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Higher Fruit Consumption Linked With Lower Body Mass Index

Biing-Hwan Lin and Rosanna Mentzer Morrison

Healthy weight children, both girls and boys, consumed significantly more fruits than overweight children.

Credit: PhotoDisc.



The growing obesity epidemic in the United States has raised questions among many health professionals: Do the overweight eat differently from thinner people? Do the obese and overweight choose different foods, or consume larger quantities, or both? Is obesity a result of metabolism and activity level?

One of the major nutrition campaigns in the last decade has been to urge Americans to eat more fruits and vegetables in terms of quantity and variety. As a starting point in exploring the effects of eating habits on body weight, researchers with USDA's Economic Research Service examined the relationship between consumption of fruits and vegetables and obesity. We wondered if people who eat more fruits and vegetables are thinner than those who eat lesser amounts. We hypothesized that people who work to incorporate nutrient-dense, low-fat fruits and vegetables in their diets will work to keep their weights at healthy levels. We found a negative relation-

ship, or inverse association, between fruit consumption and body mass index: people who eat more servings of fruit each day have lower body mass indices. Surprisingly, we found no consistent relationship between vegetable consumption and body mass index, especially among children.

Analysis Includes School-Age Children and Adults

USDA's 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII) was the source of our food consumption data. This survey asked respondents to recall what, when, where, and how much they ate over 2 nonconsecutive days. Parents or guardians of children

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younger than age 13 completed the survey for their children. We also incorporated data from the 1998 CSFII, which is a supplemental survey of 5,559 children from birth through age 9. Our analysis includes responses from 4,709 men and 4,408 women age 19 and older, 883 adolescents age 13-18, and 2,181 children between age 5 and 12.

Survey respondents were also asked their or their children's height and weight. Self-reporting of weight and height can be subject to misreporting or wishful thinking, but face-to-face interviews, such as the CSFII, tend to lessen misreporting. These two measures were used to calculate a respondent's body mass index (BMI). BMI is calculated as a person's weight in kilograms divided by his or her height in meters squared. Health authorities have established specific ranges of BMI values to define a

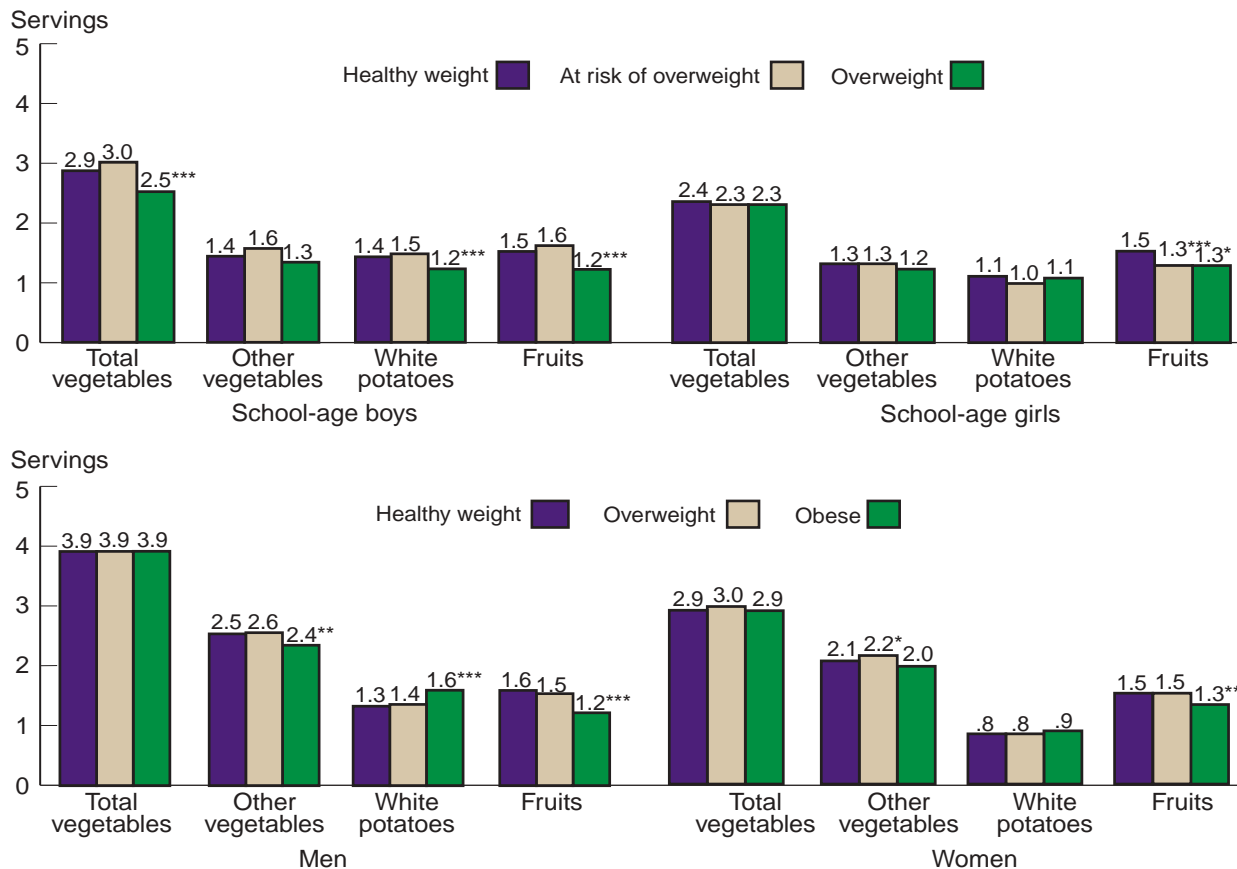
person as underweight, healthy weight, overweight, or obese. These values apply to both men and women. Children and adolescents are classified as overweight or at risk of becoming overweight if their BMI values exceed age and sex-specific BMI values established by the Centers for Disease Control and Prevention (CDC).

In the sample, 43 percent of men and 28 percent of women were overweight, as defined by a BMI between 25 and 29.9. Another 17 percent of men and 19 percent of women were obese (BMI of 30 or above). Results of the 1999 National Health and Nutrition Examination Survey indicate an estimated 35 percent of adults are overweight and an estimated 27 percent are obese. The 1994-98 CSFII data show that 14 percent of boys and girls age 5-18 were overweight (BMI above the 95th percentile of

the CDC pediatric growth charts). Another 18 percent of boys and 13 percent of girls were at risk of becoming overweight (BMI between the 85th and 95th percentiles). National figures from CDC show about 13 percent of children and adolescents are overweight.

USDA's Agricultural Research Service (ARS) maintains a pyramid servings database that expresses food consumption, both single food items and combination dishes, in terms of the number of servings. The database makes it possible to compare intake data with dietary recommendations in USDA's Food Guide Pyramid by converting grams of food into servings of 30 different food groups, including fruits and vegetables. Thus, we are able to total all vegetables and fruits eaten, whether as a single item or as a component in a vegetable stir fry or a fruit tart. We

Figure 1—Overweight Children and Obese Adults Eat Less Fruit Than Their Healthy-Weight Counterparts



Note: ***, **, and * indicates difference from healthy weight is statistically significant at 1-percent, 5-percent, and 10-percent probability. Source: Calculated by USDA's Economic Research Service using 1994-96 and 1998 CSFII data.

conducted two analyses of fruit and vegetable consumption, as expressed in servings consumed per day. First, we compared the average consumption by weight status. Then we examined the effect of fruit and vegetable consumption on BMI, controlling for the effects of age, gender, and race.

Fruit Consumption Varies by Weight Status, But Not Vegetable Consumption

In the analyses, we looked at four produce categories: total fruit, including fruit juices; total vegetables, including vegetable juices; white potatoes; and vegetables excluding white potatoes (other vegetables). Much of the white potatoes eaten in the United States are in the form of french fries—not exactly a low-fat vegetable option in the same company as kale, spinach, and sweet potatoes.

We analyzed CSFII data to examine whether healthy-weight individuals consume different amounts of fruits and vegetables than overweight or obese individuals. The CSFII respondents were grouped according to their age and gender. Children not yet attending school were excluded from the analysis. To preserve sufficient observations in the analysis, we divided the sample into four groups—school-age boys, school-age

girls, men, and women. Children were classified into three weight classes—healthy weight, at risk of overweight, and overweight. Adults were divided into three weight classes—healthy weight, overweight, and obese. About 2 percent of the adult CSFII respondents were underweight, and they were excluded from the analysis.

We found differences between the amounts of fruits eaten by healthy-weight people, overweight people, and the obese, but we found weak correlation between body weight status and vegetable consumption (fig. 1). Healthy-weight and at-risk-of-overweight boys consumed, statistically speaking, the same amount of total vegetables—about 3 servings. Overweight boys consumed less total vegetables (2.5 servings) as well as less white potatoes (1.2 servings) than other boys. Among men, there were no significant differences in the consumption of total vegetables among the three body-weight statuses. Obese men, however, consumed 1.6 servings of white potatoes, more than the 1.3 servings consumed by healthy-weight men and the 1.4 servings consumed by overweight men. For school-age girls and women, there were no significant differences in the consumption of total vegetables or white potatoes across the three weight statuses. However, overweight women did consume more other vegetables than obese or healthy-weight women.

Overweight children and obese adults of both genders consumed significantly less fruit than their healthy-weight counterparts. For example, overweight girls consumed 1.3 servings of fruit, compared with 1.5 servings of fruit eaten by healthy-weight girls. In addition, at-risk-of-overweight girls also consumed less fruit than healthy-weight girls. It appears that fruit consumption is a more accurate predictor of body weight status than vegetable consumption.

The Food Guide Pyramid recommends daily consumption of two

to four servings of fruits and three to five servings of vegetables. The recommended number of servings depends on the individual's caloric need, which in turn depends on the individual's age, sex, size, and activity level. For each subgroup in the sample, we compared average consumption as a share of the recommended servings. The recommended servings were derived from the individual's reported caloric intake. The comparison is useful especially when caloric needs of individuals in one body weight status vary greatly from the needs of individuals in other statuses.

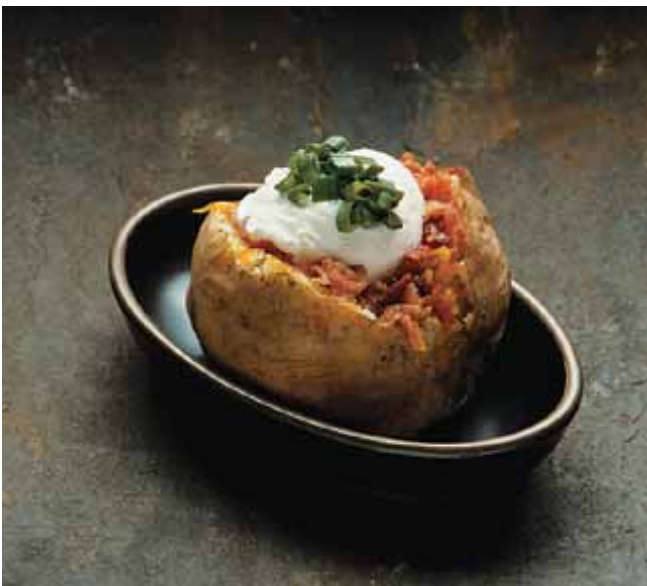
Similar to the results for average servings consumed, healthy-weight children and adults do not necessarily consume different amounts of total vegetables than their overweight or obese counterparts (fig. 2). However, healthy-weight boys and men consumed significantly more fruit than either overweight or obese individuals. For example, obese men ate just 39 percent of the recommended servings of fruit, compared with healthy-weight men who ate 51 percent of recommended fruit servings. Girls at risk of becoming overweight consumed 53 percent of the recommended servings of fruit, significantly lower than the 64 percent of the recommended servings of fruit consumed by healthy-weight girls. Obese women consumed 51 percent of the recommended servings of fruit, significantly lower than the 57 percent consumed by other women.

Fruit Consumption Better Predictor of BMI Than Veggies

As part of our analysis, we have compared the average consumption of fruits and vegetables, as servings or the share of recommended servings, among the three body-weight statuses. We examined the consumption of one food group, for example, fruits, independently of the other group. A more accurate assessment of the relationship between body weight and food con-

The weak correlation between vegetable consumption and body mass index might be explained by the way many Americans eat vegetables: deep fried, topped with high-fat dressings or sour cream, or included in high-fat mixtures.

Credit: PhotoDisc.



sumption requires studying the effects of fruit and vegetable consumption simultaneously.

One technique economists use to analyze multiple factors simultaneously is regression analysis. Regression analysis generates coefficients that indicate how closely the included factors correlate with the dependent variable—BMI in this case. Our regression model analyzed the effect of consumption of fruit, white potatoes, and other vegetables on BMI when the consumption is changed. The regression results, or estimated coefficients, indicate whether fruit and vegetable consumption are related to BMI. Statistical tests can be performed to check whether the estimated coefficients are statistically different from zero. A negative coefficient in our model for the consumption of fruits or vegetables means that an increase in consumption is linked with a lower BMI.

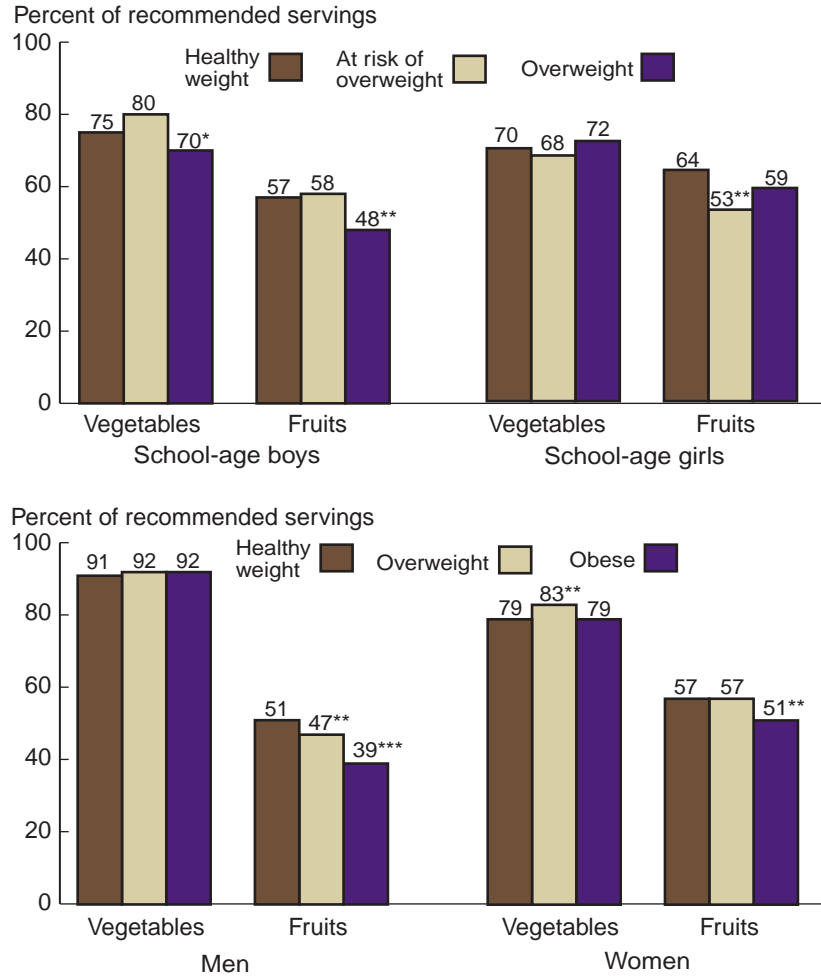
In addition to the variables representing consumption as a share of the recommended servings, we also control for the effects of age, gender, and race/ethnicity, which means that we also consider the fact that body weight is also affected by these variables. By isolating the effects of these factors, we can be more certain about the relationship between BMI and fruit/vegetable consumption. Because children's BMI can change greatly over time, especially among girls during puberty, children are separated into three age classes—5-9, 10-12, and 13 and older. With males and females separated, the analysis

comprises eight subpopulation groups: six groups of children and two groups of adults. Also, it was found that BMI increases among young adults and declines among seniors so that a quadratic term

for age (age squared) is included for men and women, but not for children.

The regression results corroborate the previous results that fruit consumption more accurately pre-

Figure 2—Little Correlation Exists Between Vegetable Consumption and Weight Status



Note: ***, **, and * indicates difference from healthy weight is statistically significant at 1-percent, 5-percent, and 10-percent probability. Source: Calculated by USDA's Economic Research Service using 1994-96 and 1998 CSFII data.

Table 1—Consumption of White Potatoes Positively Correlated With BMI for Adults

	Boys			Girls			Adults	
	Age 5-9	Age 10-12	Age 13 and older	Age 5-9	Age 10-12	Age 13 and older	Men	Women
White potatoes	NS	NS	NS	1.64 ¹	NS	-1.09 ¹	.63 ³	.72 ¹
Other vegetables	NS	NS	NS	NS	NS	NS	NS	-.38 ¹
Fruits	NS	-1.09 ²	-1.13 ³	NS	NS	-.99 ³	-.43 ²	-.56 ³

Note: NS = not statistically significant. ¹, ², and ³ denote statistical significance at 10-percent, 5-percent, and 1-percent probability. Source: Calculated by USDA's Economic Research Service using 1994-96 and 1998 CSFII data.

dicts BMI than vegetable consumption (table 1). Among the six groups of children, the consumption of white potatoes was found to statistically correlate with the BMI for two groups of girls—positive correlation among girls age 5-9 but negative among girls 13 and older. The consumption of other vegetables had no correlation to the BMI among children.

The correlation between vegetable consumption and BMI was found to be more significant among adults. Potato consumption is positively correlated with BMI for both men and women, and the consumption of other vegetables has a significant, negative relationship with BMI for women. Therefore, adults whose diets include more white potatoes have higher BMIs. Women whose diets are higher in other vegetables have lower BMIs.

Among the eight subpopulation groups, fruit consumption was found to have a significant, negative relationship with BMI in five groups—boys age 10-12, boys and girls age 13 and older, men, and women. Thus, teenagers, boys age 10-12, and adults whose diets include larger amounts of fruit have lower BMIs.

How Vegetables Are Eaten Could Be a Key

Recently, the Produce for Better Health Foundation conducted a review of scientific research on the health benefits of eating more fruits and vegetables. The foundation's review found evidence to support a significant association between fruit and vegetable intake and health, but more convincing data is needed for a relationship between fruit and vegetable consumption and disease prevention. We know that the development of overweight and obesity is a long-

term imbalance between energy intake and expenditure. The *Journal of Nutrition* reported that obesity is associated with consumption of foods high in energy density. Therefore, adding low-calorie fruits and vegetables to the diet has been explored as a weight-loss strategy.

Our analysis confirms but also raises some questions about the relationship between fruit/vegetable intake and BMI. We found a negative relationship between fruit consumption and BMI among older children and adults, but the correlation between vegetable consumption and BMI was found to be not as strong. We found no consistent correlation between BMI and vegetable consumption among children. Adults who consume more white potatoes are found to have higher BMIs. Women, but not men, who consume more vegetables other than white potatoes have lower BMIs. Both fruits and vegetables are low-fat, if not no-fat, foods when consumed straight from the orchard or garden. Americans may be eating most of their fruits raw or in juices, unadorned with sauces or fried coatings or baked in pies. On the other hand, Americans may be deep-fat frying their vegetables, topping them with high-fat dressings or sour cream, or including them in high-fat mixtures. Future research on the link between fruit and vegetable consumption and BMI should explore how these foods are eaten by separating the fruits and vegetables by preparation: fresh, baked, or fried; in mixtures; or with other accompaniments.

Another explanation for the link between higher fruit consumption and lower BMI could be that some people are eating fruit as a snack or dessert, rather than a higher calorie candy bar or piece of

cake. If fruits are eaten as a substitute for higher calorie items, this substitution is likely to result in lower BMIs. Americans may not regard vegetables as having the same snack potential as fruits. Future research on how fruits and vegetables are incorporated in our diets should further explore this food substitution issue.

According to Elizabeth Pivonka, president of the Produce for Better Health Foundation, "A colorful variety of all fruits and vegetables, healthfully prepared, makes a significant contribution to a diet that promotes good health." When urging Americans to "eat 5 a day," perhaps nutrition educators need to remind us to watch how we are preparing those fruits and vegetables and how we are incorporating them in our diets.

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