

# TASTE PREFERENCES AND FOOD INTAKE

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## ABSTRACT

Sensory responses to the taste, smell, and texture of foods help determine food preferences and eating habits. However, sensory responses alone do not predict food consumption. The view that a “sweet tooth” leads to obesity through excess sugar consumption is overly narrow. In reality, there are multiple links between taste perceptions, taste preferences, food preferences, and food choices and the amount of food consumed. Taste responses are influenced by a range of genetic, physiological, and metabolic variables. The impact of taste factors on food intake further depends on sex and age and is modulated by obesity, eating disorders, and other pathologies of eating behavior. Food preferences and food choices of populations are further linked to attitudinal, social, and—probably most important—economic variables such as income. Nutrition education and intervention strategies aimed at improving population diets ought to consider sensory pleasure response to foods, in addition to a wide range of demographic and sociocultural variables.

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## INTRODUCTION

Is taste the main influence on food selection? According to consumer survey reports (44), yes. Although dietary trends are affected by behavioral, sociocultural, and economic variables (58, 94), consumers report that their diet choices are most often guided by how foods taste (44). The popular concept of a food's "taste" includes the chemical senses of taste and olfaction, as well as the oral perception of texture (69; see also 16, 24). A pleasure or hedonic component is included as well (23). Sensory perceptions and preferences for the taste, aroma, and texture of foods affect not only food preferences but also eating habits (24, 69). Foods that are combinations of sugar and fat are universally preferred (24, 30), whereas there is widespread dislike of tastes that are bitter (93).

Children especially love sweet and dislike bitter tastes (2, 98). Children also eat more of the foods they like best (2, 5). In contrast, the impact taste factors have on the food intakes of adults is much less apparent. Adults do not equate good taste with sweetness, and their taste preferences and aversions are not always direct predictors of food consumption. As a result, it has proved difficult to link adult taste preferences with intake measures, whether in a laboratory setting or in real life. Experimental evidence linking taste and food consumption is often indirect, since few studies have examined taste responses, food preferences, and intake patterns in the same subject population (32).

Some theories on the impact of taste function on chronic disease risk have not been supported by food intake data. For example, the notion that a sensory "sweet tooth," i.e. a heightened preference for sweet taste, was the direct cause of human obesity (86, 87) is not supported by data on sugar consumption (1, 47). Similarly, no intake data support the claim that enhanced preferences for salty tastes in old age is the main reason for increased salt consumption, with the attendant risk of hypertension (72). In both cases, taste preferences alone were taken as presumptive evidence for increased intakes of sugar or salt.

In reality, many variables intervene between taste responses and food intake (23, 66). Both can be influenced by factors ranging from molecular biology to economics. For example, while individual taste preferences for fat in foods may be influenced by metabolic or physiological variables (42, 52, 63, 89), the

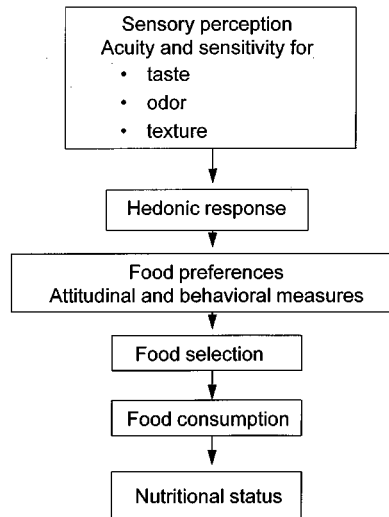


Figure 1 Variables intervening between taste function and food intake.

proportion of fat in the diet of populations is driven by economic factors and income (12, 26, 81, 83). Diverse scientific explanations for fat appetites among individuals or groups have variously invoked brain mechanisms, including endogenous opiate peptides (35) and galanin (57), the subjects' body mass (23, 29) and body fat (67), body mass of the parents (42), associative learning (52), passive overconsumption (7, 8), weight cycling (34), and binge eating (27), not to mention urbanization (83, 84), disposable income, and the gross national product (12, 81). This review examines, in turn, the diverse genetic, metabolic, physiological, and socioeconomic factors that mediate the postulated causal links between taste preferences and food consumption. A listing of the relevant concepts is presented in Figure 1.

## MEASURING TASTE AND FOOD PREFERENCES

The term taste responsiveness has been used to denote taste perception as well as taste preference. As summarized in Table 1, studies of taste function have distinguished between taste acuity, determined using detection and recognition thresholds, and taste sensitivity, as based on intensity scaling of more concentrated taste stimuli (4, 23). The typical stimuli were aqueous solutions of sugars (sweet), sodium chloride (salty), hydrochloric acid (sour), and either caffeine or quinine (bitter) (3, 4, 17, 73). Comparable methods using standard odorants

**Table 1**    Measuring taste factors and food intakes

Determinant	Principal measurements	Stimuli
Taste perception		
Acuity	Detection and recognition thresholds	Aqueous solutions
Sensitivity	Intensity scaling	Aqueous solutions
Olfaction perception		
Acuity	Detection thresholds	Odorants
Sensitivity	Intensity scaling	
Recognition	Odor recognition	Odorants or foods
Texture profile	GF texture profile <sup>a</sup>	Foods
Hedonic preference	Hedonic preference scale	Solutions, odorants, foods, or model foods
Food preference		
Sensory evaluation	Acceptability ratings	Foods
Checklist	Preference ratings	Food names
Food intakes		
Selection	Variety and diversity scores	Foods and food groups
Consumption	Dietary intake measures	Foods and food groups

<sup>a</sup>GF, General Foods.

have been used for the determination of thresholds and for intensity scaling of odors (11).

These measures of sensory functioning are distinct from the hedonic preference response, a measure of the acceptability or pleasantness of a given stimulus (70, 82). Whereas intensity ratings are a logarithmic function of stimulus concentration, hedonic preferences are a measure of the affective component of attitude (23, 106). Hedonic preference ratings for sugar solutions, sweetened lemonade, salted soups or tomato juice, or food-like mixtures of sugar and fat have been based on taste tests conducted under laboratory conditions and using the standard sip-and-spit technique (23, 65, 70, 75–78). Studies on the acceptability of real foods, conducted in sensory evaluation labs, generally ask respondents to taste and rate flavor, color, texture, and overall acceptability of the food product (13, 16, 69).

Intensity and pleasantness ratings for taste stimuli are sometimes linked and sometimes not. For example, stimuli perceived as more bitter are more strongly disliked (33). However, acceptance or rejection need not always follow intensity ratings. Hedonic response profiles for sweet taste are highly diverse, ranging from a monotonic rise, to an inverse U shape, to a sharp decline with increasing sweetness (23, 100, 106). Other than with small children (50), sweeter stimuli are not always preferred. Similarly, salty or bitter stimuli are not invariably disliked, and preferences for caviar or coffee, unusual among children, can develop in time.

It is generally assumed that taste preferences predict food preferences. This is not necessarily true (45). Some food preference data are based on checklists of food names and so reflect attitudes toward the verbal concept of food, since the food itself is never presented to the subject (45, 64). As a result, preferences for sweet and salty solutions need not predict self-reported liking for, or the likely consumption of, sweet or salty foods (59, 60, 79). Contrary to some assumptions (10), preferences for sweet need not be a proxy measure for hunger, satiety, or the likelihood of food consumption.

Food preferences, measured using preference checklists or actual taste tests, are often thought to predict food consumption in real life (14, 64). Their use allows investigators to dispense with the unreliable food diaries. Again, attitudinal responses collected in the laboratory often fail to predict real-life behavior (63), because many people do not overeat the foods they like. Potential reasons for a dissociation between taste preferences and actual intakes may include weight-related attitudes and behaviors and general concern with nutrition and health (55, 101).

Broader societal variables also play a role. As food companies have learned, market research studies based on blinded taste tests do not always predict purchase intent or actual consumer behavior. Although taste is regarded as the deciding factor, consumption patterns are also influenced by perceived nutrition, product safety, price, convenience, and prestige (56, 94). Other demographic, sociocultural, and economic factors also modulate the connection between taste responsiveness and food choice (66).

## SENSORY RESPONSE

Most research in nutrition and taste psychophysics has focused on the four basic tastes: sweet, sour, salty, and bitter (17). Among sensory responses studied were taste detection and recognition thresholds, intensity scaling of suprathreshold solutions, and hedonic preference profiles (3). Some studies in taste and food preferences have replaced aqueous solutions of pure tastants with more complex stimuli that engaged taste, texture, and olfaction (24, 30, 65, 76–78, 104). In the existing literature, most available data are on the perceptions and preferences for food stimuli that are sweet, salty, bitter, or rich in fat.

### *Sweet Taste Preferences*

The sensory appeal of sweetness is both innate and universal. Human neonates show a positive hedonic response to sweet solutions (98). Young children, ages 3–5 years, categorize foods according to whether they are familiar and/or sweet (5). In taste studies, children did not show the characteristic hedonic optimum or breakpoint for sucrose solutions, around 8–10% wt/vol, and selected the most intensely sweet solutions (50).

Much attention has been devoted to the question of whether sweet taste responsiveness leads to obesity in children, adolescents, or adults (86,87). Studies showing that obese persons did not reduce their preferences for sweet taste even after drinking 200 ml of sweet glucose solution (10) were used to support the argument that obese persons were "external" (86), hyperresponsive to sweet taste, and incapable of telling whether they were hungry or not. Again, taste preference profiles were taken as evidence of an intent to consume more sweets (10,86). However, the externality hypothesis was soon abandoned, as sensory studies demonstrated a wide variety of sensory responses to sweetness among the obese. Studies using sucrose solutions, sweetened soft drinks, or chocolate milkshakes found no connection between sweetness preferences and body weight (23). Whereas some obese subjects liked intensely sweet solutions, others did not (106). Large-scale consumer studies found no link between preferences for increasing concentration of sugar in canned peaches, lemonade, or vanilla ice cream and various indices of overweight. Studies on obesity and sweet taste failed to make the case that the sugar intake of a person with a sweet tooth was the principal cause of human obesity.

### *Sensory Response to Fats*

Fats endow foods with their characteristic taste and texture and contribute to the overall palatability of the diet. The first sensory response to fat involves perception through the nose or mouth of fat-soluble volatile flavor molecules (16,24). Oral perception of fat content is then determined by food texture as sensed by the oral cavity during chewing or swallowing (9). The precise type of sensation depends on the food product. In dairy products, fat takes the form of emulsified globules that are perceived as smooth and creamy (65). Water-binding qualities of fat account for the tenderness and juiciness of steaks and the moistness of cakes and other baked goods. Heat transfer at high temperature gives rise to food textures that are crispy, crunchy, and brittle. Among textural qualities that depend on the fat content of foods are hard, soft, juicy, chewy, greasy, viscous, smooth, creamy, crunchy, crisp, and brittle (9,24). Generally, the high-fat content of foods has been a desirable sensory feature, and one that is often linked with higher product quality (16). Preferences for fat in foods may be influenced to some extent by the amount of fat in the habitual diet (61).

Sensory studies on sweetened dairy products showed that the hedonic response to sweetness is potentiated by fat (29,30). Peak hedonic ratings were obtained of mixtures containing 20% fat wt/wt and 8% sucrose wt/wt, corresponding to whipping cream with sugar (30). Results initially obtained with mixtures of milk, cream, and sugar (29,30) were later extended to such stimuli as sweetened cream cheese, fromage blanc, cake frostings, and ice cream (28,34). Other studies systematically varied fat content in such foods as mashed potatoes

or scrambled eggs (67), or provided children with foods of varying fat content (42).

Hedonic response profiles for mixtures of milk, cream, and sugar showed that the composition of the best-tasting mixture depended, to some extent, on the subjects' body weight. Compared with normal-weight women, massively obese women selected stimuli that were less sweet but had a much higher fat content (29). Data from another laboratory later confirmed that preferences for higher-fat foods were directly linked to the subjects' own percentage of body fat (67). Most recently, a study of children, ages 3–5 years, showed that both preferences and consumption of fats were linked to body mass indices of parents (42), suggesting that preferences for fat in foods may carry a familial, and possibly genetic, component.

### *The Mechanisms of Pleasure*

Eating is one of life's greatest pleasures (102). The sensory pleasure response to foods may be mediated by brain neurotransmitters or brain peptides (27, 74). While many studies on food "cravings" have focused on the serotonergic system (107), others explored the role of endogenous opiate peptides in mediating the pleasure response to sweetness and fat (27, 35).

Endogenous opiates, or endorphins, are implicated in food cravings and in drug reward (35). In particular, preferences for sweet taste have long been known to be under opiate control. Opiate agonists increase, while antagonists decrease, preferences for sweet taste in humans (40) and the intake of sweet solutions by rats (6, 74). Fat consumption in rats was likewise increased by the opiate agonists morphine and butorphanol (74). Opiate effects were distinct from those of hunger and satiety and may act by altering the pleasure response to foods.

Opiate antagonists such as naloxone or naltrexone appear to reduce food intake by lowering preferences for selected foods. Although the consumption of sandwiches or salted soups remained stable after naltrexone (51), rated pleasantness of sweet glucose solutions declined (40), as did the consumption of the most preferred lunch foods following administration of another antagonist, nalmefene (108).

Endogenous opiate peptides have also been implicated in the binge-eating syndrome in obesity and bulimia nervosa. Significantly, many binge-eating episodes involve palatable sweet and high-fat foods. A recent clinical study (35) of 41 women, including 20 binge eaters, showed that naloxone infusions resulted in reduced hedonic preference response for mixtures of milk, cream, and sugar. Decline in taste preferences following naloxone was most marked for binge eaters and was paralleled by a selective drop in consumption of sweet, fat-rich snacks, including chocolate candy and chocolate chip cookies (35).

Obvious parallels have been drawn between binge eating and drug addiction, since both behavioral syndromes involve cravings and loss of control. Alcohol cravings are thought to be mediated through endogenous opiate peptides, and naltrexone, a long-lasting opiate antagonist, has been used to treat alcohol cravings in alcoholics (103). If similar mechanisms mediate food cravings and drug reward, then taste preferences may play a central role. Opiate addictions have been associated with an appetite for sweets, and opiate withdrawal is eased by ice cream and chocolate (35). Consequently, opiate blockade might be the therapy of choice for the treatment of binge eating in bulimia and binge-eating disorder (BED).

## THE REJECTION OF BITTER TASTE

### *Genetic Taste Markers*

Whereas many factors contribute to food preference, bitterness often predicts toxicity and can be the principal cause of food rejection (93). Plant-derived alkaloids and glycosides and other environmental toxins tend to have a bitter taste. Being able to identify and reject bitter compounds might, therefore, have a certain evolutionary advantage (38).

Sensitivity to bitter taste is a heritable trait (53). Crystals and solutions of phenylthiocarbamide (PTC) and 6-n-propylthiouracil (PROP) that taste bitter to some people are tasteless to others. In earlier studies, bimodal distribution of taste thresholds was used to separate subjects into groups of tasters and nontasters (53). More recent studies distinguished between nontasters, regular tasters, and supertasters of PROP on the basis of thresholds and intensity ratings of PROP solutions relative to NaCl solutions (4,33). Supertasters, most of whom were women, had the most fungiform taste buds and the highest density of fungiform papillae (85).

Sensitivity to PROP solutions has been associated with enhanced perception of other bitter compounds, notably saccharin and caffeine, that are found in ordinary foods (3,4,46). Past studies have also explored the potential connection between PROP sensitivity and the consumption of bitter- and sharp-tasting foods, though often with inconsistent results (see 38 for review). The most frequently cited example of taste rejection was the reported avoidance by PTC tasters of bitter compounds found in raw cruciferous vegetables: broccoli, cabbage, and Brussels sprouts (43,53). Early studies also found that PROP tasters tended to report more dislikes for common foods than did nontasters (43). Disliked foods included cabbage, Brussels sprouts, spinach, and kale, as well as rhubarb, sauerkraut, beer, coffee, and various sharp cheeses. Glanville & Kaplan (48) confirmed that PROP tasters disliked black coffee, grapefruit juice,



lemon juice, and horseradish and tended to prefer mild- over sharp-tasting foods. Another connection was drawn between taster status and predisposition to alcoholism: Most female alcoholics studied were reported to be PROP nontasters (80).

### *Functional Foods*

Plant-derived phytochemicals play a major role in cancer prevention (38). Many of these dietary constituents of vegetables and fruit have a bitter taste. These may include phytoestrogen lignans in bitter-tasting berries, indoles and isothiocyanates in cruciferous vegetables and horseradish, as well as bioactive flavonoids in citrus fruit, onions, and kale. Naringin, a bioflavonoid, is the bitter ingredient of grapefruit juice and a major inhibitor of cytochrome P-450 isozymes (38). If genetic taste markers alter preferences for bitter vegetables and fruit and, thus, affect food consumption patterns, they may turn out to be early indicators of increased risk for some of the diet-related chronic diseases (29).

## TASTE PREFERENCES AND FOOD CHOICES

Children's food preferences are often guided by taste alone (2, 5). In contrast, food choices of adults also tend to be influenced by nutritional beliefs and attitudes toward weight and dieting (58). The opposing influences of taste preferences and dietary restraint on food selection are frequently observed in clinical studies of obesity and eating disorders, such as anorexia and bulimia nervosa (31). Here, avoidance of the most preferred foods is often the norm.

### *Food Choices in Childhood*

Studies of preschool children have shown that food preferences in early life are determined by two factors: familiarity and sweetness (5). Preferences for fat may be acquired early in life, as children learn to prefer those flavors that are associated with high energy density and fat content (54). Fat and sugar are the chief components of peanut butter and jelly sandwiches, chocolate candy, cookies, and ice cream.

Both sweet-taste preferences (21, 68) and sugar consumption decline between adolescence and adult life (49). However, all evidence is indirect, since no study examined taste preferences and food intakes in the same subject group. Surveys of adolescent food habits are typically based on food preference checklists and, thus, reflect food-related attitudes rather than taste preferences or actual intakes. In general, adolescents reported liking foods rich in fat, sugar, and salt. One observational study confirmed that the most frequently consumed foods were

candy, potato chips, sweetened beverages, dry presweetened cereal, cupcakes, doughnuts, and pies (18).

Children also show an aversion to bitter foods (93). Typical food dislikes are based on taste (bitter), aversive trigeminal stimulation (sharp), and a variety of unpleasant food textures. Acquired preferences for coffee, beer, alcohol, and hot peppers are commonly cited as evidence that food preferences can be learned and modified with age. Indeed, food preferences and aversions are modifiable by growth, maturation, and hormonal status. Both taste preferences and food choices are further shaped by prior experience and associative learning. Preferences for bitter foods (caffeine), alcohol, and hot spices are all said to be the result of associating the often unpleasant taste with the desirable postingestive consequences (93). A previously neutral or even unpleasant taste can become preferred, provided it is linked with a suitable mechanism of reward.

### *Taste and Food Choices in Obesity*

Human obesity is thought to result from an interaction between genetic predisposition and exposure to environmental variables such as diet. Although the precise contribution of diet is still unclear, both energy intake and the composition of the diet are likely to play a major role. In particular, a selective appetite for high-fat foods appears to be a characteristic feature of many human obesity syndromes (36).

Studies on sugar and fat preferences among obese women showed that preferences for fat increased with body weight (29). Massively obese women selected fat-rich taste stimuli in sensory studies and listed high-fat foods as their favorites on food preference checklists (36). These findings were consistent with intake data from studies showing that obese people tend to overconsume fat, not sugar (47). However, only one study came close to showing that obese individuals with elevated sensory responses to fats were the ones who consumed the most high-fat foods (67).

Obese men and women may overconsume different sources of fat. Obese women asked to list top 10 favorite foods listed bread, doughnuts, cake, cookies, ice cream, chocolate, pies, and other desserts (36). In contrast, obese men listed steaks, roasts, hamburgers, french-fried potatoes, pizza, and ice cream. Whereas women selected foods that were mixtures of sugar and fat, food preferences of men included fat, protein, and salt (36). Obese weight cyclers showed higher preferences for ice cream and a sugar/fat mixture than did obese persons of more stable body weight (36). Selective appetite for fat in foods may be a potential behavioral mechanism for failure of weight loss and for a tendency to weight regain (37). Among potential mechanisms are increased levels of adipose tissue lipoprotein lipase and a variety of central peptides and neurotransmitters.

### *Taste and Eating Disorders*

The eating disorder anorexia nervosa is characterized by extreme caloric restriction, avoidance of energy-dense foods, and metabolic and endocrine dysfunction associated with severe loss of body weight. Bulimia nervosa is characterized by recurrent eating binges followed by purging and vomiting. An additional diagnostic category has been proposed for a BED: binge eating disorder that is not accompanied by purging. Most women with BED are reported to be obese, and many have a past history of weight cycling.

Studies of women with eating disorders point to a dissociation between taste responsiveness and eating patterns. Anorectic and bulimic women liked the taste of sweet solutions, as long as the possibility of ingestion was excluded (31). Bulimic patients and women with binge-eating disorder liked sweet and high-fat taste stimuli (28,35), though such foods are generally avoided by dieters and are consumed only in the course of a binge.

Pathological attitudes regarding body weight and dieting in eating disorders often outweigh taste responses and physiological regulation of food intake (25). Anorectic women reported liking only those foods that they also viewed as nutritious. Whereas protein-rich foods as well as grains, vegetables, and fruit were viewed as nutritious and therefore acceptable, calorie-dense sweet and high-fat foods were avoided. Clinical observations have shown that anorectic women consumed vegetables, lettuce, fresh fruit, cheese, and sometimes eggs but were disgusted by milk and meat. Among top food choices were salads, vegetables, and fresh fruit, foods devoid of both sugar and fat.

Binge-type foods were generally sweet and rich in fat. These foods included ice cream, bread, candy, doughnuts, salads, sandwiches, cookies, popcorn, milk, cereal, and large amounts of sweet but noncaloric soft drinks. Bulimic patients studied in hospital settings consumed doughnuts, pies, chocolate candy, and carbonated beverages (25). Though taste preferences for sweet and high-fat foods were high, eating patterns were influenced by a host of other variables related to pathological dieting.

### *Taste and Aging*

Age-related deficits in taste and smell are reputed to decrease the enjoyment of food, reduce food consumption, and lead eventually to malnutrition and ill health (71). However, there is little evidence to support this view. Elderly people often suffer from olfactory (22) and/or taste deficits (105), but how these deficits impact food choices, nutrition, and health is not clear. No study has demonstrated a causal relationship between sensory impairment, diminished hedonic response, and altered food patterns in the same group of elderly persons (91).

Most studies on taste and aging have focused on taste acuity and sensitivity rather than on hedonic preference (4). Aqueous solutions of sugar and salt

were the stimuli of choice because of the presumed impact that sugar and salt intake has on diabetes and hypertension. The frequent assumption was that elderly subjects suffering from taste losses would prefer sweeter and saltier stimuli and, thus, consume more sugar and salt. Though some studies (73) reported that hedonic ratings for solutions of sucrose, sodium chloride, and citric acid increased with age, other studies failed to confirm a broad age-related shift in hedonic response (109). Taste function is relatively robust and acuity and sensitivity of response measured by whole-mouth tasting are normal even into advanced old age. In at least one study, older adults showed no impairments in taste sensitivity, and their hedonic response profiles for sucrose solutions, sodium chloride solutions, or salted chicken broth were no different from those of young adults (32). Furthermore, individual preference profiles for the taste of salt had no impact on sodium consumption (32).

Some investigators have suggested that olfactory rather than taste losses are responsible for the reduced enjoyment of foods. Some studies examined flavor perception in relation to the pleasure response in the elderly (20). Classic studies by Schiffman (95) showed that impaired identification of blended foods by the elderly was most likely due to the loss of smell function. However, food consumption was not measured. In a recent study of older women, widespread smell deficits had a minimal impact on nutrition and health (39). In another study, clinical patients with taste and smell defects reported frequent taste and food aversions and sometimes lost, but other times gained, weight (62). Taste and smell deficits do not always have a consistent effect on nutrition and health.

It has also been argued that sensory losses are responsible for reduced dietary variety in old age. Flavor amplification has been suggested as one mechanism to increase food intake (96, 97). However, although diets of some older persons are indeed monotonous, it is difficult to separate the effects of taste function from those of illness, education, and income (90, 91). Changed social and economic circumstances as well as a host of psychological variables, including depression, loneliness, bereavement, and social support, all have a major impact on diet habits (19). Social nutrition as well as taste factors have a major impact on food intakes in old age.

## LINKING TASTE PREFERENCES AND FOOD CONSUMPTION

Demographic, economic, and sociocultural variables also play a major role in determining food choices at any age. Whereas taste preferences for sugar and fat may well be innate, group consumption of sugars and fats is determined by economic factors, including income (12).

### *Fat and Sugar in Nutrition Transition*

Economic growth has been associated with an improvement in and a progressive globalization of the human diet. As incomes grow, grain-based diets rich in complex carbohydrates and fiber are abandoned in favor of more diverse diets that contain more meat, milk, and sugars (83, 84). This is not a new phenomenon. Throughout history, economic development has been associated with elimination of systematic famine and replacement of coarse grains (corn, millet, and sorghum) and starchy roots with staple crops rice and wheat, and with selective breeding of domesticated animals for maximum fat content. The nutrition gap between rich and poor countries has grown narrower, as most converge on a diet that derives 30–40% of energy from fat (12, 26, 83).

This nutrition transition toward palatable sweet and high-fat foods appears to be both taste and income driven. Multiple between-country studies have shown a direct relationship between diet composition and the gross national product in American dollars (41, 81). Arguably, the trend is not simply toward greater consumption of fat and sugar. As incomes rise, more people consume a greater variety of foods and incorporate more different foods into their diets. As long as the new foods include milk, meat, vegetables, and fresh fruit, the overall diet will be higher in fats, saturated fats, and sugars and lower in complex carbohydrates and fiber.

### IMPLICATIONS FOR PUBLIC HEALTH

Nutrition education and intervention strategies aimed at improving diet quality have focused almost exclusively on the nutritional quality of foods and not on taste or the pleasure response. Much effort has been spent to persuade consumers to replace palatable energy-dense foods with less palatable, but arguably healthier, starches and grains (102). Social marketing and other strategies for behavioral change (15) are used in an effort to reduce fat and sugar consumption by children, adolescents, and adults. Yet studies point to innate preferences for sugar and fat and to the fact that the consumption of sugars and fats increases with income, socioeconomic status, and the availability of sugars and fats in the food supply. Studies in social nutrition further show complex sociocultural reasons behind the development of food preferences among individuals, families, and ethnic groups. Dietary intervention strategies aimed at improving diet quality should consider the sensory pleasure response to foods, as well as a wide range of demographic, economic, and sociocultural variables.

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