Trends in food availability, 1909–2007[1–3]

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ABSTRACT

The increase in childhood obesity mainly reflects increased energy intake. However, it is not clear which food categories are responsible for this increase. Food availability data, which are calculated from annual food production, imports, beginning stocks, subtracting exports, ending stocks, and nonfood uses, provide clues about which categories are the primary contributors. Data from 1909 to 2007 show increases in per capita availability of several product classes: added oils increased from 16.1 to 39.4 kg/y, meat increased from 56.3 to 91.2 kg/y, cheese increased from 1.7 to 14.9 kg/y, and frozen dairy products increased from 0.7 to 11.5 kg/y. From 1970 to 2007, per capita availability of sweeteners increased from 54.1 to 62.0 kg/y. Carbonated beverage availability has increased, partly at the expense of fluid milk. Flour and cereal availability decreased from 1909 until the late 1960s but rebounded thereafter. Availability of fruit, fruit juices, and vegetables has increased. We conclude that the major contributors to increased energy intake over the last century are oils, shortening, meat, cheese, and frozen desserts, with more recent increases in added sweeteners, fruit, fruit juices, and vegetables. These changes may have influenced the prevalence of childhood obesity. *Am J Clin Nutr* 2010;91(suppl):1530S–6S.

INTRODUCTION

Childhood obesity, which is defined as an age- and sex-specific body mass index (BMI) ≥95th percentile, is increasing at an alarming rate (1). Recent studies attribute this trend primarily to increased energy intake, rather than to reduced energy expenditure (2). But which foods are contributing to the increased caloric load? This question can be partially answered through food availability data, which has been maintained by the Economic Research Service of the US Department of Agriculture (USDA) since 1909 (3). The purpose of this article is to translate these raw data into understandable trends that extend from the beginning of recorded data until 2007.

There is a variety of methods for reporting dietary habits, and each has strengths and weaknesses. Food availability (sometimes called food disappearance) reflects total annual food production, imports, and beginning stocks of commodities, subtracting exports, ending stocks, and nonfood uses. The result is a proxy for foods actually consumed and is particularly useful for examining trends over time. Because these data are drawn from government and industry reports, they are free of the inaccuracies that occur in consumer survey estimates caused by poor memory, volitional skewing of responses, or difficulties in describing the components of foods made from several ingredients.

Food availability data do not, however, typically account for losses through spoilage, plate waste, food preparation practices, or other factors. As a result, they overestimate consumption. Beginning in 1970, the USDA estimated food availability adjusted for losses by calculating specific loss coefficients for each major food group (4). The estimates have limitations: Loss-adjusted data are not available before 1970, so they cannot replace unadjusted data in evaluating longer-term trends. Also, because the USDA's loss coefficients are, in some cases, based on studies from the mid-1970s or earlier, the USDA considers them to be tentative and only a starting point for additional research (5).

The following sections describe time trends by food group and report food availability values as close to actual consumer use as possible. For example, for meat availability, the most relevant data exclude bones and trimmable fat that would typically be discarded by consumers. For availability since 1970, loss-adjusted data are also presented. Quantitative cause-and-effect relations between changing food availability and changes in obesity are beyond the scope of this review.

MEAT

Per capita availability of red meat, poultry, and fish totaled 56.3 kg/y in 1909 (6) (**Table 1**). Falling during World War I and the Great Depression, meat availability rebounded in the 1940s. The steep rise in total meat availability between about 1940 and 1970 was due to increases for red meat. Thereafter, rapidly increasing consumption of poultry, particularly chicken, forced red meat into a decline. Combined per capita chicken and turkey availability increased >6-fold overall, from 5.1 kg/y in 1909 to 33.5 kg/y in 2007. Meat, poultry, and fish availability exceeded 90 kg/y in 2002 and in subsequent years, which represented a 60% increase over values from early in the 20th century (**Figure 1**).

Estimated losses due to spoilage, waste, and cooking processes are as high as 57% for this food group. In a loss-adjusted analysis, total meat, poultry, and fish availability rose from 48.3 kg/y in 1970 to 54.4 kg/y in 2007. This reflects increases in per capita poultry,

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TABLE 1
Availability of major food commodities in the United States, 1909–2007[1]

	1909	1935	1970	2007
Meats (kg/y)				
Meat, total[2]	56.3	44.6	80.7 (48.3)[3]	91.2 (54.4)
Red meat	46.2	35.0	60.0 (37.3)	50.3 (31.2)
Poultry	5.1	4.9	15.4 (9.1)	33.5 (19.8)
Fish and shellfish	5.0	4.8	5.3 (1.9)	7.4 (3.4)
Eggs (individual eggs/y)				
Eggs, fresh and processed	284.0	270.9	302.2 (238.9)	245.1 (189.6)
Dairy products (kg/y)				
Fluid milk, total	133.7	129.1	122.3 (86.2)	81.0 (57.0)
Whole milk (plain and flavored)	105.0	109.5	99.6 (70.1)	25.0 (17.5)
Low-fat and skim milk	28.7	19.7	22.7 (13.3)	56.0 (35.0)
Cream	5.6	5.7	1.8 (2.3)	3.8 (0.0)
Butter	8.1	8.0	2.5 (2.0)	2.1 (1.7)
Cheese, whole and part-skim milk	1.7	2.4	5.2 (4.0)	14.9 (11.2)
Cheese, cottage	0.3	0.6	2.3 (1.6)	1.2 (0.8)
Frozen dairy products	0.7	3.8	13.0 (9.1)	11.5 (8.0)
Evaporated and condensed milk	2.8	8.5	5.5 (3.8)	3.5 (2.5)
Dry milk	NA	0.8	2.6 (2.5)	1.5 (1.4)
Added fats and oils (kg/y)				
Added fats and oils, total	16.1	21.8	25.3 (17.5)	39.4 (25.9)
Butter	8.1	8.0	2.5 (2.0)	2.1 (1.7)
Margarine	0.6	1.4	4.9 (3.9)	2.0 (1.6)
Lard	3.1	4.4	2.0 (1.0)	0.7 (0.4)
Edible tallow	NA	NA	0.2 (0.1)[4]	1.3 (0.7)
Shortening	3.6	5.5	7.9 (5.3)	9.5 (6.4)
Salad and cooking oils	NA	NA	7.0 (4.4)	22.8 (14.5)
Other fats and oils	0.7	2.7	1.0 (1.0)	0.8 (0.7)
Peanuts and tree nuts (kg/y)				
Peanuts	NA	NA	2.5 (2.1)	2.9 (2.4)
Tree nuts	NA	NA	0.8 (0.7)	1.5 (1.3)
Fruit and fruit juices (kg/y)				
Fruit and fruit juices, total	NA	NA	79.3 (49.3)	96.8 (60.2)
Fresh fruit	NA	NA	43.7 (19.2)	54.4 (24.5)
Fruit juice	NA	NA	22.0 (18.5)	32.5 (27.5)
Other processed fruit[5]				
Canned	NA	NA	10.6 (9.0)	6.4 (5.4)
Frozen	NA	NA	1.5 (1.3)	2.1 (1.8)
Dried	NA	NA	1.2 (1.0)	1.0 (0.8)
Other process	NA	NA	0.3 (0.2)	0.4 (0.3)
Vegetables (kg/y)				
Vegetables, total	NA	NA	103.4 (67.7)	130.0 (80.3)
Fresh	NA	NA	65.6 (37.3)	85.0 (45.1)
Canned	NA	NA	22.9 (19.3)	21.3 (18.0)
Frozen	NA	NA	9.8 (6.8)	17.7 (12.0)
Grains (kg/y)				
Flour and cereal products	136.4	92.7	62.0 (43.2)	89.5 (62.6)
Caloric sweeteners (kg/y)				
Total caloric sweeteners	NA	NA	54.1 (38.5)	62.0 (44.1)
Cane and beet sugar	NA	NA	46.3 (33.0)	28.2 (20.0)
Corn-based sweeteners	NA	NA	7.2 (5.1)	33.1 (23.6)
Syrups and honey	NA	NA	0.7 (0.5)	0.6 (0.5)

[1] Data are from reference 3. NA, not available.
[2] Meat (beef, veal, pork, and lamb), poultry (chicken and turkey), fish, and shellfish are boneless and trimmed.
[3] Loss-adjusted value in parentheses (all such values).
[4] Values for edible tallow are from 1979.
[5] Includes canned, frozen, dried, and other processed products other than juice.

fish, and shellfish availability, which more than compensated for the drop in per capita red meat availability (7) (Table 1). According to USDA estimates, these data correspond to an increase in per capita energy availability from red meat, poultry, and fish, adjusted for losses, from 367 kcal/d in 1970 to 387 kcal/d in 2007.

EGGS

Egg availability remained near 300 fresh or processed eggs annually per capita early in the past century, but peaked well above 350 in the decade immediately after World War II, after which availability declined (8) (Table 1). Adjusted for losses,

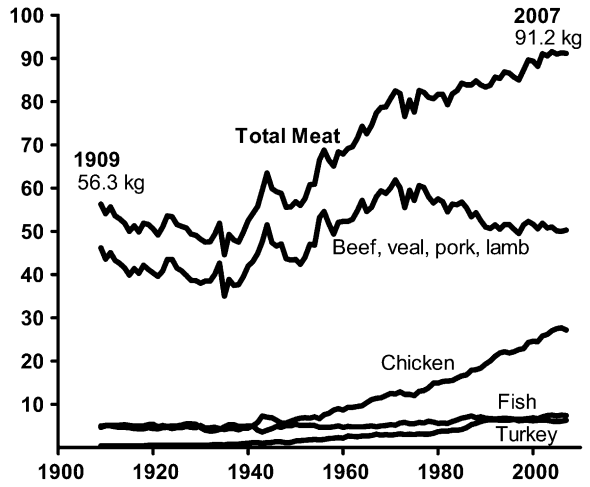

FIGURE 1. US per capita red meat, poultry, and fish availability (kg/y). Data are from reference 6.

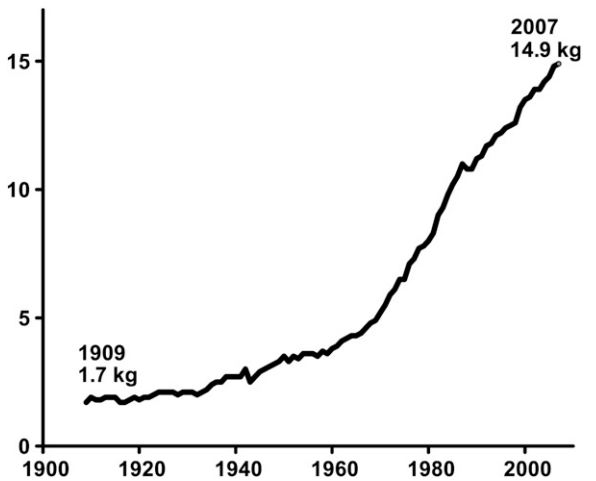

FIGURE 2. US per capita cheese availability (kg/y). Data are from reference 9.

which are estimated at ≈22–24%, per capita egg availability declined from 238.9 eggs annually (0.7/d) in 1970 to 189.6 annually (0.5/d) in 2007, which represents a drop from the equivalent of 33 to 26 kcal/d during this interval (7).

DAIRY PRODUCTS

Fluid milk, cream, and butter availability has fallen since the 1960s (9). In contrast, cheese availability has increased dramatically, beginning in the post World War II period and escalating since 1970 (10) (**Figure 2**). Approximately 60% of cheese is provided in the form of commercially manufactured and prepared foods (11). In 2002, mozzarella overtook cheddar as the most heavily consumed cheese, which reflects pizza's popularity. Nonetheless, cheddar cheese consumption has continued to rise. The third most popular cheese is cream cheese, which reflects the increased consumption of bagels (12). Availability of ice cream and other frozen dairy products rose considerably in the middle of the last century and has fallen only slightly since then.

In analyses adjusted for losses due to spoilage and other factors, which are estimated at ≈30%, per capita fluid milk availability declined from 86.1 kg/y in 1970 to 57.0 kg/y in 2007, whereas cheese availability increased nearly 3-fold (13). As a result of these conflicting trends, per capita energy availability from dairy products overall remained essentially flat between 1970 (286.7 kcal/d) and 2007 (283.7 kcal/d). For milk, energy availability dropped from 135.8 to 79.0 kcal/d during this interval, whereas energy availability from cheese increased from 41 to 108 kcal/d.

FATS AND OILS

Availability of butter (as noted above) and lard has steadily declined (14). Margarine availability peaked in the 1970s and 1980s, but later fell to less than half its peak levels. In contrast, salad and cooking oil availability has increased dramatically since data were first reported in 1966, with most of that change occurring in recent years, nearly doubling from ≈12 kg/y per capita in the mid-1990s to 22.8 kg/y in 2007. This category includes pourable oils used in salad dressings, sautéing, and stir-frying in either home or commercial food preparation (Table 1, **Figure 3**). The availability of shortening (eg, fats used in restaurant fryers) has increased as well. Analyses adjusted for losses, which are estimated at ≈30%, show an increase in total fat and oil availability from 17.5 kg/y in 1970 to 25.9 kg/y in 2007, which corresponds to an increase from 403 to 613 kcal/d per capita (15).

PEANUTS AND TREE NUTS

Peanut availability is reported, not with other legumes, but as a separate category. Likewise, tree nuts are reported separately from other food groups. Peanuts are consumed primarily as peanut butter, with smaller quantities sold as snack peanuts and peanut candy. Availability data show modest increases since records first became available for peanuts in 1967 and for tree nuts in 1970 (16). Adjustment for losses (estimated at 15.4% for peanuts and tree nuts) does not dramatically change these values. Corresponding per capita energy availability, adjusted for losses, rose from 33.1 kcal/d in 1970 to 37.3 kcal/d in 2007 from peanuts and from 12 to 21 kcal/d for tree nuts (7).

FRUIT AND FRUIT JUICES

Fruit availability data are not available before 1970. Since that time, fresh fruit availability has increased, with a smaller increase in juice availability (17). Although citrus fruit, both fresh and processed, dominate this category, their availability has declined since the 1970s, in contrast to apples, melons, bananas, and berries, which have increased in availability. Per capita energy availability from fruit, adjusted for losses, rose from 71 kcal/d in 1970 to 91 kcal/d in 2007 (17).

VEGETABLES

Overall availability of vegetables, including legumes, increased from 1970 to 2007 (18). Increases were apparent for both fresh and frozen vegetables. Adjusted for losses of nearly 60%, availability increased from 67.7 to 80.3 kg/y during this period. USDA data show that per capita energy availability from vegetables, adjusted for losses, rose modestly from 121 to 130 kcal/d (18).

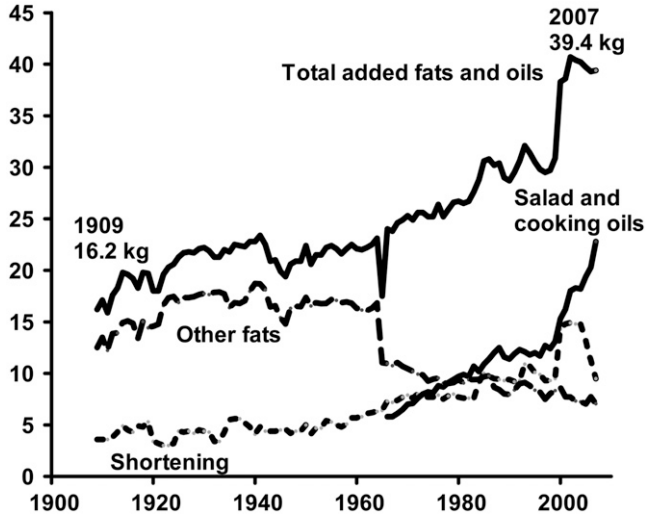

FIGURE 3. US per capita availability of added fats and oils (kg/y). Data are from reference 14.

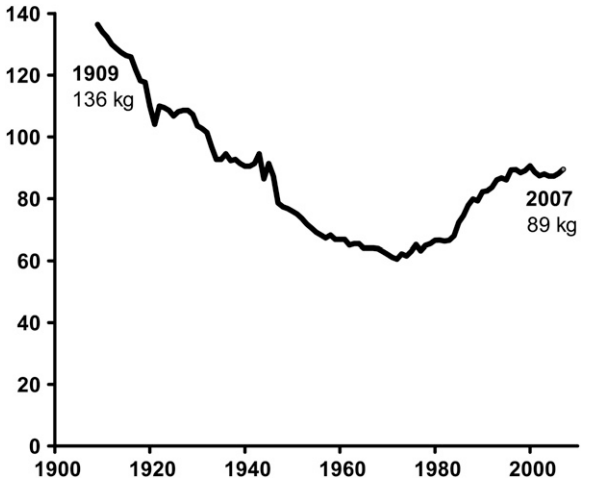

FIGURE 4. US per capita flour and cereal availability (kg/y). Data are from reference 20.

Availability of fresh potatoes declined, whereas that of frozen potatoes, which are commonly used in commercial settings such as fast-food restaurants, rose. Adjusted for losses, per capita availability declined from 17.6 to 11.2 kg/y for fresh potatoes and increased from 3.7 to 7.8 kg/y for frozen potatoes.

GRAINS

In the late 1800s, wheat flours became more popular and available due to the introduction of new wheat varieties, milling techniques, and transport methods, and during this time new breakfast cereals were introduced by John Harvey Kellogg, CW Post, and the Quaker Oats Company (19). Thereafter, however, per capita availability of flour and cereal products gradually dropped as increased prosperity, improved mechanization, and transport (eg, refrigerated railway cars) increased competition from other food groups (19, 20) (Table 1, **Figure 4**). In the late 1960s, the availability of these products began a partial rebound as commercial baking replaced home baking and the rapidly expanding fast-food market emphasized the use of flour products in sandwiches, breaded coatings, pizza crust, and bagels (19). Per capita grain availability, adjusted for losses, increased from 43.2 to 62.6 kg/y between 1970 and 2007, which corresponds to an increase in energy availability from 432 to 626 kcal/d during this interval (21).

SWEETENERS

The overall rise in availability of caloric sweeteners reflects the net effect of a sharp decline for cane and beet sugar and an increase for high-fructose corn syrup (22) (Table 1). Currently, sugar is used mainly by food manufacturers, and beverage manufacturers tend to use high-fructose corn syrup (23). Energy availability per capita from added sweeteners, adjusted for loss, increased from 402 kcal/d in 1970 to 459 kcal/d in 2007 (24).

BEVERAGES

Data for beverage availability are not available before 1970. The period from 1970 to 2007 saw a drop in beverage milk availability from 118.3 to 78.2 L/y (25) (**Table 2**, **Figure 5**). During this period, the market shifted toward lower-fat varieties. Values for carbonated soft drink availability were not available until 1980 or later but have shown large increases since then, much of which has been for "diet" brands, which constituted 56.6 of the 184.8 L per capita of carbonated beverage availability in 2007. Bottled water data became available in 1976, showing a large increase over the next 3 decades.

TRENDS IN FOOD AVAILABILITY

Data over the past century show several major trends: *1*) increased availability of fats, oils, meat, cheese, and frozen dairy products; *2*) a large fall in grain availability until the late 1960s, followed by a partial rebound; *3*) decreased fluid milk availability and increased carbonated beverage availability in recent decades; and *4*) increased fruit and vegetable intake.

Increased availability of fats, oils, meat, cheese, and frozen dairy products

Availability of fats and oils increased over the past century, and especially since 1970, due to a large increase in the availability of salad and cooking oils and shortening. The marked increase in pourable oils may reflect, in part, health concerns about shortening use, particularly in home settings. Meat consumption has risen more or less continuously since the end of World War II. Cheese and frozen dairy product consumption has also increased, with cheese availability rising sharply since 1970.

People who eat meat regularly are heavier, as a group, than people who avoid meat (26). In a cohort study including 60,903 Seventh-day Adventists, mean BMI (in kg/m^2) progressively increased with increasing animal product consumption among 5 diet groups: vegans (23.6), lactoovovegetarians (25.7), pescovegetarians (those eating fish but no other meats; 26.3), semivegetarians (those consuming $\geq$1 meat meal/mo, but $<$1 meat meal/wk; 27.3), and meat eaters (28.8; $P < 0.0001$) (27). The European Prospective Investigation into Cancer and Nutrition (EPIC), which studied 37,875 generally health-conscious adults, similarly reported that vegans weighed the least (mean BMI: 22.5 for men, 22.0 for women) and meat eaters weighed the

TABLE 2
United States per capita beverage availability, 1970–2007[1]

	1970	2007
	L/y	*L/y*
Milk	118.3	78.2
Whole milk	96.5	24.2
Other milk	21.9	54.0
Carbonated soft drinks	127.3[2]	184.8
Fruit juice	20.9	31.0
Bottled water	6.2[3]	110.0
Beer	70.0	82.5
Wine	5.0	9.3
Distilled spirits	6.9	5.4

[1] Data are from reference 3.
[2] Value is from 1980. Earlier data are not available.
[3] Value is from 1976. Earlier data are not available.

most (mean BMI: 24.4 for men, 23.5 for women), with BMIs of pesco-vegetarians and lactoovovegetarians in between these values (28). The EPIC study also showed that a group of 10,784 meat eaters gained more weight (406 g for men, 423 g for women) over a 5-y period, compared with vegans (284 g for men, 303 g for women; $P < 0.05$) (29).

Changing grain availability

Although flour and cereal product availability increased in the latter half of the 20th century, which contributed to a large increase in estimated energy availability, it remained far below the levels of the early 1900s (Figure 4). Historically, grain intake falls as meat intake rises, but, given the role of grain products in hamburger buns, sandwiches, and breading for fried products, grain availability has paralleled the rise in meat and cheese availability.

Increased carbonated beverage availability

Availability of carbonated beverages has increased by 57 L/y per capita since 1980, accompanied by a smaller increase in juice availability (Figure 5). A 2006 systematic review of 30 cross-sectional, prospective, and experimental studies showed that sugar-sweetened beverage consumption is associated with weight gain in children and adults (30).

If increased carbonated beverage intake compensated only for reduced milk intake, the effect on overall energy intake would be either nil or a net decrease. Energy density of typical carbonated soft drinks is similar to that of nonfat milk (≈0.34 kcal/g) (31) and lower than that of whole milk (≈0.61 kcal/g), and diet beverages are essentially calorie-free. In adults, however, the soda-milk trade-off has not been in equilibrium. Rather, total beverage intake has increased over the past 4 decades (32). The same may not be true for children. Although carbonated beverage intake among children has increased (33), evidence does not yet show that this increase has outstripped the reduction in energy intake from flagging milk consumption (33).

This trade-off in beverages contrasts with the increase in other dairy products (especially cheese and ice cream), whose availability has increased without any obvious compensatory decline in another food group. Cheese added to pizza or sandwiches, for example, may not displace other foods in the way that calories from soda replace calories from milk.

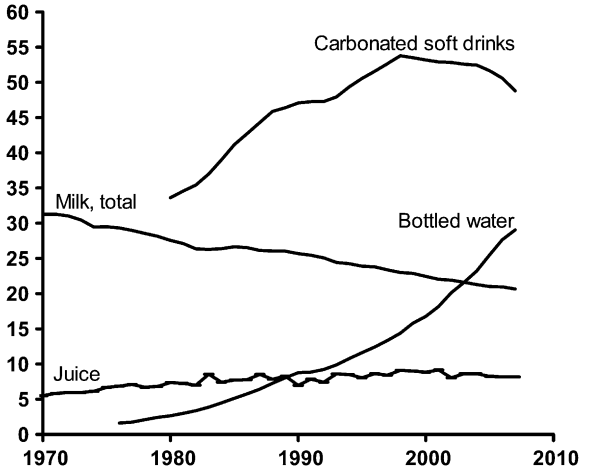

FIGURE 5. US per capita beverage availability (gallons). Data are from reference 25.

Increased fruit and vegetable intake

Availability of fruit, fruit juices, and vegetables has increased since data on these products became available around 1970. However, due to their low energy density, fruit and vegetables contribute little to overall energy intake. The same may not be true of fruit juices, which can provide a large glycemic load and may have added caloric sweeteners. The effect of fruit juices on weight gain remains unsettled (30).

WHAT DRIVES THE TRENDS?

A detailed discussion of the factors driving food purchases is beyond the scope of this review. However, a few salient factors are mentioned below.

Increasing disposable income

Rising personal income has exceeded increases in food spending such that the percentage of income spent on food overall has declined (34) (**Figure 6**). With increased purchasing power, foods such as cookies and other sugar-fat mixtures, chocolate, cheese, and meat, for which preferences may reflect nonnutritional factors (eg, opiate effects) (35–37), are more within reach.

More meals from commercial settings

Food preparation has shifted from the home to commercial settings, particularly with the advent of fast-food and pizza restaurant chains, which emphasize meat, cheese, fried foods, and carbonated beverages. Of the $1.165 trillion Americans spent on food in 2008, 48.5% was for food consumed away from home (34). Although the trend for food away from home partly stems from rising disposable income, it also reflects several other historic factors, which include the need for reduced food preparation time, particularly as more women work away from home (6).

Advertising

Television advertising influences food and beverage preferences, purchase requests, and short-term consumption of children aged 2–11 y, and exposure to television advertising is associated with adiposity in children (38).

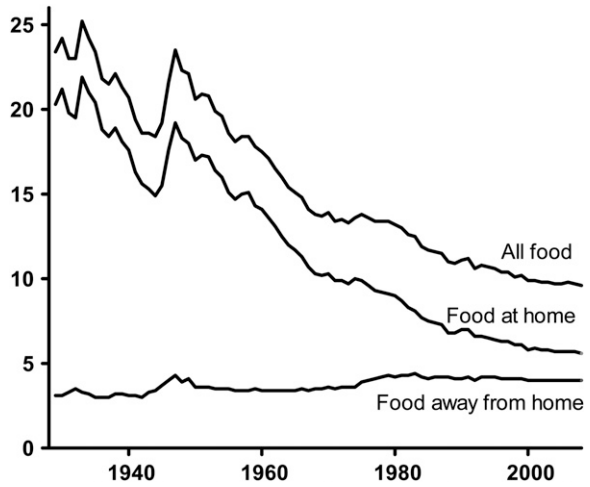

FIGURE 6. Food expenditures as a percentage of disposable income, 1929–2008. Data are from reference 35.

Government programs

Federal programs influence both the price and the availability of foods. Subsidies for the production of meat, cheese, and sweeteners reduce the costs of the raw materials of fast-food and pizza chains, among other settings. Among these federal programs are commodity purchases that tend to favor meat, cheese, and egg purchases and contribute directly to the foods available for school nutrition programs.

The National School Lunch Program and the Special Supplemental Nutrition Program for Women, Infants, and Children boost purchasing power, and their programmatic guidelines specifically influence children's food intake. National School Lunch Program guidelines ensure, for example, that school meals provide specified quantities of nutrients (eg, protein) and specific products (eg, cow milk). According to USDA data from 2004 to 2005, lunches consumed by National School Lunch Program participants averaged 633 calories, of which 33.7% came from fat and 11.5% came from saturated fat, although the percentage of schools meeting the USDA standard for saturated fat (<10% of energy) had increased, compared with data from 1998 to 1999, from 15 to 34% of elementary schools and from 13 to 26% of secondary schools (39).

The effect of government nutrition policies may be blunted, however, by competitive foods (those sold a la carte or through vending machines, school stores, or special events). On a typical school day, 40% of children selected competitive foods, according to USDA data from 2004 to 2005 (40). For these children, competitive foods contributed an average of 13% of total daily energy intake and consisted mainly of juice drinks, cookies/cakes/brownies, candy, carbonated sodas, and bottled water.

In 2009, the Food and Nutrition Service of the USDA changed the food packages of the Special Supplemental Nutrition Program for Women, Infants, and Children to increase the availability of fruit, vegetables, and whole grains and to limit high-fat dairy products, juice, and eggs (41). The Supplemental Nutrition Assistance Program (the Food Stamp progam) increases the food purchasing power of the >34 million program participants (42).

Food availability data have both strengths and limitations. Unlike nutrient intake surveys, they are not subject to inaccuracies due to poor memory or volitional skewing of responses, nor are they limited to population subsets or specific points of time, as nutrient intake surveys are. However, food availability data tend to overestimate consumption, a problem that loss-adjusted estimates attempt to overcome. So far, however, loss-adjusted estimates remain tentative and are not available before 1970.

CONCLUSIONS

Long-term trends indicate marked increases in availability of added oils, meat, cheese, frozen dairy products, sweeteners (particularly those used in carbonated beverages), fruit, fruit juices, and vegetables, which may have influenced the prevalence of childhood obesity. Flour and cereal availability has fallen since the early 1900s but has rebounded in recent decades. Changes in the available food options within federal programs may help address the problem of overweight and obesity in children and adolescents.

The author is president of the Physicians Committee for Responsible Medicine and The Cancer Project, organizations that promote the use of low-fat, plant-based diets and discourage the use of animal-derived, fatty, and sugary foods. He also writes books and articles and gives lectures about therapeutic diets, including vegan diets, and has received royalties and honoraria from these sources.

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