indicated at least one food they frequently ate which was not shown on the checklist. A few of these foods such as green pepper and cabbage might be significant fiber sources. The fiber content of these foods was not included, because it would have contaminated the validation check of the checklist in this study.

The ability of the checklist to classify subjects into low, medium and high intakes, or percentage of agreement with the weighted 2-day food record, was a modest 47%, but similar to that found in the self-administered FFQ (53%) where Saba and colleagues used a 7-day weighed food record for validation (Saba et al., 1995). In the present study, 4 subjects (6%) were placed into opposite subgroups of fiber intake. That is, their fiber intakes were determined as high by one measurement but low by the other one. This misplacement

percentage for the checklist was lower in the present study than the 12% misplacement error in the study by Saba et al.

Stages of Change Questionnaire

Surprisingly 18 (18%) subjects returned their SC questionnaires blank, while they completed the other instruments. The problem might be caused by subjects' lack of attention to the self-administered questionnaire, but it is more likely a sign of the subjects' unfamiliarity with the questionnaire in flowchart format. Although the SC questionnaire did achieve the goal of stratifying subjects effectively, because no subject chose two stages at the same time, this might also be part of the problem, if some people did not fall neatly into one of the five stages. The large number of subjects in the Maintenance stage confirmed that a voluntary, health-related survey is more likely to recruit respondents who are self-conscious about diet and health.

Table 24 shows a close comparison of fiber intakes at different stages from the present study with those from studies done by Spomy (Spomy et al., 1995), Glanz (Glanz et al., 1994). and Huang (Manuscript in process, 1997). In this study, fiber intake did not increase significantly, perhaps due to the small sample size, compared to the significant increase of fiber consumption found earlier at the Action stage in both Spomy's and Glanz's studies. In Huang's study, the significant increase was not found until the Maintenance stage.

As a way to examine the theoretical relevance of the SC questionnaire to intake of dietary fiber, the mean and standard deviation of grams fiber consume at each stage among the cited studies were compared. Except for the Maintenance stage in Spomy's study and the Contemplation and Preparation stage in Glanz's study, there was no difference in the fiber intake at each stage between this study and the other two cited. These findings indicate fair compatibility between the checklist and the SC questionnaire in demonstrating

the relationship between the actual fiber intake and different stages of readiness to increase fiber consumption.

Table 24

Comparison of gram amount of dietary fiber intake (mean±SD) by stage of change between Shih's checklist and data of Glanz et al., 1994; Spomy et al., 1995; and Huang et al., 1997

	n	Precont.	Contemplation	Preparation	Action	Maintenance
Glanz et al., 1994 [1]	17,039	12.6±0.1 [a]	13.0±0.1 [b]	13.8±0.2 [c]	15.4±0.1 [d]	19.6±0.2 [e]
Spomy et al., 1995	618	11.8±2.6 [a]	11.8±2.9 [a]	N/A	13.7±3.6 [b]	14.7±3.7 [c]
Huang et al., 1997	128	N/A	15.4±1.4 [a]	16.5±1.1 [b]	16.2±0.9 [b]	19.6±1.2 [c]
Shih et al., 1997[f]	81	12.5±9.0*	14.7±10.6	20.4±13.8	13.1±7.2*	19.8±9.3

[1] Based on 2,000 kcal diet

[a-c] Means not sharing the same superscript are significantly different at $p<.05$ or beyond, using post-hoc Scheffe constract.

[f] Duncan's multiple range test, Precontemplation, Action vs Maintenance

* $p<.05$

Distribution of subjects across the stages of change

Table 25 shows the percentage of distribution of subjects at each stage in this study compared with results from other studies. The highest percentage was at the Maintenance stage, indicating almost half of the subjects in this study were aware of benefits of dietary fiber and willing to maintain a fiber-rich diet. In Huang's study, subjects were the participants of MSU Healthy U program who already seemed motivated to learn about a healthy lifestyle. The distribution by stages of change confirmed that assumption and revealed that the largest group was people at the Action stage. It is believed that a

voluntary, health-related mail survey is more likely to recruit respondents who are self-conscious about diet and health. Both the distributions of this study and Sporny's confirmed that assumption, because the methods used for data collection were similar. It appears that when the survey is conducted on participants of intervention programs, however, the percentage of people at the Action stage tends to be higher than that at the other stages.

Table 25
Distribution of subjects in five stages of change for fiber intake from several relevant studies

	n	Precont.	Contemplation	Preparation	Action	Maintenance
Shih et al., 1997	99	17.1%	10.1%	6%	13.1%	35.3%
Huang et al., 1997	128	0%	7.3%	22.6%	54.7%	15.3%
Sporny et al., 1995	618	7.7%	9.2%	N/A	37.8%	45.1%
Glanz et al., 1994	16,980	12.2%	28.1%	8.7%	33.4%	17.6%

Attitudes and Beliefs Questionnaire

The AB questionnaire showed a fair content validity with the three major constructs within in it accounting for 53% of the variance of subjects' response to attitudes toward fiber consumption. The AB questionnaire demonstrated ability to reveal characteristics related to fiber intake at some stages of change. The major three constructs in questionnaire—health benefits of fiber, social and environmental support, and interest in fiber-rich foods— resemble three of 10 social psychological variables in Sporny's study—perceived benefits, social modeling, and overall health concern (Sporny et al., 1995).

Subjects at the Maintenance stage in both studies reportedly perceived more health benefits of fiber and more social and environmental support to consume fiber-rich foods than their cohorts at the Precontemplation and Contemplation stage. Subjects at the Precontemplation stage were also found to have the lowest score in the construct of "interested in fiber-rich foods" in both studies.

The rank of foods based on the quantitative contribution to total fiber intake

Compared to Huang's similar analysis of dietary fiber from 3-day food record of MSU Healthy U participants (n=128)(Huang, manuscript in process), subjects in this research showed similar dietary patterns for fiber consumption. Thirteen out of 20 foods appear in Huang's list with slight difference in the order. Some less-frequently consumed foods, such as prune and refried beans, were listed in the top 20 foods because of their high fiber content.

Compared to Block and Lanza's list of dietary fiber sources in U.S.(Block et al., 1987), analyzed from NHANES II data, a different dietary pattern of fiber consumption was found in the present study. The top 1 and 2 foods on Block and Lanza's list were white bread and pinto and other dried beans, respectively, which were not in ranking of top 20 foods consumed by this population. White bread provided 11.4% of total fiber intake in NHANES II (n=11,658), but it only accounted for 1.2% in the present study. The top 1 food in the present study was apple, which accounted for 7% of total fiber intake but only 3.6% in NHANES II.

Strengths

This research has the following strengths.

1) A high sensitivity (80%) for the checklist distinguished subjects who actually had low fiber intake from those who reportedly had high intakes.
2) The short administration time of the three test instruments was good. It took less than 10 minutes to complete the checklist and both SC and AB questionnaires, based on the responses from the pilot test.
3) The study promoted awareness among respondents of dietary fiber intake, a topic often neglected in health promotion interventions.
4) Good compatibility was found among three instruments to form a validated screening package for fiber intake and readiness to increase fiber consumption in this sample.

Limitations

This research also has the following limitations.

1) There was only a moderate correlation (0.52) between the checklist and the weighted 2-day food records for fiber intake.
2) There was a small sample size, due to the poor response rate of 25%. The large proportion of respondents not answering the SC questionnaire lowered the statistical power of analysis.
3) The SC questionnaire did not go through a separate validation process.
4) The 18% of non-respondents to the SC flowchart was worrisome and must be explored further before this tool can be recommended for use.

5) The two constructs of "Childhood intake of fiber" and " Difficulty of increasing in take of fiber" had only one question each in the factor analysis, yet together accounted for nearly 20% of the variance in response to attitudes and beliefs. Future research might expand the number of questions for these two constructs so that they could be added to the scale of "Attitudes and Beliefs about Fiber".

The following reasons might be responsible for the low response rate in this study.

1) We were not able to send an official endorsement letter from the President of the CTU with the survey.
2) Incentives were not attractive enough to the target population.
3) The time-consuming 2-day food recording task reduced subject's interest.
4) Non-respondents might have had a negative influence on those who were hesitant at first and who worked within the same department, because subjects from the same department tended to be respondents or non-respondents collectively.
5) Subjects had low interest in the health benefits of dietary fiber.

Conclusion

This study demonstrated the development and validation of a new dietary assessment tool using behavioral approach. Results demonstrated that the combination of the theoretical model and brief dietary assessment was a feasible way to identify a high risk population before the intervention begins. Due to limited time, money, and resources, findings from this study must be considered preliminary and should be repeated with larger, more diverse populations than the 99 CTU's at MSU. Future research efforts might focus on:

1) The validation of the checklist with larger, more diverse populations.
2) Expanding the number of questions for the constructs—"Childhood intake of fiber" and "Difficulty increasing fiber intake"—perhaps by using responses from the open-ended questions.
3) Exploring the reasons for non-response to the flowchart SC questionnaire and redesign an usable version.
4) Developing appropriate intervention strategies for people before the Action stage.

Bibliography

ADA. Position of The American Dietetic Association: health implications of dietary fiber. J Am Diet Assoc. 1988;88:216-221.

ADA reports. Position of the American Dietetic Association: Health implications of dietary fiber. J Am Diet Assoc. 1993;93:1446-1447.

Alaimo K, McDowell MA, Briefel RR, Bischof AM, Caughman CR, Loria CM, Johnson CL. Dietary intake of vitamins, minerals,and fiber of persons ages 2 months and over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91. Advance Data, National Center for Health Statistics. No.258,Nov,1994.

Alberton AM, Tobelman RC. Consumption of grain and whole-grain foods by an American population during the years 1990 to 1992. J Am Diet Assoc. 1995;95:703-704.

Anderson JW, Akanji AO. Dietary fiber – an overview. Diabetes Care. 1991;14:1126-1131.

Anderson JW, Smith BM, Gustafson NJ. Health benefits and practical aspects of high-fiber diets. Am J Clin Nutr. 1994;59(suppl):1242S-7S.

Anderson JW, Story L, Sieling B, Chen W-JL, Petro MS, Story J. Hypocholesterolemic effects of oat-bran or bean intake for hypercholesterolemic men. Am J Nutr. 1984;40:1146-1155.

Anderson JW. Dietary fiber in the nutrition management of diabetes. In: Basic and Clinical Aspects of Dietary Fiber. G. Vahouny and D. Kritchevsky, Eds. 343-350. New York, NY: Plenum Press, 1985.

AOAC. Official methods of analysis. 15th ed. Arlington, VA, 1990.

Asp NG, Schweizer TF, Southgate DAT, Theander O. Dietary fibre analysis. In Dietary Fibre – a component of food. Nutritional function in health and disease, eds TF Schweizer & CA Edwards, pp 57-101. London: Springer Verlag., 1992.

Asp NG. Dietary fibre analysis – an overview. Eur J Clin Nutr. 1995;49:S42-S47.

Atwood JR, Aickin M, Giordano L, Benedict J, Bell M, Ritenbaugh C, Rees-McGee S, Sheehan E, Buller M, Ho EE, Meysken FL, Albert D. The effectiveness of adherence intervention in a colon cancer prevention field trial. Prev Med. 1992;21:617-53.

Baghurst KI, Record SJ, Baghurst PA, Syrette JA, Crawford D, Worsley A. Socio-demographic determinants in Australia of the intake of food and nutrients implicated in cancer epidemiology. Med J Aust. 1990;153:444-452.

Baranowski T, Simons-Morton BG. Dietary and physical activity assessment in school-aged children: Measurement issues. J School Health. 1991;61:195-196.

Block G, Clifford C, Naughton D, Henderson M, McAdams M. A brief dietary screen for high fat intake. J Nutr Educ. 1989;21:199-207.

Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnaire design and testing. Am J Epidemiol. 1986;124:453-469.

Block G, Hartman AM. Issues in reproducibility and validity of dietary studies. Am J Clin Nutr. 1989;59:1133-1138.

Block G, Lanza E Dietary fiber sources in the United States by demographic group. J Natl Cancer Inst. 1987;79(1):83-91.

Block G. Health habits and history questionnaire: Diet history and other risk factors. Bethesda, MD.: National Cancer Institute, 1988.

Block G. Human dietary assessment: Methods and issues. Prev Med. 1989;18:653-660.

Block G. Validations of dietary assessment methods. Am J Epidemiol. 1982;115:492-505.

Boeing H, Wahrendorf J, Heinemann L, Kulesza W, Rywik SL, Sznajd J, Thiel C. Results from a comparative dietary assessment in Europe. I. Comparison of dietary information derived from concurrently applied frequency questionnaires and quantitative measurement instruments. Eur J Clin Nutr. 1989;43:367-377.

Bridges SR, Anderson JW, Deakins DA, Dillon DW, Wood CL. Oat bran increases serum acetate of hypercholesterolemic men. Am J Clin Nutr. 1992;56:455-459.

Brinberg D, Axelson ML. Increasing the consumption of dietary fiber: A decision theory analysis. Health Educ Res. 1990;5:409-420.

Brodribb AJM. Dietary fiber in diverticular disease of the colon. In Spiller G.A. and Kay R.M., eds.: Medical Aspects of Dietary Fiber. New York, NY: Plenum Press, 1980.

Brownell KD, Cohen LR. Adherence to dietary regimens 2: Components of effective interventions. Behav Med. 1995;20:155-164.

Bunch KL. 1989 California dietary practices survey, focus on fruits and vegetables highlights, nutrition and cancer prevention program, California Dept. of Health Services, California Public Health Foundation. Nutrition and cancer prevention program, Sacramento, CA., 1990.

Burkitt DP, Trowell HC. Refined carbohydrate foods and disease. Some implications of dietary fibre. London, England: Academic Press, 1975.

Campbell MK, DeVellis BM, Strecher VJ, Amerman AS, DeVellis RF, Sandler RS. Improving dietary behavior: The effectiveness of tailored messages in primary care settings. Am J Public Health. 1994;84:783-7.

Carmines G, Zeller A. Reliability and validity assessment. Beverly Hills, CA.:Sage,1979.

Carruth BR, Anderson HL. Scaling criteria in developing and evaluation an attitude instrument. J Am Diet Assoc. 1977;70:42-50.

Chenoweth WL, Bennick HR. Hypocholesterolaemic effect of oat fibre. Fed Proc. 1976;35:495.

Comi D, Brugnani M, Gianino A. Metabolic effects of hypocaloric high-carbohydrate/high-fibre diet in non-insulin dependent diabetic patients. Eur J Clin Nutr. 1995;49:S242-S244.

Contento I, Murphy BM. Psycho-social factors differentiating people who reported making desirable change in their diets from those who did not. J Nutr Educ. 1990;22:6-14.

Contento IR, Maksymowicz-Murphy B. Psycho-social factors differentiating people who reported making desirable changes in their diets from those who did not. J Nutr Educ. 1990;22:6-14.

Contento IR. Theoretical frameworks or models for nutrition education. J Nutr Educ. 1995;27:287-292.

Cotugna N, Subar AF, Heimendinger J, Kahle L. Nutrition and cancer prevention knowledge,beliefs, attitudes, and practices: The 1987 National Health Interview Survey. J Am Diet Assoc. 1992;92:963-968.

Cummings JH, Branch WJ. Postulated mechanisms whereby fibre may protect againtst large bowel cancer. In Dietary fibre in health and disease, eds G Vahouny &D Kritchevsky, pp 313-325. Plenum: New York, NY, 1982.

Curry SJ, Kristal AR, Bowen DJ. An application of the stage model of behavior change to dietary fat reduction. Health Educ Res. 1992;7:97-105.

DiClemente CC, Hughes SO. Stages of change profiles in alcoholism treatment. J Subst Abuse Treat. 1990;2:217-235.

DiClemente CC, Prochaska JO, Fairhurst SK, Velicer WF, Velasquez MM, Rossi JS. The process of smoking cessation: An analysis of precontemplation, contemplation and preparation stages of change. J Consult Clin Psych. 1991;59:295-304.

Dittus KL, Hiller VN, Beerman KA. Benefits and barriers to fruit and vegetable intake: Relationship between attitudes and consumption. J Nutr Educ. 1995;27:120-126.

Dreher ML. Handbook of dietary fiber. New York, NY.: Marcel Dekker, 1987.

Eastwood MA, Passmore R. Dietary Fibre. Lancet. 1983;July:202-206.

Eastwood MA. The physiological effect of dietary fiber: An update. Annu Rev Nutr. 1992;12:19-35.

Ershoff, DH, Mullen PD, Quinn VP. A randomized trial of serialized self-help smoking cessation program for pregnant women in an HMO. Am J Public Health. 1989;79:182-187.

FDA. Fed Register. 1993;58:2302-2964.

Frølich W. Bioavailability of micronutrients in a fibre-rich diet, especially related to minerals. Eur J Clin Nutr. 1995;49:S116-S122.

Frazao B, Cleveland L. Diet-health awareness about fat and cholesterol—only a start. Foodreview. 1994;Jan-Apr:15-22.

Glanz K, Eriksen M. Individual and community models for dietary behavior change. J Nutr Educ. 1993;25:80-6.

Glanz K, Kristal AR, Sorensen G, Palombo R, Heimendinger J, Probart C. Development and validation of measures of psychosocial factors influencing fat- and fiber-related dietary behavior. Prev Med. 1993;22:373-387.

Glanz K, Lewis FM, Rimer BK. Health Behavior and Health Education: theory research and practice. San Francisco, CA: Jossey-Bass Publishers, 1990.

Glanz K, Mullis RM. Environmental interventions to promote healthy eating: A review of models, programs, and evidence. Health Educ Q. 1988;15:395-415.

Glanz K, Patterson RE, Kristal AR, DiClemente CC, Heimendinger J, Linnan L, McLerran DF. Stages of change in adopting healthy diets: Fat, fiber, and correlates of nutrient intake. Health Educ Q. 1994;21:499-519.

Glasgow RE, Perry JD, Toobert DJ, Hollis JF. Brief assessments of dietary behavior in field settings. Addict Behav. 1996;21:239-247.

Greene GW, Rossi SR, Reed GR, Willey C, Prochaska JO. Stages of change for reducing dietary fat to 30% of energy or less. J Am Diet Assoc. 1994;94:1105-1110.

Greenberg RS, Daniels SR, Flanders D, Eley JW, Boring JR. Medical epidemiology. 1st ed. Appleton & Lange:Norwalk, Conn., 1993.

Guyatt G, Walter S, Norman G. Measuring change over time: Assessing the usefulness of evaluative instruments. J Chron Dis. 1987;40:171-8.

Haber GB, Heaton KW, Murphy D. Depletion and disruption of dietary fibre: Effects on satiety, plasma-glucose, and serum-insulin. Lancet. 1977;ii:679-682.

Havas S, Heimendinger J,Damron D, Nicklas TA, Cowan A, Beresford SAA, Sorensen G, Buller D, Bishop D, Baranowski T, Reynolds K. 5 A Day for Better Health-- Nine community research projects to increase fruit and vegetable consumption. Public Health Reports. 1995;110:68-79.

Healthy People 2000: National health promotion and disease prevention objectives. Washington, DC: U.S. Dept. of Health and Human Services, Public Health Services; 1990.

Heimendinger J. Community nutrition intervention strategies for cancer risk reduction. Cancer. 1993;72:1019-23.

Hill MJ, Crowther JS, Drasar BS, Hawksworth G, Aries V, Williams REO. Bacteria and the aetioloty of cancer of the large bowel. Lancet. 1971;95-100.

Hipsley EH. Dietary "fibre" and pregnancy toxaemia. Br Med J. 1953;2:420-422.

Hjollund E, Pederson O, Richelsen B, Beck-Nielson H, Sorenson NS. Increased insulin binding to adipocytes and monocytes and increased insulin sensitivity of glucose transport and metabolism in adipocytes from non-insulin dependent diabetics after low-fat/high-starch/high-fiber diet. Metabolism. 1983;32:1067-1075.

Holland D, Welch A, Unwin I, Duss D, Paul A, Southgate D. McCance and Widdowson's The Composition of Foods. 5th ed. Cambridge, UK: Royal Society of Chemistry, 1991.

Huang YL, Song WO, Schemmel RA, Hoerr SM. What do college students eat? Food selection and meal pattern. Nutr Res. 1994;14:1143-1153.

Huang YL. Dietary change of women after the worksite nutrition programs predicted by blood lipids, BMI, dietary intakes, stages of change and psychosocial factors. Manuscript in process, 1997.

Hunter JE. Cluster analysis: Reliability, construct validity, and the multiple indicators approaches to measurement. Presented at a workshop titled "Advanced Statistics" given at the U.S. Civil Services commission, 1977.

ILSI (International Life Science Institute). Dietary fibre: Nutritional function in health and disease. Washington, D.C., 1995.

Jacobs LR. Effect of dietary fiber on colon cell proliferation and its relationship to colon carcinogenesis. Prev Med. 1987;16:566-571.

Jain M, Howe GR, Rohan T. Dietary assessment in epidemiology: Comparison of a food frequency and a diet history questionnaire with a 7-day food record. Am J Epidemiol. 1996;143:953-960.

Jenkins DJA, et al. Dietary fiber and bloods: treatment of hypercholesterolemia with guar crisbread. Am J Clin Nutr. 1979;33:575-581.

Jenkins DJA, et al. Dietary fibre and blood lipids: reduction of serum cholesterol in Type II hyperlipidemia by guar gum. Am J Clin Nutr. 1980;32:16-18.

Jenkins DJA, Wolever TMS, Vuksan V, Brighenti F, Cunnane SC, Rao AV, Jenkins AL, Buckley G, Patten R. Singer W, Corey P, Josse RG. Nibbling versus gorging: metabolic advantages of increased meal frequency. N Engl J Med. 1989;321:929-934.

Jensen J, Counte MA, Glandon GL. Elderly health beliefs, attitudes and maintenance. Prev Med. 1992;21: 483-97.

Johnson DW, Johnson RT. The process of nutrition education: a model for effectiveness, a synthesis of research. J Nutr Educ. 1985;17:S1-44.

Johnson SB, Freund A, Silverstein J, Hansen CA, Malone J. Adherence-health status relationships in childhood diabetes. Health Psych. 1990;9:606-631.

Kaaks R, Riboli E. Colorectal cancer and intake of dietary fibre. A summary of the epidemiological evidence. Eur J Clin Nutr. 1995;49:S10-S17.

Kay RM, Strasberg SM, Peetruka CN, Wayman M. Differential absorption of bile acids by lignins. In Inglett GE and Falkenhag SI eds.: Dietary fibres, Chemistry and Nutrition. New York, NY:Academic Press, 1979.

Klurfeld DM. Dietary fiber-mediated mechanisms in carcinogenesis. Cancer Res. 1992;52:2055s-2059s.

Krebs-Smith SM, Cronin FJ, Haytowitz DB, Cook DA. Food sources of energy macronutrients, cholesterol, and fiber in diets of women. J Am Diet Assoc. 1992;92:168-174.

Kristal AK, Bowen DJ, Curry SJ, Shattuck AL, Henry HJ. Nutrition knowledge, attitudes and perceived norms as correlates of selecting low-fat diets. Health Educ Res. 1990;5:467-477.

Kristal AR, Beresford SA, Lazovich D. Assessing change in diet-intervention research. Am J Clin Nutr. 1994;59(suppl):185s-9s.

Kristal AR, Patterson RE, Glanz K, Heimendinger J, Hebert JR, Feng Z, Probart C. Psychosocial correlats of healthful diets: Baseline results from the Working Well Study. Prev Med. 1995;24:221-228.

Kristal AR, Shattuck AL, Henry HJ, Fowler AS. Rapid assessment of dietary intake of fat, fiber, and saturated fat: Validity of an instrument suitable for community intervention research and nutritional surveillance. Am J Health Prom. 1990;4:288-295.

Kristal AR, Shattuck AL, Henry HJ. Patterns of dietary behavior associate with selecting diets low in fat: Reliability and validity of a behavioral approach to dietary assessment. J Am Diet Assoc. 1990;90:214-20.

Kritchevsky D, Story JA. Binding of bile salts in vitro by non nutritive fibre. J Nutr. 1974;104:458-464.

Kushi LH, Folsom AR, Jacobs DR, Luepker RV, Elmer PJ, Blackburn H. Educational attainment and nutrient consumption patterns: The Minnesota Heart Survey. J Am Diet Assoc. 1988;88:1230-1236.

Laforge RG, Greene GW, Prochaska JO. Psychosocial factors influencing low fruit and vegetable consumption. J Behav Med. 1994;17:361-374.

Lanza E, Jones DY, Block G, Kessler L. Dietary fiber intake in the U.S. population. Am J Clin Nutr. 1987;46:790-797.

Lee SC, Prosky L. International survey on dietary fiber: Definition, analysis, and reference materials. J AOAC Int. 1995;78:22-36.

Levy AS, Fein SB, Stephenson M. Nutrition knowledge levels about dietary fats and cholesterol: 1983-1988. J Nutr Educ. 1993;25:60-6.

Li BW. Determination of total dietary fiber in foods and food products by using a single-enzyme, enzymatic-gravimetric method: Interlaboratory study. J AOAC Int. 1995;78:1440-1444.

Lindegarde F, Larsson L. Effects of a concentrated bran fibre separation on HDL-cholesterol in hypocholesterolaemic men. Hum Nutr Clin Nutr. 1984;38C:39.

Lwanga SK, Lemeshow S. Sample size determination in health studies: A practical manual. World Health Organization; Geneva, 1991.

MacLennan R, Jensen OM, Mosbech J, Vuori H. Diet, transit time, stool weight, and colon cancer in two Scandinavian populations. Am J Clin Nutr. 1978;31:s239-s242.

Manhire A, Henry CL, Hartog M, Heaton KW. Unrefined carbohydrates and dietary fibre in treatment of diabetes mellitus. J Hum Nutr. 1981;35:99-101.

Marcus BH, Banspach SW, Lefebvre RC, Rossi JS, Carleton RA, Abrams DB. Using the stages of change model to increase the adoption of physical activity among community participants. Am J Health Promot. 1992;6:424-429.

Margetts BM, Beilin LJ,Armstrong BK, Vandongen R. Vegetarian diet in mild hypertension: effects of fat and fiber. Am J Clin Nutr. 1988;48:801-5.

Marlett JA. Content and composition of dietary fiber in 117 frequently consumed foods. J Am Diet Assoc. 1992;92:175-186.

McConnaughy EA, Prochaska JO, Velicer WF. Stages of change in psychotherapy: Measurement and sample profiles. Psychotherapy: Theory, Research, and Practice. 1983;20:368-375.

Modan B, Barell V, Lubin F, Modan M, Greenberg RA, Graham S. Low fiber intake as an etiologic factor in cancer of the colon. J Nat Cancer Inst. 1975;55:15-18.

National Cancer Institute. Cancer control objectives for the nation: 1985-2000. Washington, DC: US Dept of Health and Human Services; 1986. NIH publication 86-2880, no.2.

National Research Council. Committee on Diet and Health, Food and Nutrition Board. Diet and health. Implications for reducing chronic disease risk. Washington DC: National Academy Press, 1989.

National Research Council. Recommended Dietary Allowances. 10th edition. Washington, DC: National Academy Press, 1989.

Nicklas TA, Farris RP, Myers Leann, Berenson GS. Dietary fiber intake of children and young adults: The Bogalusa Heart Study. J Am Diet Assoc. 1995;95:209-214.

Norcross JC, Prochaska JO, Hambrecht M. Treating ourselves vs. Treating our clients: A replication with alcohol abuse. J Subst Abuse Treat. 1991;3:123-129.

Nuttall FQ, Brunzell JD Principles of nutrition and dietary recommendations for individuals with diabetes mellitus. J Am Diet Assoc. 1979;75:527-530.

Ockene JK, Kristeller JL, Goldberg R, Ockene I, Merriam P, Barrett S, Pekow P, Hosmer D, Gianelly R. Smoking cessation and severity of disease: The Coronary Artery Smoking Intervention Study. Health Psychol. 1992;11:119-126.

Ockene JK, Ockene IS. Helping patients to reduce their risk for coronary heart disease: an overview. In Ockene IS, Ockene JK eds. Prevention of Coronary Heart Disease. Boston, Mass.: Little, Brown; 1990.

O'Connell DO, Velicer WF. A decisional balance measure of the stages of change model for weight loss. Int J Addict. 1988;23:729-740.

Patrick D, Elinson J. Methods of sociomedical research. Handbook of medical sociology. In Freeman H, Levin S, Reeder L eds. Prentice-Hall, Inc., Englewood Cliffs, NJ.:1979.

Patrick DL, Beery WL. Measurement issues: Reliability and validity. Am J Health Promov. 1991;5:305-310.

Patterson RE, Haines PS, Popkin BM. Diet Quality Index: Capturing a multidimensional behavior. J Am Diet Assoc. 1994;94:57-64.

Pennington JA. Bowes and Church's food values of portions commonly used. 15th ed. New York, NY: Harper & Row, Publishers, 1989.

Pilch SM. Physiologic effects and health consequences of dietary fiber. Life Science Research Office, Bethesda, MD: Federation of American Societies for Experimental Biology, 1987.

Prochaska JO, DiClemente CC. Stages and processes of self-change in smoking: Toward an integrative model of change. J Consult Clin Psychol. 1983;5:390-395.

Prochaska JO, DiClemente CC. Towards a comprehensive model of change. In Miller W and Heather N eds. Treating addictive behaviors, Plenum Press, New York, NY.,1986.

Prochaska JO, DiClemente CC. Common processes of self-change in smoking, weight control, and psychological distress. In S. Shiffman & TA Wills (Eds.), Coping and Substance Use. San Diego, CA: Academic Press, 1985.

Prochaska JO, DiClemente CC. Stages of change in the modification of problem behaviors. In Hersen M, Eisler RM, Miller PM eds.: Progress in Behavior Modification. Sycamore, Ill.: Sycamore Press, 1992.

Prochaska JO, DiClemente CC. The transtheoretical approach: Crossing traditional boundaries of therapy. Melbourne, FL.:Krieger., 1991.

Prochaska JO, DiClemente CC, Norcross JC. In search of how people change: application to addictive behaviors. Am Psycho. 1992;47:1102-1114.

Prochaska JO, DiClemente CC. Transtheoretical therapy: Toward a more integrative model of change. Psychotherapy. 1982;20:161-173.

Prochaska JO, Norcross JC, Fowler JL, Follick MJ, Abrams DB. Attendance and outcome in a work site weight control program: Processes and stages of change as process and predictor variables. Addict Behav. 1982;7:133-142.

Prochaska JO, Velicer WF, DiClemente CC, Fava JL. Measuring processes of change: Applications to the cessation of smoking. J Consult Clin Psych. 1988;56:520-528.

Prochaska JO. Self-change processes, self-efficacy and self-concept in relapse and maintenance of cessation of smoking. Psych Reports. 1982;51:983-990.

Prochaska, JO, Norcross JC, DiClemente CC. Changing for Good. New York, NY. William Morrow and Co. Inc. 1994.

Prosky L, Asp NG, Furda I, Devries JW, Schwezer TF, Harland BF. Determination of total dietary fiber in foods, food products, and total diets: Interlaboratory study. J Assoc Off Anal Chem. 1984;67:1044-1051.

Pusateri DJ, Roth WT, Ross JK, Shultz TD. Dietary and hormonal evaluation of men at different risks for prostate cancer: plasma and fecal hormone-nutrient interrelationships. Am J Clin Nutr. 1990;51:371-7.

Putnam JJ. American eating habits changing: Part 2, Grains, vegetables, fruit, and sugars. FoodRev. 1994;17:36-48.

Rhoades R, Pflanzer R. Human physiology. 2nd ed. New York, NY: Saunders College Publishing, 1992.

Rosenstock IM. The Health Belief Model and preventive health behavior. Health Educ Monographs. 1974;2:354-386.

Ross JK, Pusateri DJ, Shultz TD. Dietary and hormonal evaluation of men at different risks for prostate cancer: fiber intake, excretion, and composition, with in vitro evidence for an association between steroid hormones and specific fiber components. Am J Clin Nutr. 1990;51:365-70.

Rossi SR, Greene GW, Reed G, Prochaska JO, Velicer WF, Rossi JS. A comparison of four Stage of Change algorithms for dietary fat reduction. Presented at the Society for Behavioral Medicine Annual Meetings, San Francisco, CA., March, 1993.

Saba A, D'Amicis A, Turrini A. Evaluation of a fibre questionnaire using weighed records. Eur J Clin Nutr. 1995;49:S135-S138.

Saltzer EB. Locus of control and the intention to lose weight. Health Educ Monographs. 1978;6:118-28.

Samet JM, humble CG, Skipper BE. Alternatives in the collection and analysis of food frequency interview data. Am J Epidemiol. 1984;120:572-581.

Sandoval WM, Heller KE, Wiese WH, Childs DA. Stage of Change: A model for nutrition counseling. Top Clin Nutr. 1994;9:64-69.

Schlamowitz P, Halberg T, Warnoe O, Wilstrup F, Ryttig K. Treatment of mild to moderate hypertension with dietary fibre. Lancet. 1987;ii:622-3.

Schneeman BD. Dietary fiber: physical and chemical properties, methods of analysis and physiological effects. Foods Tech. 1986;40:104-110.

Schneeman BO, Lefevre M. Effectsof fibre on plasma lipoprotein composition. In Dietary fibre: basic and clinical aspects, eds GV Vahony & D Kritchevsky, pp 309-331. New York, NY: Plenum Press, 1985.

Schwarzer R. Self-efficacy in the adoption and maintenance of health behaviors: theoretical approaches and a new model. In: Schwarzer R, ed. Self-efficacy: thought control of action. Washington, DC: Hemisphere Publishing, 1992.

Selvendran RR, DuPont MS. Analysis of dietary fibre. In Developments in food analysis techniques, ed RD King, pp 1-68. London: Applied Science, 1984.

Shelton DL. How people change. Am Med News. 1995;Jan:9-10.

Shinnick FL, Hess RD, Fischer MH, Marlett J. Apparent nutrient absorption and upper gastrointestinal transit with fiber-containing internal feedings. Am J Clin Nutr. 1989;49:471-475.

Sigman-Grant M. Stages of change: A framework for nutrition interventions. Nutrition Today 1996;31:162-170.

Smallwood DM, Blaylock JR. Fiber: Not enough of a good thing? Foodreview. 1994;Jan-Apr:23-29.

Smith AF, Jobe JB, Mingay DJ. Question-induced cognitive biases in reports of dietary intake by college men and women. Health Psychol. 1991;10:244-51.

Smith AM, Baghurst K, Owen N. Socioeconomic status and personal characteristics as predictors of dietary change. J Nutr Educ. 1995;27:173-181.

Smith AM, Baghurst KI. Public health implications of dietary differences between social status and occupational category groups. J Epidemiol Comm Health. 1992;46:409-416.

Smith AM, Owen N. Associations of social status and health-related beliefs with dietary fat and fiber densities. Prev Med. 1992;21:735-45.

Southard DR, Winett RA, Walberg-Rankin JL et al. Increasing the effectiveness of the National Cholesterol Education Program: Dietary and behavioral interventions for clinical settings. Ann Behav Med. 1992;14:21-30.

Southgate DAT. Definitions and terminology of dietary fiber. In Vahouny GV, and Kritchevsky D eds.: Dietary fiber in health and disease. New York, N.Y.: Plenum Press, 1982.

Sporny LA, Contento IR. Stages of change in dietary fat reduction: Social psychological correlates. J Nutr Educ. 1995;27:191-199.

Subar AF, Thompson FE, Smith AF, Jobe JB, Ziegler RG, Potischman N, Schatzkin A, Hartman A, Swanson C, Kruse L, Hayes RB, Riedel-Lewis D, Harlan LC. Improving food frequency questionnaires: A qualitative approach using cognitive interviewing. Am J Diet Assoc. 1995;95:781-788.

Subar AS, Heimendinger J, Krebs-Smith SM, Patterson BH, Kessler R, Pivonka E. 5-A-Day for better health. A baseline study of American's fruit and vegetable

consumption, National Cancer Institute, National Institutes of Health, Rockville, MD., 1992.

Trenkner LL, Rooney B, Viswanath K, Baxter J, Elmer P, Finnegan JR. Development of a scale using nutrition attitudes for audience segmentation. Health Educ Res. 1990;5:479-487.

Trowell H, Southgate DA, Wolever TM. Dietary fibre redefined. Lancet. 1976;1:967.

U.S. Department of Agriculture. Nutrient Database for Individual Food Intake Surveys. Release 4. Washington, D.C., 1990.

U.S. Department of Agriculture. Composition of Food: Raw, Processed, Prepared Agric. Handbook No. 8. Washington, D.C., 1990.

Vega WA, Sallis JF, Patterson TL, Rupp JW, Morris JA, Nader PR. Predictors of dietary change in Mexican American families participating in a health behavior change program. Am J Prev Med. 1988;4:194-9.

Venter CS, Vorster HH. Possible metabolic consequences of fermentation in the colon for humans. Med Hypoth. 1989;29:161-166.

Weisburger JH. On the mechanisms relevant to nutritional carcinogenesis. Prev Med. 1987;16:586-591.

Willett WC, Reynolds RD, Cottrell-Hoehner S, Sampson L, Browne ML. Validation of a semi-quantitative food frequency questionnaire: Comparison with a 1-year diet record. J Am Diet Assoc. 1987;87:43-47.

Willett WC, Sampson L, Stampfer MJ, Rosner B, Bain C, Witschie J, Hennekens CH, Speizer FE. Reproducibility and validity of a semiquantitative food frequency questionnaire. Am J Epidemiol. 1985;122:51

Willett WC. Nutritional Epidemiology. New York, NY: Oxford University Press, 1990.

Wright A, Burstyn PG, gibney MI. Dietary fibre and blood pressure. Br Med J 1979;ii:1541-43.

Young LR, Nestle M. Portion sizes in dietary assessment: Issues and policy implications. Nutr Rev. 1995;53:149-158.

Appendices

Appendix A

MICHIGAN STATE
UNIVERSITY

September 18, 1996

TO: Sharon Hoerr
204 GM. Trout Building
Michigan State University

RE: IRB#: 95-471
TITLE: THE APPLICATION OF STAGES OF CHANGE THEORY ON IMPROVEMENT OF SOLUABLE AND INSOLUABLE DIETARY FIBER INTAKE
REVISION REQUESTED: 08/21/96
CATEGORY: 1-C
APPROVAL DATE: 09/18/96

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete. I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project and any revisions listed above.

RENEWAL: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Investigators planning to continue a project beyond one year must use the green renewal form (enclosed with the original approval letter or when a project is renewed) to seek updated certification. There is a maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB # and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/ CHANGES: Should either of the following arise during the course of the work, investigators must notify UCRIHS promptly: (1) problems (unexpected side effects, complaints, etc.) involving human subjects or (2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of any future help, please do not hesitate to contact us at (517)355-2180 or FAX (517)432-1171.

Sincerely,

David E. Wright, Ph.D.
UCRIHS Chair

DEW:bed

Appendix B

September 28, 1996

Dear MSU CTUs:

The importance of dietary fiber to prevent several chronic diseases—including colonic cancer, diverticular disease, diabetes, etc.—has been mentioned in various publications. However, the U.S. public seems less concerned about fiber than about fat in their diets. To promote the awareness of its health benefits by increasing daily fiber intake, we are going to conduct a survey about your readiness to change fiber consumption. Some of you will receive a package of short questionnaires via campus mail next week. We also will enclose a $1 coupon for MSU dairy store in the package and offer a $25 value of dietary assessment to express our appreciation for your participation. This survey has been granted by MSU Healthy U Committee and received the permission from the President of MSU CTU.

Best Regards

Sharon Hoerr, RD., Ph.D.
Associate Professor
Dept. of Food Science and Human Nutrition(FSHN)

Won Song, RD., Ph.D.
Associate Professor
Dept. of FSHN

Ralph Levine, Ph.D.
Professor
Dept. of Psychology

Appendix C

Consent Form

The purpose of this study is to develop and validate: 1) a short checklist to assess intake of dietary fiber; 2) a flowchart to determine where you at relative to dietary fiber intake; 3)a questionnaire to assess your attitudes and behaviors related to dietary fiber; and 4) your ideas about how to increase the intake of fiber-rich foods. It will take you about 10-15 minutes to complete all three instruments. You are of course free to refuse to answer any question that makes you uncomfortable.

We are also asking you to provide a 2-day record of the foods you eat for our cross-reference. All of the data you provide for the questionnaires and dietary records will be analyzed confidentially. Only the research team will have access to the original data and no individuals will be identified by name.

To express our appreciation for your consideration and , we hope your cooperation, a $2.00 coupon for the MSU Dairy Store is enclosed for your use, whether or not you complete and return the forms. In addition, a free analysis of your diet (a $25.00 value) is available for you if you check the box on the sheet of ow to fill out the food record form".

If you have any questions, please contact Collin Shih at 355-1010 or via e-mail at shihjenh@pilot.msu.edu or Sharon Hoerr RD, Ph.D. at 355-7701 or 20533sgh@ibm.msu.edu. this study is part of the MSU Healthy U Program. Your participation is appreciated as we work to improve the program.

If you agree to participate in this research, please sign your name on the line

_____ _____

(Name) (Date)

Note: Please return this form with your completed instruments. Thanks!

Appendix D

November 18, 1996

Dear MSU CTU:

Two weeks ago, we mailed you a set of questionnaires about your dietary fiber intake. We are still looking forward to your response. Enclosed is another set of the questionnaires in case you cannot find the originals. This will be our last contact with you, so please take a few minutes to help us acquire valuable perspectives from you to design health promotion programs. Thanks for your cooperation ! if you do not plan to participate, please return the blank questionnaires to us and mark "Regrets" on the top.

Sincerely

Sharon Hoerr, RD., PhD.
Collin Shih

Department of Food Science and Human Nutrition
Michigan State University

Appendix E

Check your dietary fiber intake

Please write in the number of servings you had of following foods over last month.
If you ate less than once a week, leave blank.

	Daily	Times/wk
Fruits: (1 serv=1/2 cup/ 1 piece)		
apple	( )	( )
banana	( )	( )
berries	( )	( )
grapes	( )	( )
melon	( )	( )
orange	( )	( )
peach/nectarine	( )	( )
pear	( )	( )
prunes/plum	( )	( )
raisins	( )	( )
other_____	( )	( )
Vegetables, cooked or raw: (1 serv=1/2 cup)		
broccoli	( )	( )
Brussels sprouts	( )	( )
carrots	( )	( )
cauliflower	( )	( )
celery	( )	( )
corn	( )	( )
French fries	( )	( )
green beans	( )	( )
lettuce	( )	( )
potato	( )	( )
spinach	( )	( )
summer squash (zucchini)	( )	( )
tomato	( )	( )
tossed salad	( )	( )
other_____	( )	( )
Beans, legumes: (1 serv=1/2 cup)		
baked beans	( )	( )
green peas	( )	( )
kidney beans	( )	( )
lima beans	( )	( )
refried beans	( )	( )
other_____	( )	( )

	Daily	Times/wk
Breads, grain and pasta: (1 serv=1/2 cup/ 1 slice)		
brown rice	( )	( )
noodles	( )	( )
pasta or spaghetti	( )	( )
white bread	( )	( )
whole-wheat bread	( )	( )
other_____	( )	( )
Nuts: (1 serv=1/4 cup or 4 Tbsp)		
peanut butter	( )	( )
peanuts	( )	( )
walnuts	( )	( )
other_____	( )	( )
Snack foods:		
bagel (1 whole)	( )	( )
chips (10 chips or 1 oz)	( )	( )
crackers (4-6 pc)	( )	( )
pizza (1 slice of 16")	( )	( )
popcorn (2 cups)	( )	( )
tortillas (1 whole)	( )	( )
other_____	( )	( )
Cereals: (1 serv=1 cup)		
bran cereals	( )	( )
granola	( )	( )
oatmeal	( )	( )
whole grain cereals	( )	( )
other_____	( )	( )

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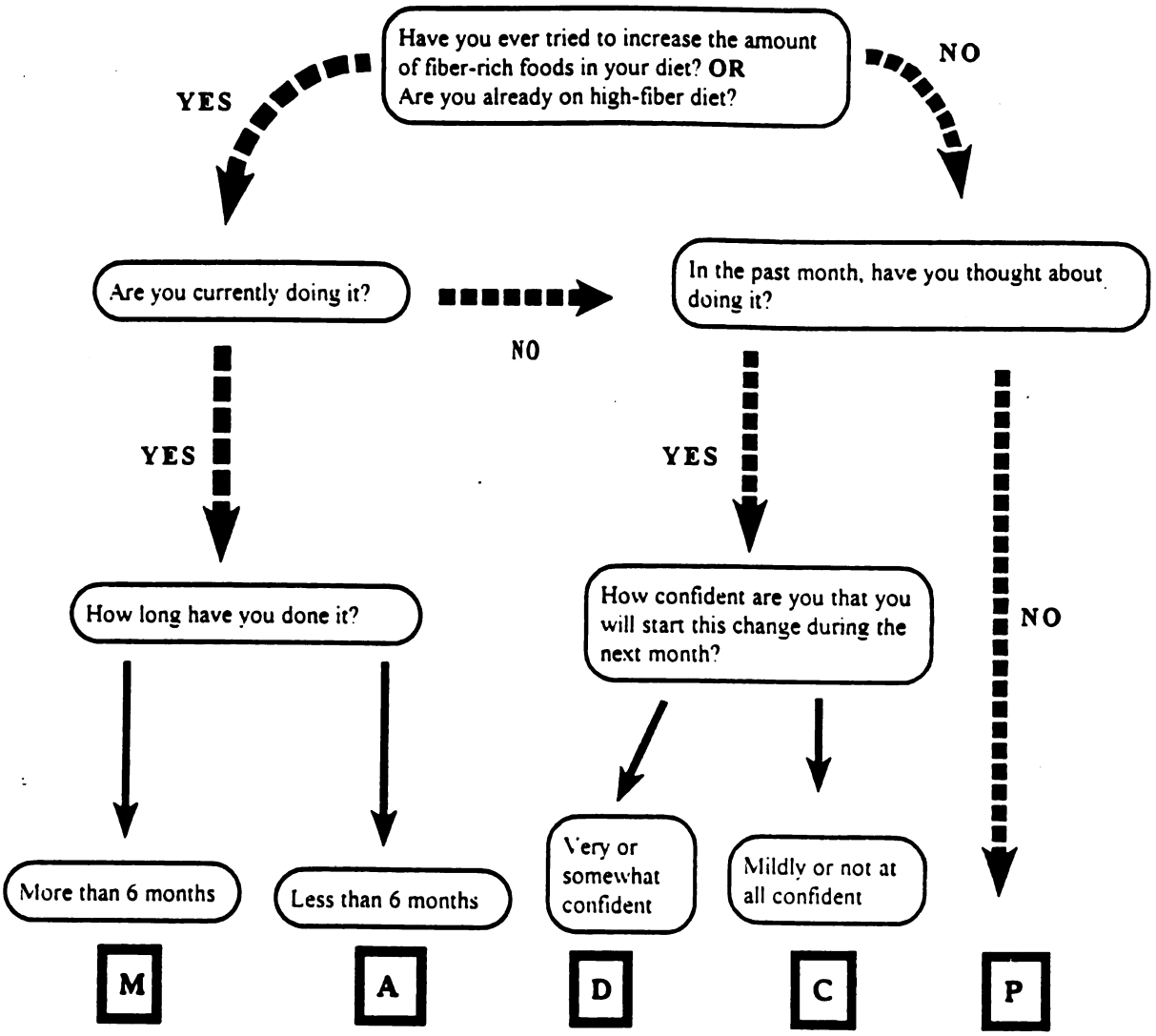
Appendix F

Find the direction of your dietary fiber intake

Fiber-rich foods mean fruits, vegetables, beans, nuts, and high-fiber cereals. Tomato sauce, refried beans, and salsa are also included. Follow the direction of the arrows with your response, and circle a letter at the bottom.



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Michigan State University, 1996

Appendix G

What do you think about fiber-rich foods ?

Again, ***fiber-rich foods*** mean fruits, vegetables, nuts, beans, whole grain breads, and high-fiber cereals

	Strongly Disagree				Strongly Agree
1. Eating a lot of fiber-rich foods decreases my chances of getting serious diseases such as cancer and heart disease.	1	2	3	4	5
2. What I eat is important for my health.	1	2	3	4	5
3. Fiber-rich foods taste good.	1	2	3	4	5
4. I ate a lot of fiber-rich foods when I was growing up.	1	2	3	4	5
5. I've gotten a lot of advice about how to eat fiber-rich foods.	1	2	3	4	5
6. My friends encourage me to eat fiber-rich foods.	1	2	3	4	5
7. My family encourages me to eat fiber-rich foods.	1	2	3	4	5
8. It is easy to select fiber-rich foods when I eat out.	1	2	3	4	5
9. Eating fiber-rich foods is important.	1	2	3	4	5
10. I'm willing to try a new food if it is fiber-rich.	1	2	3	4	5
11. It is hard to increase my intake of fiber-rich foods.	1	2	3	4	5
12. I can increase intake of fiber-rich foods in next 6 months.	1	2	3	4	5
13. I can be healthy, if I eat fiber-rich foods.	1	2	3	4	5

Your feedback to following questions will help Healthy U improve its program.

1 What could you do to increase your intake of dietary fiber?

2. What keeps you from eating more fiber-rich foods?

When you are done with this page, please fold, staple and put it in campus mail.
Then please complete the two days food records.

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