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Review article

Dietary fiber and body weight

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Abstract

Objective: This review provides an update of recent studies of dietary fiber and weight and includes a discussion of potential mechanisms of how dietary fiber can aid weight loss and weight maintenance.

Methods: Human studies published on dietary fiber and body weight were reviewed and summarized. Dietary fiber content of popular low-carbohydrate diets were calculated and are presented.

Results: Epidemiologic support that dietary fiber intake prevents obesity is strong. Fiber intake is inversely associated with body weight and body fat. In addition, fiber intake is inversely associated with body mass index at all levels of fat intake after adjusting for confounding factors. Results from intervention studies are more mixed, although the addition of dietary fiber generally decreases food intake and, hence, body weight. Many mechanisms have been suggested for how dietary fiber aids in weight management, including promoting satiation, decreasing absorption of macronutrients, and altering secretion of gut hormones.

Conclusion: The average fiber intake of adults in the United States is less than half recommended levels and is lower still among those who follow currently popular low-carbohydrate diets, such as Atkins and South Beach. Increasing consumption of dietary fiber with fruits, vegetables, whole grains, and legumes across the life cycle is a critical step in stemming the epidemic of obesity found in developed countries. The addition of functional fiber to weight-loss diets should also be considered as a tool to improve success.

Keywords: Dietary fiber; Weight maintenance; Weight loss

Introduction

The increasing prevalence of obesity in the United States population and associated morbidity compels us to develop dietary strategies to combat the problem. Although it is well known that excess calorie intake is the primary dietary cause, alterations in food patterns or nutrients must be considered. Dietary guidance universally recommends diets higher in fiber for health promotion and disease prevention, but there are inconsistencies in the literature on the relation of dietary fiber to body weight. The first goal of this review is to describe the challenges in measuring dietary fiber intake in studies and describe recent developments in dietary fiber definitions and recommendations. Second, epidemiologic studies on the role of fiber in weight maintenance will be summarized. Third, intervention studies on dietary fiber and weight loss will be presented. Fourth, potential mechanisms for how dietary fiber may aid weight loss will be described. The current obesity epidemic in developed countries demands that we design diets to improve weight loss and maintenance. In addition, the popularity of low-carbohydrate diets that are low in dietary fiber must be considered in this discussion.

What is dietary fiber?

Examining the relation between dietary fiber intake and body weight is difficult because we struggle to define dietary fiber and agree on recommended intake levels. New definitions for dietary fiber and recommendations for fiber intake were published as dietary reference intakes [1]. Dietary fiber consists of non-digestible carbohydrates and lignin that are intrinsic and intact in plants. Functional fiber

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consists of isolated, non-digestible carbohydrates that have beneficial physiologic effects in humans. Total fiber is the sum of dietary fiber and functional fiber.

The Panel on Dietary Reference Intakes for Macronutrients was responsible for reviewing the research on dietary fiber and disease prevention and deciding whether to set a recommended intake level for dietary fiber. Before this report, there was no recommended dietary allowance for dietary fiber. The panel also found in its deliberations that there was no official definition of dietary fiber. Thus, a National Academy of Sciences Panel on the Definition of Dietary Fiber was formed to review existing literature on dietary fiber and determine the best scientific definition of dietary fiber [2].

All fiber is not created equal. Previously, dietary fiber was divided into soluble and insoluble fiber in an attempt to assign physiologic effects to chemical types of fiber. Scientific support for the belief that soluble fibers decrease serum cholesterol but that insoluble fibers increase stool size is inconsistent at best. A meta-analysis testing the effects of pectin, oat bran, guar gum, and psyllium on blood lipid concentrations associated 2 to 10 g/d of viscous fiber with small but significant decreases in total and low-density lipoprotein cholesterol concentrations [3]. Oat bran decreases serum lipids but wheat bran does not [4]. Resistant starch, generally a soluble fiber, does not affect serum lipids [5]. Thus, not all soluble fibers are hypocholesterolemic agents and other traits, such as viscosity of fiber, play a role and must be considered.

The association between insoluble fiber and laxation also is inconsistent. Fecal weight increases to 5.4 g/g of wheat bran fiber (mostly insoluble), 4.9 g/g of fruits and vegetables (soluble and insoluble), 3 g/g of isolated cellulose (insoluble), and 1.3 g/g of isolated pectin (soluble) [6]. Many fiber sources are mostly soluble but increase stool weight, such as oat bran and psyllium. Not all insoluble fibers are particularly good at relieving constipation, e.g., isolated cellulose. The disparities between the amounts of soluble and insoluble fiber measured chemically and the magnitude of their physiologic effects led the National Academy of Sciences Panel on the Definition of Dietary Fiber to recommend that the terms *soluble fiber* and *insoluble fiber* gradually be eliminated and be replaced by specific beneficial physiologic effects of a fiber, perhaps *viscosity* and *fermentability*.

The dietary reference intake committee used the new definitions for dietary, functional, and total fiber in their report. In addition, they set an adequate intake for total fiber in foods of 38 g and 25 g/d for young men and women, respectively, based on intake levels observed to protect against coronary heart disease (Table 1). Adequate intake is the recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate and is used when an recommended dietary allowance cannot be determined. There was insufficient evidence to set a tolerable upper intake level for dietary fiber or functional fibers.

Table 1
Dietary reference intake values for total fiber by life stage

Life stage	Adequate intake (g/d)	
	Male	Female
1–3 y	19	19
4–8 y	25	25
9–13 y	31	26
14–18 y	38	26
19–30 y	38	25
31–50 y	38	25
51–70 y	30	21
>70 y	30	21
Pregnancy		28
Lactation		29

Median intake of dietary fiber ranged from 16.5 to 17.9 g/d for men and from 12.1 to 13.8 g/d for women in the Continuing Survey of Food Intakes by Individuals (1994 to 1996, and 1998). Thus, there is a large fiber gap to fill between usual intake of dietary fiber and recommended intakes. Because fiber intake is directly related to total food intake, consumers of low-calorie diets are particularly susceptible to low fiber intakes. In addition, the trend toward high-protein, low-carbohydrate diets for weight loss has further limited dietary fiber intakes.

Fiber levels of popular weight-loss diets

In general, dietary fiber intakes are linked to total food intake and thus calorie intake. Fiber recommendations published in the dietary reference intakes are related to calorie intake and explain why the recommendation for men, 38 g/d, is higher than the recommendation for women, 25 g/d. Previous recommendations suggested that Americans consume 10 to 13 g of fiber per 1000 kcal consumed [7].

The fiber levels of popular diets have been reported by Anderson et al. [8]. When the dietary fiber content of weight-loss diets at 1600 kcal was determined, dietary fiber intakes ranged from 4 g/d for the Atkins diet to 49 g/d for the Ornish diet. The Zone diet at 1600 kcal/d provided 18.1 g of dietary fiber, whereas Protein Power provided 10.6 g of dietary fiber.

Novartis Consumer Health (summit, NJ, USA) recently sponsored a Harris Interactive QuickQuery Survey (August 21 to 25, 2003) to determine the most popular weight-loss diets. The survey was weighted to the U.S. adult general population and its findings were included in a press release on September 16, 2003. Not surprisingly, high-protein, low-carbohydrate diets were the most popular diets, including the Atkins diet and the South Beach diet. We examined the dietary fiber content of these currently popular diets, based on representative menus shown on their Web sites. Because