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# DIETARY CHANGE AND TRADITIONAL FOOD SYSTEMS OF INDIGENOUS PEOPLES

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ABSTRACT

Traditional food systems of indigenous peoples are defined as being composed of items from the local, natural environment that are culturally acceptable. Rapid dietary change of indigenous peoples worldwide is posing threats to use of this food and the traditional knowledge required for traditional food system maintainance. This review describes the many influences on choice of food by indigenous peoples, the qualities of traditional food systems, the forces of non-directed dietary change causing decline in use of traditional food systems, and the consequences of change for indigenous peoples. Several examples are given of dietary change research with indigenous peoples.

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## INTRODUCTION AND DEFINITIONS

In this review, we discuss the impact of nondirected dietary change on the use of traditional food systems by indigenous peoples, and the consequences it has on their nutrition and health. Our approach is primarily within the scope of nutritional anthropology, or "anthropological nutrition." We focus on culture and ecology as major determinants of nondirected dietary change. We also discuss the perspectives other disciplines have given toward understanding the impact these changes have on nutrition and health. A major portion of this review is dedicated to defining the unique qualities of traditional food systems of indigenous peoples, and we present examples of specific cultures where research on dietary change has uncovered nutrition and health consequences that are a result of the loss of these nutritional resources. We close with a summary of the threats to use of traditional food systems by indigenous peoples, and the current rationale and methods for protecting them.

"Traditional food system" is used to identify all food within a particular culture available from local natural resources and culturally accepted. It also includes the sociocultural meanings, acquisition/processing techniques, use, composition, and nutritional consequences for the people using the food. "Indigenous people" refers to a cultural group in a particular ecologic area that developed a successful subsistence base from the natural resources available. The plural form, "indigenous peoples," refers to more than one cultural group.

Durning (28) described indigenous peoples as the fast changing and geographically diverse populations known in different parts of the world by different names: small nationalities, remote area dwellers, tribes, primitive tribal groups, orang asli, native peoples, autochthonous peoples, aboriginal peoples, First Nations, or Founding Nations. He defined these peoples as the original inhabitants of areas that became occupied by more powerful outsiders, and whose language, culture, and/or religion remain distinct from the dominant group. These people consider themselves caretakers—not owners—of their land and resources, often maintaining ties to subsistence economies derived from hunting-gathering, fishing, nomadic or seasonal herding, shifting forest farming, or subsistence peasant cultivating. Their social relations involve complex networks of individual bonds, collective management of resources, and group decisions, often by consensus and involving elders. The World Bank (150) uses a more legalistic definition, derived from the United Nations Economic and Social Council Commission on Human Rights (1982). It includes peoples who are living more in conformity with their own social, cultural, and economic traditions than with those of the country of which they now form a part, a country incorporating social and cultural characteristics alien to their own. Estimates of numbers of indigenous peoples depend on the specific use of the definition, but they range from 266 million (150) to 660 million (28),

80% of which, according to Goering's summary of the geographic distribution of 380 different indigenous peoples (40), are found in Asia.

The following quote captures the essence of our review: "The Ngoni themselves say that the change of diet is the chief cause of their smaller stature today and the prevalence of various illnesses. The diet, by their own account, is much less varied today than formerly, and much less meat and milk are consumed. The knowledge of how to prepare (the special dishes) is passing as the older women die...The old Ngoni dishes, which were of considerable dietetic value, are unknown to the modern mission-trained girls who hanker after wheat flour and sugar which they have seen and used in missionaries' houses, and which can only be bought for money in the stores" (118).

## CULTURE, ECOLOGY, AND DIETARY CHANGE

### *How Culture and Ecology Influence Dietary Choice*

The reasons people choose what they do to meet their food needs are multifactorial and relate to a wide range of environmental, societal, and personal influences. To understand how indigenous peoples relate to their traditional food systems and to the changing patterns of food use, it is helpful to begin with an overview of how culture and ecology determine the dietary choices of all people (Table 1).

What foods are available from which the individual can choose is dependent on the environment and is moderated by technology and politics. Climatic conditions are especially important, not only for the agricultural activities that produce the crops presented through the marketplace, but also for the diversity, i.e. the number of different types, of wildlife animal and plant species used as food. For many indigenous peoples with hunting and gathering traditions, this diversity is essential for a balanced diet. But it is the quantity of the species available that is the key to dietary adequacy. Contemporary concerns with environmental quality and control of local and long-range transport of industrially generated contaminants bring the issues of environmental protection to the forefront of considerations of food availability. Issues that deal with protection of the natural environment for species diversity are also important. The knowledge indigenous peoples have about the natural environment and their traditional food resources has given them a reputation as stewards and monitors of environmental health and species diversity (49, 120, 123).

Food species harvested from the environment, whether by local indigenous people or through industrialized agriculture, is technologically managed with processing techniques to prepare it for distribution through a variety of networks to reach the individual finally consuming it. An infinite variety of indigenous food technologies have been reported and have much to offer the

**Table 1** Cultural and ecological influences on dietary choice

| |
|---|
| Food available[a] |
| Environment |
| Climate and crop/wildlife potential |
| Food species—types, quantity |
| Pollution control |
| Technology |
| Harvest and/or production |
| Processing |
| Distribution |
| Politics |
| Peace, stability, prosperity |
| Food selection[b] |
| Cultural preferences |
| Beliefs |
| Food flavor, color, texture, aroma |
| Dietary structure |
| Social and personal elements |
| Affordability |
| Time and personal energy |
| Expendible income and food price |
| Education and media |
| Biological need[c] |
| Physiological state |
| Age, gender |
| Physical exercise |
| Complete nutrients |
| State of health or pathology |

[a]Selected references: 22, 25, 27, 41, 49, 50, 53, 59, 79, 82, 104, 123, 127, 128, 140.
[b]Selected references: 7, 10, 20, 39, 42, 47, 51, 94, 101, 124.
[c]Selected references: 12, 17, 52, 87, 130, 131.



study of human food knowledge. However, indigenous technologies of food processing and distribution are disappearing as more and more indigenous peoples move away from their traditional lands, local food, and cultural knowledge (50, 78, 120).

Central to many of the issues concerning retention of traditional food knowledge and use of traditional food systems by indigenous peoples is the issue of politics. To practice and retain cultural knowledge and values, peace, stability, and prosperity are needed. Unfortunately, all too often it is the indigenous peoples within a nationality who are discriminated against, oppressed, margi-

nalized, and colonized, which makes it difficult to retain their cultural practices (91).

When a variety of food is available, what determines which items are selected is categorized according to cultural preference, affordability, influences of education and the media, and individual biological need. Cultural preference for food has been documented by many authors and is indeed fascinating. Beliefs about the qualities given by consuming a particular food and the reasons for adopting a particular structure to the diet are often central to cultural expression and participation. Beliefs about a food's healthful qualities can extend the value of that food, particularly when a plant, into the realm of traditional medicine (92, 94); however, many indigenous peoples do not separate plant species into those that are food and those that are medicine because the same item can be one, the other, or both at the same time, depending on the stage of plant development, the method of preparation, and the state of health or pathology of the individual (48).

Dietary structure is the way that meals, or the day's food, are composed. For example, in traditional Nuxalk culture, the meal was usually fish and something else, such as berries or a root vegetable; for highlands in Ethiopia, the meal is enjera (a type of bread) and wot (a sauce). Dietary structure also accounts for seasonal availability of food and how the culture adapts to variations in species. The sensory elements of food flavor, color, texture, and aroma are important in defining food preferences culturally, as well as in fulfilling the biological need for food individually (10). Certain textures, for instance, are considered appropriate as food for infants and the elderly. The color blue is important for certain traditional Hopi food, and preparation technologies favor the development of the blue color in blue corn bread (piki) and other meal items. These considerations, in turn, become important aspects of the dietary structure (66).

Social and personal elements that determine food selection include such functions as whether the food will be shared, as at social events; whether the food is for birthdays or other personal events; and whether the food is used to express individual, family, and group identity with a culture. Food is often used as an ethnicity marker. It is also used to express love, demonstrate power, or express rebellion. There are innumerable social and personal reasons for how foods are selected (7, 20, 93, 124).

The selection and acquisition of food can be dependent on income. Food price, which depends on the supply-and-demand equation, fluctuates with availability and ability to purchase. The concept of affordability also extends to the amount of time and personal energy available to harvest and prepare traditional cultural food items. This is noteworthy in cultures of indigenous peoples who are undergoing transition to a wage-based economy but who still want to participate in traditional food events, such as hunting, fishing, berry

picking, or helping with the cultivation of traditional crops, such as maize and beans. These activities can be costly in terms of time, energy, transportation, ammunition, fishing gear, etc. For some indigenous people, the barriers of affordability are too great, even though the wish to participate is there. For some, the selection of traditional cultural items is limited to holiday events, or during vacation time, which permits return to "the rez," or the traditional home lands.

Education and the media have had profound influences on food choices of indigenous peoples. Mission schools, boarding schools, public health programs, and nutrition education programs emphasizing the food known to the dominant culture have had their impact on children for more than 100 years, particularly in the Americas, Africa, and Australia. The introduction of new foods such as sugar, refined grain flour and bread, sweetened tea, and alcohol took place rapidly, and at the same time there was little acknowledgment or respect, and very little understanding, of the nutritional and cultural benefits traditional food gave to indigenous peoples. This trend continued with the introduction of the mass media, and with the sophisticated advertising of industrialized food, which must be purchased with currency (for example, see 63). The most notorious example of this phenomenon has been the marketing and sale of infant formula in areas where poor literacy precludes the population's ability to follow written instructions, and where water supplies are unsafe for consumption by infants. The result has been reduction in the extent of breast-feeding, and multiple deaths from intestinal infection, diarrhea, and dehydration (3).

The biological needs of the individual, as determined by contemporary science, have been well described in many excellent references. The profession of dietetics excels at bringing awareness of those biological needs to the public, enabling them to select foods to meet those needs. Age, gender, stage of development, and physiological state are central to dietary recommendations, as are the extent of a person's physical exercise, work performance, and state of health or pathology. For indigenous peoples, difficulties are encountered when interacting with contemporary health care specialists when the traditional cultural food system is not scientifically defined, and it is not included in health care education. Lack of incorporation of traditional health values into health care can lead to a lack of confidence in the traditional care or, alternatively, to a lack of participation in the modern medical system (H Kuhnlein, O Receveur, personal observation). For many indigenous peoples in developing countries, economic and political forces have had serious consequences for nutritional health. Compromise is a necessity in balancing food selection to meet the biological needs for growth, activity, parity, and infection resistance. The phenomenon of biological adaptation to dietary insult has received intensive study (13).

## *The Forces of Nondirected Dietary Change*

Generally speaking, the dietary changes indigenous peoples undergo are neither planned nor directed, either from the context of health education programs or from a deliberate reduction in available food supplies. Such dietary change is categorized as nondirected, a by-product or consequence of other events in the environment. For example, shifts in climate or weather patterns can disrupt the regular seasonal cycle of available plant and animal species. Political upheavals or militarization can interrupt anticipated food supplies or place unexpected population pressures on available food supplies. For indigenous peoples living close to the land, economic forces and industrialization have contributed to nondirected change as land resources are redirected for use as cash crops or industrial development and are no longer available for the traditional use of providing family food. Also, social and political structures that result in relocation, migration, and urbanization create nondirected change in the types and quantities of food available.

Delocalization of the food supply, which results from a complex set of industrial and modernizing influences, has been described as a major determinant of nondirected dietary change (111). Delocalization includes the processes by which food species and varieties, production techniques, and use patterns disseminate throughout the globe. In recent years, these processes have been intensifying with the increasing networks of socioeconomic and political interdependence. For any one individual or indigenous group, this means that an ever-increasing portion of the day's food comes from distant sources, usually through commercialization. In industrialized countries, the available diversity of food species and of processing techniques increases with delocalization and benefits those who can afford to purchase them. However, for indigenous peoples in rural areas, and for those in less-industrialized countries, there may be an opposite effect: a decreasing diversity of food items consumed as people use less of their traditionally harvested food and rely more on limited kinds of market food (111, 114).

## *Disciplinary Perspectives on Dietary Change*

Several disciplines have contributed to our understanding of dietary change. Among them, we have selected five that made important contributions: nutritional anthropology, nutrition, archeology, epidemiology, and economics. The dual realms of qualitative and quantitative research have been employed to advantage. We regard qualitative research as that describing people's perceptions or recall of events, including interviewing and library and archival work, whereas quantitative research includes actual linear measures, such as anthropometry data (90).

NUTRITIONAL ANTHROPOLOGY Nutritional anthropology has recently contributed a great deal to our understanding of the overall arena of dietary change. In addition to describing dietary delocalization, Pelto & Pelto (111) presented descriptions of several food transitions that occurred in history, and a detailed understanding of dietary change within Finland as an example of dietary change in northern European nations (112, 113). Studies of dietary modernization in Mexico revealed that socioeconomic status, education, a decline in self-reliance, new food-processing technologies, and the mass media were paramount in causing dietary change (26, 92). Bryant et al (20), Jerome et al (47), and Robson (120) brought the concept of changing ecologic circumstances to the forefront of understanding the cultural constructs of dietary change.

NUTRITION Nutritionist EM Widdowson teamed with anthropologist A Richards in the 1930s in Rhodesia to do pioneering research that included community use of food, energy expenditure, and food composition to determine dietary quality (119). When scholars identified as nutritionists study dietary change, the work takes a biological focus, either in terms of adaptation of human biology (13) or in terms of changes in nutritional profiles of the diet. Allen (4) described changing per capita consumption of maize, beans, and other items from 1962 to 1979 in rural and urban Mexico and attributed the change to urban migration, social class resulting from employment, the need to conserve personal and fossil fuel energy, and influences of the food industry and advertising. The nutritional consequences of this change are contrasted between urban (leading to chronic diseases) and rural (causing nutritional deficiencies) areas. Nutritionists studying dietary change with emphasis on food composition and urban migration in Guatemala found several micronutrients to be compromised because of changing food use (14, 15, 55, 56). Geissler (38) used aggregated figures on dietary intake and anthropometry to demonstrate positive changes in Korea and Thailand as compared with Iran and the Philippines, respectively. Change in diet can also be related to change in levels of biological markers such as glucose intolerance (102) or serum lipids (105). Ecologic associations of dietary change and patterns of illness can also be informative (151).

ARCHEOLOGY As a discipline that defines changes that occurred in the past from human remains and from the remains of their dietary elements, archeology offers much to the understanding of dietary change. Angel (5) described changes in health in the Mediterranean as a consequence of the transition over several centuries from hunting and gathering to developed farming, and Cassidy (23) described skeletal changes in a woodland culture of North America as a result of the shift from hunting/fishing/gathering to agriculture. Eaton &

Konner (29) have contributed to our understanding of dietary change over several millennia of human evolution with the conclusion that the human diet was far superior with the hunting and gathering subsistence of paleolithic times compared with the current western diet. Botanists and ethnobotanists research plant food used in the past and at the present time. The discipline of archeobotany has contributed important insights into how populations have evolved with changing use of plant food. An example is the work of Ford (37), in which plant remains in middens of Arizona pueblos were used to demonstrate use of food species and their relative quantities from 2000 B.C. to 1600 A.D. The introduction of corn, beans, and squash as agricultural crops was shown to begin at about 1200 B.C.; use increased with time until 1600, when these crops were the primary source of energy in the diet. Wing & Brown (149) describe the many ways that archeologic techniques are used to document dietary change.

EPIDEMIOLOGY The study of populations with variations in rates of diseases can provide useful clues about the etiology of diseases. Wide variations also exist in the diets of indigenous peoples: The Masai diet is based on milk and land animals; the Inuit diet is based on sea mammals, fish, and caribou; the Tarascan's is based on corn; the Truk's is based on starchy fruit, meat and fish; and the Manus diet is based on roots and nuts. Although these variations exist, systematic studies of dietary change and health outcomes have seldom been conducted among indigenous peoples. Low prevalences of heart disease and diabetes have been documented among indigenous peoples with widely differing diets such as the Masai, the Inuit, or the Tarahumara; yet, the potential link with diets or physical activity remains largely unexplored, while populations are rapidly converging towards a dietary pattern characterized by high saturated fat, sugars, refined foods, and low fiber (115, 116). Development of health and nutrition monitoring systems among indigenous peoples has not been readily feasible in the recent past because of their relative isolation. Epidemiologic study of indigenous people may uncover etiologic factors and be used to prevent, through education, the negative health consequences of undesirable dietary changes.

ECONOMICS The economic implications of a shift from traditional food harvest to a cash-cropping and wage economy has been the object of diverging observations. Earlier literature, summarized by Fleuret & Fleuret (35), consistently documented nutritional declines, also coined transitional malnutrition, in association with new cultigens as well as new income strategies. The need for incorporating nutrition and health-status monitoring into agricultural projects was suggested, with attention to the value of traditional food production and an awareness of the community-level consequences of change in agricul-

tural production. More recently, various studies concluded that "[N]egative factors and side effects that often dominate the debate on cash-cropping were found to be rather limited and can be dealt with by policy and program design" (144).

Emphasizing the need for historical context, Brun (19) in West Africa and Barrett (11) in Central America depict ruthless changes imposed through forced labor by military and governing elites. They also present how the Gourous and the Maya managed to maintain traditional methods of production in coexistence with export-oriented agriculture, thereby insuring a continuous supply of nutritious food as well as cultural cohesion. This dual economy may in fact be the rule; von Braun (144) noted in a survey of 78 developing countries that 65% devoted less than 30% of their cultivated area to cash-cropping.

INTERDISCIPLINARY RESEARCH ETHICS FOR PROJECTS WITH INDIGENOUS PEOPLES Research in indigenous communities also brings forward two most important ethical questions: Who sets research priorities, and how does research get done (45)? The first question relates to ownership of the scientific agenda and the fact that the research may not be necessarily or obviously relevant or beneficial to the community; the second emphasizes that communities often do not know what the research is for. In reaction to investigation characterized by a lack of communication between researchers and indigenous peoples, ethical principles were published to promote cooperation and mutual respect (1). New partnerships have evolved between scientists and indigenous communities that favor participatory research and that affect the mode as well as the content of research (126). For indigenous peoples, research is most acceptable when it contributes directly to community development.



## INDIGENOUS PEOPLES AND TRADITIONAL FOOD SYSTEMS

### *Qualities of Traditional Food Systems*

The major qualities of traditional food systems of indigenous peoples that require attention are the various species and species diversity that are accepted as food from the natural environment in diverse climates and latitudes, the technologies developed to harvest and process the food, and the sensory qualities and dietary structures developed for food selection (see Table 1). These qualities determine the chemical composition of the indigenous food items and the nutritional content of the diets of indigenous peoples. In understanding these qualities, we gain a perspective on the vast diversity of food available, and how many different dietary patterns can provide complete human nutrition.

SOURCES OF LITERATURE ON QUALITIES OF TRADITIONAL FOOD SYSTEMS To gain a purview on the diversity of food species used by indigenous people, the qualitative research offered through ethnographic literature in journals, monographs, and books is suggested reading. Within North American libraries, these sources include *Ecology of Food and Nutrition*, the *Journal of Ethnobiology*, *Economic Botany*, the *Journal of Ethnobotany*, and the *Journal of Food Composition and Analysis*; publications from university presses such as the University of Arizona, the University of Michigan, and the University of Oklahoma; and publications from national museums such as the National Museums of Canada, the Smithsonian Institution, etc. Monographs of specific cultures from other nations can be found through universities and national libraries. Traditional food system literature is also found within general ethnographies (e.g. 85) or in ethnobotanies that give descriptive information on all uses of plants within a culture (e.g. 34). Food composition data of indigenous foods processed and used by indigenous peoples are not commonly found in national tables of food composition, largely because of limited use of many of these items.

DIETARY DIVERSITY Review of the ethnographic literature for traditional food system information always reveals that a broad range of plant and animal species are used. An example is the diversity of animals and birds used by Arctic peoples (54, 125). Johns et al (49) call attention to the issue of environmental protection of species used for food by indigenous peoples. It is routine that the variety of species used in traditional food systems contributes to complete diets with ample amounts of fiber and micronutrients and limited saturated fat and refined carbohydrate (29). Further, the indigenous technologies used to process these items can be unique and can offer new understandings of food properties acceptable to a wide range of palates. Waugh (146) described 40 different ways of preparing Iroquois corn; Hough (43) described 70 ways the Hopi prepared their eight major varieties of food corn. In another example, Johns & Kubo (50) systematically described the multitude of ways indigenous peoples processed plants and their resulting qualities. Kuhnlein & Turner (78) described the variety of plant foods used by Canadian indigenous peoples, how the foods are processed, and their resulting nutrient composition.

SENSORY QUALITIES AND DIETARY STRUCTURE Traditional food systems of indigenous peoples offer knowledge about a great variety of sensory qualities of food, and many ways that food can be combined to form the preferred cultural dietary structure. The sensory qualities, dietary structure, and nutrient complementarity of the corn-beans-squash triad of food used by many native cultures is a prime example (4, 146). Johns (48) described several palatability

factors that affect consumption of wild food plants, and how and why plants are incorporated into dietary structures of indigenous peoples to serve other than strictly nutritional purposes— medicinal, for example, or to maintain cultural identity. Rice, fish, and coconut are the Indonesian dietary structure triad; ample and unusual spices and many different fruits and vegetables provide infinite dishes in that exotic cuisine (30).

NUTRITIONAL QUALITIES The literature on nutrient composition of traditional, indigenous food items is gradually growing. As a champion in the field of documenting indigenous food resources, Robson & Yen (121) presented previously unknown data on nutritional aspects of the Philippine Tasaday diet. The INFOODS network (129) is also building databases of regional food composition, but information on plant and animal species used as traditional food of indigenous peoples is not yet complete in many areas. In particular, a thorough documentation of the uses of wild green leafy vegetables is needed, because of their diversity and variation in nutrient composition depending upon environment, and because of their substantial contributions to dietary micronutrients (e.g. 14, 62).

## *Examples of Dietary Change Research with Indigenous Peoples*

In this section we present eight case studies of research with indigenous peoples that demonstrate change in the use of traditional cultural food and a resulting change in diet and nutrition.

!KUNG BUSHMEN OF THE KALAHARI DESERT, BOTSWANA Anthropologist RB Lee (81, 82) documented the traditional way of life of the Kalahari bushmen and included extensive study of their traditional food system. He documented the impressive success of this culture, a way of life that included a varied and balanced diet obtained by hunting and gathering, steady work of 1–2 hours per day in subsistence activities, and a regular amount of daily leisure. The diet was typified as "as much meat as they can get, and as much vegetable/plant food as they need." In the early 1960s, the July-August seasonal diet provided 35% of energy as meat and 65% of energy from vegetable and plant food, the majority of this coming from the mongongo nut. Some 54 species of wild game and 85 species of wild plants were used, each in their seasonal turn, in variable quantities, depending on availability. Drastic changes in nutritional status of the !Kung San took place from this time until 1984. Fernandes-Costa et al (33) reported that, with transition to settlement life, food was purchased from local stores or was provided by government agencies, with the majority of food energy coming from maize, with small amounts of meat and vegetables.

In comparing measurements from 1969 to 1981, the authors documented high rates of anemia secondary to iron and folate deficiencies; parasitism and alcoholism were rampant, and raised gamma-glutamyl transferase levels indicated general hepatic damage.

NUXALK OF BRITISH COLUMBIA The variety and extent of species used in the traditional fishing/hunting/gathering food system of the Nuxalk were researched using a combination of qualitative tools, including evaluation of the existing ethnographic literature and interviews with elders and with contemporary reserve-resident and urban-resident adults. Results showed many fewer of the traditional species used in the 1980s compared with those reported by the ethnographers in the 1940s (58). A series of food composition studies uncovered the rich sources of nutrients among traditional Nuxalk foods (61, 62, 69, 77, 79, 141). In particular, oil rendered from the smelt-like fish, the ooligan, has been shown to contain excellent levels of retinol and omega fatty acids (69, 80). Research on dietary change was conducted by interviewing three generations of adult women for retrospective food use during three different decades of their life (60, 63). It was shown that during this century there has been a steady decline in the use of traditional plant foods in such categories as berries, root food items, and greens; there was also a decline in use of animal wildlife food. However, families continued to use large amounts of fish on a daily basis. Older women were shown to have a greater taste appreciation of less-frequently used species of fish than the middle-aged or younger women had (60). The primary factors influencing changing traditional food use were food availability and taste appreciation, and these were statistically linked to use frequency. Interview data with community residents identified their perception of reasons for changes in their diets as: legislation restricting food resource use (fishing and game acts, trespassing restrictions), increasing population pressure on their allocated reserve lands, availability of market and gardened food, education and the media, and employment such that there was little time for traditional harvesting. This was especially true for the more intensive women's activities of harvesting berries and root foods (63).

HOPI Research on Hopi dietary change demonstrated a dramatic decline in use of their traditional food. Use of quantitative techniques of trace element analysis in deciduous teeth of children demonstrated that tooth composition changed from the 16th century to the 1970s. In particular, there was significantly more strontium, a marker for traditional food use, in archeologic samples from an excavation on the Hopi reservation compared with that in teeth of contemporary Hopi children; further, there was more lead in the contemporary teeth, reflecting greater exposure to this food contaminant from market food

(65). The traditional practice of adding plant ash to corn food enriches the corn dishes with several nutritional minerals, as well as with strontium and lead (57, 67, 68). Qualitative interview techniques with Hopi women and children during the 1970s showed that, at that time, less than one quarter of the dietary recalls contained one traditional food item, and this was usually a corn dish (66). Further, the number of species of traditional food items retained were a small fraction of those reported in Whiting's ethnographies of the 1930s (148); also, of the 25 different wild leafy plants mentioned by Hough (43) and Fewkes (34), only a few elders in the 1970s were known to collect them, and they appeared infrequently in dietary records as seasonal items (66). Wheat products were consumed more often than corn dishes by women and children; beef, fried potatoes, and eggs predominated in diets; colas were the preferred beverages of children. Although health data specific to the Hopi were not recorded as part of this research, it is clear that obesity is prevalent in all Southwest desert tribes, with body weight exceeding ideal weights by more than 25% in 39% of men and 65% of women. Recently, Brown & Brenton (18) reported dietary intakes of fifth-grade Hopi children and demonstrated intakes below the recommended daily allowance for vitamin D, calcium, and zinc; energy, fat, sucrose, and cholesterol were above recommended levels; and traditional food use was not reported at all for these children. Thus, it is clear that dietary change has continued to take place for the Hopi, and that this is coincident with changes in nutritional status. For prepubertal children, a major concern is that developing obesity could predispose to later gestational diabetes and the risks it carries for the next generation. Native people throughout North America are becoming susceptible to this health problem (136).

NANKANE OF NORTHERN GHANA Tripp (140) studied the changes in dietary practices among the Nankane, in Northern Ghana. Changes in diet for this indigenous population were induced by trading and labor migration and by the evolution of the cropping system. In this densely populated area, changes have occurred gradually. Millet replaced sorghum as the main food staple, hunting decreased significantly, and grazing became restricted. Women became more involved in trading and farming activities as men increasingly traveled to urban centers to trade or seek wage employment. Changes provided more stability to the local food supply and an increase in diet variety.

PAPUA NEW GUINEA Changes in food use and nutritional status have been documented in various regions of Papua New Guinea (142, 143). Great variations were present between highlands and coastal areas, as well as within each geographic region. The Busama's diet was characterized by taro and sago; the Kalapit's was characterized by sweet potato, plantain, and coconut; the Patep's diet was mainly taro and sweet potato; and the Katavaria's was yam,

sweet potato, coconut, and taro. Variations in anthropometric measurements paralleled variations in diet. Changes brought about by an increase in cash-cropping have been documented in the Simbu province in the highlands: Consumption of starchy tubers was largely replaced by imported rice, and traditional sources of fish and meat were replaced by imported tinned meat and fish. Fat and alcohol consumption increased. The author concludes that changes in traditional food systems has generally led to an improvement in nutritional status but that further information is needed to evaluate change that occurred in villages where men left their families to seek work in urban centers.

SAHTÚ DENE/MÉTIS Dietary change research with the Sahtú people of the western Canadian Arctic has focused on differences in food use and nutrient intake among three generations of adults. Dietary intake data were complemented with a series of food composition studies that documented a wide range of nutrients in traditional food previously unreported, and which was needed to complete the dietary analyses (6, 64, 97). Dietary intake data were split according to the portion containing the traditional food and that containing market food and then were analyzed by generation. Despite a prevalence of land-animal wildlife food, and a total amount of daily traditional food that ranged from 198–692 g per person per day for adults, the traditional food portion of the Sahtú diet was surprisingly low in fat, because of the low-fat contents of these meats. It was found that the youngest generation was consuming significantly less traditional food than were middle-aged adults and elders. Further, the youngest adult generation consumed a higher-fat diet because of the amount of fat in the market portion. Nutrient density determinations of the two dietary components demonstrated higher nutrients in the traditional food component of the diet for protein, iron, zinc, copper, and magnesium, whereas the market portion of the diet had greater density for total fat, calcium, vitamin A, and sodium. Of the nutrients assessed, those below the Canadian recommended nutrient intakes (RNIs) were calcium and vitamin A: Approximately 50% of all diets assessed were below 50% of the RNIs for these two nutrients (72, 98). Thus, it is apparent that, for the Sahtú, there is loss of traditional food use with each generation, and that dietary quality is lost with decreased use of nutrient-dense traditional food and increased use of market food.

MAYA OF GUATEMALA Various studies have assessed dietary changes following production for export of nontraditional food in the Department of Sacatepéquez (2, 44, 145). In one community, dietary information was collected in the 1950s (36), and the first comprehensive longitudinal study of infection and nutrition in a community setting was also conducted (89). The diet consisted of corn, black beans and peas, hot peppers, cabbage, green vegetables,

fruits, and herbs. Diet diversity was reported to have increased slowly in the 1950s and 1960s (89). In the 1970s, an evaluation of the impact of adoption of nontraditional food production reported further improvement in diet variety (2), but evaluation of the same cooperative project in the 1980s reported no differences in food intake among participants and nonparticipants in export-crop production. Children's nutritional status, measured by height and weight, did not change significantly over time: In 1985, the prevalence of children 6–60 months of age with weight-for-age z-scores below –2.0 was still 42.4%. The authors concluded that the severe economic crisis of the 1980s may explain the absence of overall improvement in nutritional status.

BAFFIN INUIT Dietary research with the Baffin Inuit was conducted every second month over one calendar year to capture the seasonal variation in use of the traditional food system. At the same time, locally harvested and prepared traditional food items for which no nutrient data existed were collected and analyzed to facilitate analysis of diets (70, 74). The traditional food system is composed of sea mammals, land animals, fish, birds, shellfish, and plants, with the majority of dietary energy coming from sea mammals. The 24-h recall dietary data were compartmentalized into traditional and market portions and were analyzed by three generations of adults, teens, and young children to capture the changes in traditional food use by generation. Traditional food was found to contribute 30–40% of average daily energy, and to be consumed significantly less by younger people, who consumed more market food. Nutrient density comparisons of the traditional and market portions of the diets revealed that traditional food had greater density for protein, iron, zinc, copper, magnesium, and vitamin A in two older age groups. More than 50% of the population fell below two thirds of the RNIs for calcium and vitamin A. Market food contributed about 66% of total energy on the yearly average, and more fat, carbohydrate, calcium, and sodium. It was concluded that traditional food for this culture is vital to maintaining dietary adequacy for many nutrients because market food that is available, purchased, and consumed is of inferior nutritional quality (76, 75).

## THREATS TO TRADITIONAL FOOD SYSTEMS AND CONSEQUENCES OF CHANGE

Figure 1 captures the overview of threats to continued use of traditional food systems of indigenous peoples, and a summary of consequences resulting from their loss. For indigenous peoples, this is a loss of food use as well as a loss of the knowledge required to recognize, harvest, prepare, and enjoy traditional indigenous food resources. It is also a loss of knowledge to all humankind. The consequences of this loss to indigenous peoples are recognized not only

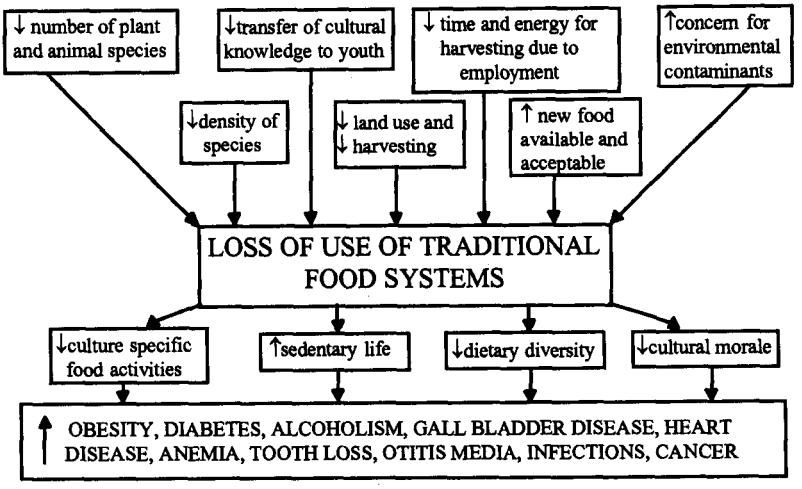


*Figure 1* Factors influencing dietary change and consequences of change for indigenous peoples.

culturally, but as a corollary to a variety of chronic diseases that have food and compromised nutritional status within their etiology.

Depending on the particular location and economic situation of a group of indigenous people, the most important force to dietary change varies. As for the !Kung, noted above, it may be the relocation of people into settlements, where they take on wage employment. In such a case, the most important factors would be decreased access to land use and decreased harvesting, followed by decreasing time and energy for harvesting due to employment, and increasing new foods (imported into settlements through markets) and their acceptability.

Traditional peasant agriculturalists, for example in Mexico or Guatemala where modest hunting and gathering were also practiced, have been forced from their traditional land into marginal areas as a result of population pressure and cash-cropping activities. For them, the most important factors would be a decrease in the number and density of plant and animal species available, as well as decreased land use and harvesting. The same factors in Figure 1 would be relevant for indigenous people who migrate into urban areas.

Environmental contaminants such as heavy metals and organochlorines from long-range or local sources are finding their way into many animal and plant species used as food by indigenous peoples. Human health concerns from contamination in a particular food item is dependent on the amount of contaminant in the food as well as on the amount of food consumed. Documen-

tation is now emerging on a variety of contaminant concerns in traditional food resources (11, 24, 73, 147).

Whether or not people stop using their traditional land base, environmental contamination may cause lack of viability of indigenous plant and animal wildlife. Further, any concerns for environmental contaminants that are widely disseminated in the media will cause people to restrict their use of resources (fish, wildlife, water, etc). If this concern is combined with employment and the availability and acceptability of new food, an eventual loss of the traditional food system will take place. Further, any of the factors that cause decreased use of traditional food systems will lead to declining transfer of traditional knowledge to young people on how to recognize, harvest, process, and prepare their food.

## *Consequences of Loss of Traditional Food Systems*

If people remain close to their traditional environment, decreasing use of their traditional food is a gradual process. As noted for the Nuxalk, a gradual decline in use of traditional plant food took place during this century, but the regular use of fish by reserve-resident families has been maintained (63). However, people relocated from their homelands have little opportunity to maintain traditional knowledge of available resources and technologies for processing and use. They will quickly adapt to new food patterns and will likely not transfer traditional food knowledge to the next generation. In general, the loss of traditional food systems will result in decreasing culture-specific food activities, decreasing dietary diversity for those in rural areas and in poor economic circumstances, and decreasing cultural morale as a result of these elements. A sedentary lifestyle is often the case, particularly if employment is undertaken, market food is purchased, and traditional hunting/gathering or farming is not practiced.

The nutrition and health consequences of changing lifestyles of indigenous peoples in North America have been documented to a greater extent than for indigenous peoples in any other part of the world, with the possible exception of Australia. On these two continents, as least, indigenous peoples are among the most economically disadvantaged, and they suffer from poor diets and a spectrum of chronic diseases associated with poor diets. It is beyond the scope of this review to give a complete discussion of the diseases suffered by indigenous peoples in cultural transition, and how dietary change is interfaced with other lifestyle changes such as smoking, disintegration of social networks, decreasing physical activity, and increased stress. However, the major trends that appear in the literature relate to obesity, diabetes, and the complications of diabetes including cardiovascular disease. These conditions are higher among native people in the United States and Canada than among any other

population subgroup; these problems are attributed to changing dietary patterns and reduced physical activity. Increased saturated fat, sucrose, and alcohol in diets has led to greater incidence of gall bladder disease, alcoholism and its complication including fetal alcohol syndrome, and tooth loss. Micronutrient deficiencies from poor dietary quality may have contributed to greater incidence of anemia, otitis media, a variety of infections, and some kinds of cancer (46, 96, 102, 107–109, 133–135, 137–138, 152–156).

With decreased use of sea mammals, fish, and fish oils, indigenous peoples who have these items in their traditional food systems will face a reduction in the quantities of omega fatty acids in their regular diets, which can impact on several of the chronic diseases noted above (8, 9, 69, 76, 102).

### *Alternatives*

When indigenous peoples lose their traditional, cultural food systems, it is possible that circumstances can favor maintaining positive nutritional status and good health, even though the intimate relationship between people and their natural environment is lost. As noted for the Nankani, if economic circumstances are favorable and dietary stability with a variety of food is possible, nutritional quality of diets can be maintained. By the same token, urban migration usually results in lack of availability of traditional food resources from homelands; but if efforts are made to transport these to city markets, they can be purchased if funds are available (21) and used with other food to form nutritionally adequate diets. Thus, loss of nutritional quality with traditional food systems can be countered with adequate income, availability of good-quality food, and education in the use of good-quality food.

Several examples of directed dietary change have demonstrated positive results from cultural revival and reintroduction of traditional foods. In Hawaii, a traditional diet was used to reduce obesity and cardiovascular risk (132). Traditional dietary items were used to introduce positive dietary change in Micronesia (122); among the Nuxalk, a traditional food promotion program successfully increased use of fish and traditional plants (59, 71). O'Dea showed that a temporary return to traditional diet and lifestyle improved carbohydrate and lipid metabolism for diabetic Australian indigenous people (107, 108).

Indigenous people who migrate to urban areas may often return to their homelands, harvest and preserve their traditional food, and take it with them when they return to the city (58).

## PROTECTING TRADITIONAL FOOD SYSTEMS

Traditional food systems can provide strategies to combat malnutrition while ensuring sustainable development (100, 110, 117). As early as 1985, the Food and Agricultural Organization (FAO) requested that assistance be given to

governments to promote traditional food plants (31), and publications supported this effort (32). It is also now recognized that other food items such as small animals and wild foods must be considered as important in many areas where malnutrition is evident (99). Since indigenous peoples are tenants of traditional food system knowledge, interinstitutional initiatives will be more likely to contribute to the development of these resources if indigenous peoples are encouraged to participate.

In spite of current treats to the integrity of traditional food systems, significant activities are under way to document this traditional knowledge. Important resources have already been invested in the creation of additional food composition data for traditional food from the Arabian Gulf (103), Australia (16), Mali (106), Indonesia (86), and Chile (88), to name a few examples. A conference organized in March 1994 by FAO/UNU (United Nations University) was the first since 1983 to evaluate opportunities for recording worldwide food composition data (84). The documentation of traditional food systems is urgent because the knowledge of food harvesting and preparation is fast disappearing. As noted by Mintz (95), substantial ethnographic detail is needed to interpret dietary change and the effect of change. For indigenous peoples, protecting traditional food systems will provide many cultural benefits; these efforts may also prevent the emergence of the chronic disease patterns associated with progression of economic development.



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## *Literature Cited*

1. ACUNS (Assoc. Can. Univ. North. Stud.). 1982. *Ethical Principles for the Conduct of Research in the North, ACUNS Occasional Publ. 7.* Ottawa, Ontario, Can: National Library of Canada. 16 pp.
2. Agency for International Development. 1981. *The Social Impact of Agribusiness: A Case Study of ALCOSA in Guatemala.* Washington, DC: US Agency for Int. Dev.
3. Akre J. 1989. Infant feeding: the physiological basis. *WHO Bull.* 67(Suppl.):1–108
4. Allen LA. 1992. The Mexican food system: traditional and modern. *Ecol. Food Nutr.* 27:219–34
5. Angel JL. 1984. Health as a crucial factor in the changes from hunting to developed farming in the eastern Mediterranean. In *Paleopathology at the Origins of Agriculture*, ed. N Cohen, GJ Armelagos, p. 51–73. New York: Academic
6. Appavoo DM, Kubow S, Kuhnlein HV. 1991. Lipid composition of indigenous foods eaten by the Sahtú (Hareskin) Dene-Métis of the Northwest Territories. *J. Food Compos. Anal.* 4:107–19
7. Axelson ML. 1986. The impact of cul-

ture on food-related behavior. *Annu. Rev. Nutr.* 6:345–63
8. Bang HO, Dyerberg J. 1972. Plasma lipids and lipoproteins in Greenlandic west coast Eskimos. *Acta Med. Scand.* 192:85–94
9. Bang HO, Dyerberg J, Sinclair HM. 1980. The composition of the Eskimo food in North Western Greenland. *Am. J. Clin. Nutr.* 33:2657–61
10. Barker LM. 1983. *The Psychobiology of Human Food Selection.* Westport, CT: AVI. 262 pp.
11. Barrett B. 1995. Commentary: plants, pesticides, and production in Guatemala: nutrition, health and non-traditional agriculture. *Ecol. Food Nutr.* 33: 293–309
12. Beaton GH. 1985. The significance of adaptation in the definition of nutrient requirements and for nutrition policy. In *Nutritional Adaptation in Man*, ed. K Blaxter, JC Waterlow, pp.219–32. London: John Libbey
13. Blaxter K, Waterlow JC. 1985. *Nutritional Adaptation in Man.* London: John Libbey. 244 pp.
14. Booth S, Bressani R, Johns T. 1992. Nutrient content of selected indigenous leafy vegetables consumed by the K'ekchi people of Alta Verapaz, Guatemala. *J. Food Compos. Anal.* 5:25–34
15. Booth S, Johns T, López-Palacios CY. 1993. Factors influencing the dietary intake of indigenous leafy greens by the K'ekchi people of Alta Verapaz, Guatemala. *Ecol. Food Nutr.* 31:127–45
16. Brand Miller JC, James KW, Maggiore P. 1993. *Tables of Composition of Australian Aboriginal Foods.* Canberra, Aust: Aboriginal Studies
17. Briggs GM, Calloway DH. 1984. *Nutrition and Physical Fitness.* New York: CBS College. 623 pp. 11th ed.
18. Brown AC, Brenton B. 1994. Dietary survey of Hopi Native American elementary students. *J. Am. Diet. Assoc.* 94:517–22
19. Brun TA. 1991. The nutrition and health impact of cash cropping in West Africa: a historical perspective. In *Impacts on Nutrition and Health, World Rev. Nutr. Diet*, ed. AP Simopoulos, 65:124–62. Basel: Karger
20. Bryant CA, Courtney A, Markesbery BA, DeWalt KM. 1985. *The Cultural Feast: An Introduction to Food and Society.* St. Paul, MN: West Publ.
21. Bye RA. 1981. Quelites—ethnoecology of edible greens—past, present, and future. *J. Ethnobiol.* 1(1):109–23
22. Caliendo M. 1979. *Nutrition and the World Food Crisis.* New York: MacMillan. 138 pp.
23. Cassidy C. 1980. Nutrition and health in agriculturists and hunter-gatherers: a case study. In *Nutritional Anthropology: Contemporary Approaches to Diet and Culture*, ed. N Jerome, R Kandel, GH Pelto, pp. 117–45. Pleasantville, NY: Redgrave
24. Chan HM, Kim C, Khoday K, Receveur O, Kuhnlein HV. 1995. Assessment of dietary exposure to trace metals in Baffin Inuit food. *Environ. Health Perspect.* 103(7–8):740–46
25. den Hartog AP. 1992. Dietary change and industrialization—the making of the modern Dutch diet (1850–1985). *Ecol. Food Nutr.* 27:307–18
26. DeWalt KM, Pelto GH. 1977. Food use and household ecology in a Mexican community. In *Nutrition and Anthropology in Action*, ed. TK Fitzgerald, pp. 79–93. Amsterdam: Van Gorcum
27. Dichter CR. 1987. The fifth world food survey: an assessment of food supplies and malnutrition. *J. Am. Diet. Assoc.* 87(12):1668–72
28. Durning AT. 1992. *Guardians of the Land: Indigenous Peoples and the Health of the Earth, Worldwatch Paper 112.* Washington, DC: Worldwatch Inst.
29. Eaton SB, Konner M. 1985. Paleolithic nutrition. *N. Engl. J. Med.* 312(5):283–90
30. Eiseman FB. 1990. *Bali: Sekala and Niskla*, Vol 1. Hong Kong: Periplus Editions
31. FAO (Food Agric. Org.). 1985. The role of minor crops in nutrition and food security. In *Report of the Eighth Session of the Committee on Agriculture, 18–20 March, Rome, Italy.* 50 pp.
32. FAO (Food Agric. Org.). 1988. *Traditional Food Plants, FAO Food and Nutrition Paper #42.* Rome: FAO
33. Fernandes-Costa FJ, Marshall J, Ritchie C, Van Tonder SV, Dunn DS, et al. 1984. Transition from a hunter-gatherer to a settled lifestyle in the !Kung San: effect on iron, folate, and vitamin B12 nutrition. *Am. J. Clin. Nutr.* 40:1295–303
34. Fewkes JW. 1896. A contribution to ethnobotany. *Am. Anthropol.* 9:14–20
35. Fleuret P, Fleuret A. 1980. Nutrition, consumption, and agricultural change. *Hum. Organ.* 39(3):250–60
36. Flores M, Reh E. 1955. *Estudios de habitos dieteticos en poblaciones de Guatemala. IV. Santa Maria Cauque Supl. No. 2 Bol. Of. San. Pan. Publ. Cient. INCAP*
37. Ford RI. 1972. An ecological perspec-

tive on the Eastern Pueblos. In *New Perspectives on the Pueblos*, ed. A Ortiz, pp. 1–17. Albuquerque, NM: Univ. New Mexico Press
38. Geissler C. 1993. Stature and other indicators of development: comparisons in Thailand and the Philippines, Korea and Iran. In *Food, Diet and Economic Change Past and Present*, ed. C Geissler, DJ Oddy. Leicester, UK: Leicester Univ. Press
39. Gifft HH, Wasbon MB, Harrison GG. 1972. *Nutrition, Behavior, and Change.* Englewood Cliffs, NJ: Prentice-Hall. 392 pp.
40. Goering B. 1993. *Indigenous Peoples of the World: An Introduction to Their Past, Present and Future.* Saskatoon, Saskatchewan, Can: Purich
41. Harris RS, Karmas E. 1975. *Nutritional Evaluation of Food Processing.* Westport, CT: AVI. 2nd ed.
42. Hernandez M, Hidalgo CP, Hernandez JR, Madrigal H, Chavez A. 1974. Effect of economic growth on nutrition in a tropical community. *Ecol. Food Nutr.* 3:283–91
43. Hough W.1897. The Hopi in relation to their plant environment. *Am. Anthropol.* 10:33–38
44. Immink MD, Alarcon JA. 1991. Household food security, nutrition, and crop diversification among smallholder farmers in the highlands of Guatemala. *Ecol. Food Nut.* 25:287–305
45. Inuit Tapirisat of Canada. 1993. *Negotiating Research Relationships in the North.* Background paper for a workshop on guidelines for responsible research, Yellowknife, 22–23 September. Ottawa, Ontario, Can: ITC
46. Jackson Y. 1986. Nutrition in American Indian health: past, present and future. *J. Am. Diet. Assoc.* 86:1561–65
47. Jerome N, Kandel R, Pelto GH. 1980. *Nutritional Anthropology: Contemporary Approaches to Diet and Culture.* Pleasantville, NY: Redgrave
48. Johns T. 1994. Ambivalence to the palability factors in wild food plants. In *Eating on the Wild Side*, ed NL Etkin, pp. 46–61. Tucson: Univ. Ariz. Press. 305 pp.
49. Johns T, Chan HM, Receveur O, Kuhnlein HV. 1994. Nutrition and the environment of indigenous peoples. *Ecol. Food Nutr.* 32: 81–87
50. Johns T, Kubo I. 1988. A survey of traditional methods employed for the detoxification of plant foods. *J. Ethnobiol.* 8:81–129
51. Johns T, Kuhnlein HV. 1990. Cultural determinants of food selection and behaviour. In *Diet and Behavior*, ed. GH Anderson, pp. 17–31. Berlin: Springer-Verlag
52. Johnston FE. 1987. *Nutritional Anthropology.* New York: Liss
53. Katz SH, Hediger ML, Valleroy LA. 1974. Traditional maize processing techniques in the new world. *Science* 184:765–73
54. Kemp W. 1984. Baffinland eskimos. In *Handbook of North American Indians, Arctic,* ed. D Damas, 5:463–75. Washington, DC: Smithsonian Inst.
55. Krause VM, Solomons NW, Tucker KL, López-Palacios CY, Ruz M, Kuhnlein HV. 1992. Rural-urban variation in the calcium, iron, zinc and copper content of tortilla and intake of these minerals from tortilla by women in Guatemala. *Ecol. Food Nutr.* 28(4):289–97
56. Krause VM, Tucker KL, Kuhnlein HV, López-Palacios CY, Ruz M, Solomons NW. 1992. Rural-urban variation in limed maize use and tortilla consumption by women in Guatemala. *Ecol. Food Nutr.* 28(4):279–88
57. Kuhnlein HV. 1981. Dietary mineral ecology of the Hopi. *J. Ethnobiol.* 1:84–94
58. Kuhnlein HV. 1984. Traditional and contemporary Nuxalk foods. *Nutr. Res.* 4:789–809
59. Kuhnlein HV. 1986. The Nuxalk food and nutrition program: overview and objectives. *Nutr. Newsl.* 7:26–34
60. Kuhnlein HV. 1989. Factors influencing use of traditional foods among the Nuxalk people. *J. Can. Diet. Assoc.* 50(2): 102–8
61. Kuhnlein HV. 1989. Nutrient values in indigenous wild berries used by the Nuxalk people of Bella Coola, British Columbia. *J. Food Compos. Anal.* 2:28–36
62. Kuhnlein HV. 1990. Nutrient values in indigenous wild green plants and roots used by the Nuxalk people of Bella Coola, British Columbia. *J. Food Compos. Anal.* 3:38–46
63. Kuhnlein HV. 1992. Change in the use of traditional foods by the Nuxalk native people of British Columbia. *Ecol. Food Nutr.* 27(3–4):259–82
64. Kuhnlein HV, Appavoo DM, Morrison N, Soueida R, Pierrot P. 1994. Use and nutrient composition of traditional Sahtú (Hareskin) Dene/Métis foods. *J. Food Compos. Anal.* 7:144–57
65. Kuhnlein HV, Calloway DH. 1977. Minerals in human teeth: differences between pre-industrial and contemporary Hopi Indians. *Am. J. Clin. Nutr.* 30:883–86

66. Kuhnlein HV, Calloway DH. 1978. Contemporary Hopi food intake patterns. *Ecol. Food Nutr.* 6(3):16–24
67. Kuhnlein HV, Calloway DH.1979. Adventitious mineral elements in Hopi Indian diets. *J. Food Sci.* 44(1):282–85
68. Kuhnlein HV, Calloway DH, Harland BF. 1979. Composition of traditional Hopi foods. *J. Am. Diet. Assoc.* 75(1): 37–41
69. Kuhnlein HV, Chan AC, Thompson JN, Nakai S. 1982. Ooligan grease: a nutritious fat used by native people of coastal British Columbia. *J. Ethnobiol.* 2(2): 154–61
70. Kuhnlein HV, Kubow S, Soueida R. 1991. Lipid components of traditional Inuit foods and diets of Baffin Island. *J. Food Compos. Anal.* 4:227–36
71. Kuhnlein HV, Moody SA. 1989. Evaluation of the Nuxalk food and nutrition program: traditional food use by a native Indian group in Canada. *J. Nutr. Educ.* 21(3):127–32
72. Kuhnlein HV, Receveur O, Morrison NE, Appavoo DM, Souieda R, Pierrot P. 1996. Dietary nutrients of Sahtú Dene/Métis vary by food source, season and age. *Ecol. Food Nutr.* 34:183–95
73. Kuhnlein HV, Receveur O, Muir DCG, Chan HM, Soueida R. 1995. Arctic indigenous women consume greater than acceptable levels of organochlorines. *J. Nutr.* 125:2501–10
74. Kuhnlein HV, Soueida R. 1992. Use and nutrient composition of traditional Baffin Inuit foods. *J. Food Compos. Anal.* 5:112–26
75. Kuhnlein HV, Soueida R, Receveur O. 1996. Dietary nutrient profiles of Canadian Baffin Island Inuit differ by food source, season and age. *J. Am. Diet. Assoc.* 96:155–62
76. Kuhnlein HV, Soueida R, Receveur O. 1995. Baffin Inuit food use by age and gender. *J. Can. Diet. Assoc.* 56:175–83
77. Kuhnlein HV, Turner NJ. 1987. Cow-parsnip (*Heracleum lanatum* Michk.): an indigenous vegetable of native people of northwestern North America. *J. Ethnobiol.* 6(2):309–24
78. Kuhnlein HV, Turner NJ. 1991. *Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany and Use.* Philadelphia: Gordon & Breach Sci. 620 pp.
79. Kuhnlein HV, Turner NJ, Kluckner PD. 1982. Nutritional significance of two important 'root' foods (Springbank Clover and Pacific Silverweed). *Ecol. Food Nutr.* 12:89–95
80. Kuhnlein HV, Yeboah F, Sedgemore M, Sedgemore S, Chan HM. 1996. Nutritional qualities of ooligan grease: a traditional food fat of British Columbia First Nations. *J. Food Compos. Anal.* 9:18–31
81. Lee RB. 1968. What hunters do for a living, or, how to make out on scarce resources. In *Man the Hunter*, ed. RB Lee, L DeVore. Chicago: Aldine
82. Lee RB. 1984. *The Dobe !Kung*. New York: Holt. 173 pp.
83. Lepofsky D, Turner NJ, Kuhnlein HV. 1985. Determining the availability of traditional wild plant foods: an example of Nuxalk foods, Bella Coola, British Columbia. *Ecol. Food Nutr.* 16:223–41
84. Lupien JR. 1995. Developing comprehensive policies and programs for improved food supplies and nutrition. In *Quality and Accessibility of Food-Related Data, Proc. First Int. Food Data Base Conf.*, pp. 3–10. Arlington, VA: Assoc. Off. Anal. Chem. Int.
85. McIlwraith TF. 1948. *The Bella Coola Indians*, Vol. 1, 2. Toronto: Univ. Toronto Press. 2nd ed.
86. Mahmud MK, Slamet DS, Apryantono RR. 1990. *The Indonesian Food Composition Table*. Bogor: Dir. Nutr. Nutr. Res. Dev. Ctr.
87. Martorell R. 1985. Child growth retardation: a discussion of its causes and its relationship to health. In *Nutritional Adaptation in Man*, ed. K Blaxter, JC Waterlow, pp.13–30. London: John Libbey
88. Masson L. 1995. CHILEFOODS: food composition activities in Chile and Latin America. In *Quality and Accessibility of Food-Related Data, Proc. First Int. Food Data Base Conf.*, pp. 17–24. Arlington, VA: AOAC Int.
89. Mata LJ.1978. *The Children of Santa Maria Cauqué: A Prospective Field Study of Health and Growth.* Cambridge, MA: MIT
90. Mechanic D. 1989. Medical sociology: some tensions among theory, method, and substance. *J. Health Soc. Behav.* 30:147–60
91. Menchu R. 1984. *I, Rigoberta Menchu. An Indian Woman in Guatemala.* New York: Verso
92. Messer E. 1977. The ecology of vegetarian diet in a modernizing Mexican community. In *Nutrition and Anthropology in Action*, ed. TK Fitzgerald, pp. 117–24. Amsterdam: Van Gorcum
93. Messer E. 1984. Anthropological perspectives on diet. *Annu. Rev. Anthropol.* 13:205–49
94. Messer E. 1984. Sociocultural aspects of nutrient intake and behavioral responses to nutrition. In *Nutrition and*

*Behavior: Human Nutrition*, ed. R Alfin-Slater, D Kritchevsky, pp. 417–69. New York: Plenum
95. Mintz SW. 1989. Food and culture: an anthropological view. In *Completing the Food Chain: Strategies for Combating Hunger and Malnutrition*, ed. PM Hirschoff, NG Kotler, pp. 114–21. Washington, DC: Smithsonian Inst.
96. Mohs ME, Leonard TK, Watson RR. 1988. Interrelationships among alcohol abuse, obesity and type II diabetes mellitus: focus on Native Americans. *World Rev. Nutr. Diet.* 56:93–172
97. Morrison NE, Kuhnlein HV. 1993. Retinol content of wildlife foods consumed by the Sahtú (Hareskin) Dene/Métis. *J. Food Compos. Anal.* 6:10–23
98. Morrison NE, Receveur O, Kuhnlein HV, Appavoo DM, Soueida R, Pierrot P. 1995. Contemporary Sahtú Dene/Métis use of traditional and market food. Ecol. *Food Nutr.* 34:197–210
99. Muehlhoff E, Simmersbach F, Baron P, Egal F. 1995. Alleviating malnutrition in communities: FAO's evolving strategies. *Food Nutr. Agric. (FNA/ANA)* 13/14
100. Murcott A. 1988. Sociological and social anthropological approaches to food and eating. *World Rev. Nutr. Diet* 55:1–40
101. Murcott A. 1992. Cultural perceptions of food and eating: obstacles to change? *Ecol. Food Nutr.* 27:283–90
102. Murphy NJ, Schraer CD, Thiele MC, Boyko EJ, Bulkow LR, et al. 1995. Dietary change and obesity associated with glucose intolerance in Alaska Natives. *J. Am. Diet. Assoc.* 95:676–82
103. Musaiger AO. 1993. *Traditional Foods in the Arabian Gulf Countries.* Bahrain: Arabian Gulf Univ.
104. National Research Council. 1978. *Plant and Animal Products in the U.S. Food System.* Washington, DC: Natl. Acad. Sci.
105. Nobman ED, Mamleeva FY, Klachkova EV. 1994. A comparison of the diets of Siberian Chukotka and Alaska native adults and recommendations for improved nutrition, a survey of selected previous studies. *Arctic Med. Res.* 53(3): 123–29
106. Nordeide MB, Osbaugh A, Holm H. 1995. Nutrient composition of wild-gathered foods from Mali. In *Quality and Accessibility of Food-Related Data, Proc. First Int. Food Data Base Conf.*, pp. 25–29. Arlington, VA: AOAC Int.
107. O'Dea K. 1984. Marked improvement in carbohydrate and lipid metabolism in diabetic Australian Aborigines after temporary reversion to traditional lifestyle. *Diabetes* 33:596–603
108. O'Dea K. 1991. Westernisation, insulin resistance and diabetes in Australian Aborigines. *Med. J. Aust.* 155:258–64
109. O'Dea K, White NG, Sinclair AJ. 1988. An investigation of nutrition-related risk factors in an isolated Aboriginal community in northern Australia: advantages of a traditionally-orientated life-style. *Med. J. Aust.* 148: 177–80
110. Okigbo B. 1986. Broadening the food base in Africa: the potential of traditional food plants. *Food Nutr.* 12(1):4–17
111. Pelto GH, Pelto PJ. 1983. Diet and delocalization: dietary changes since 1750. *J. Interdis. Hist.* 14(2):507–28
112. Pelto GH, Pelto PJ. 1992. Dietary modernization in Finland: case study of a national food system. *Ecol. Food Nutr.* 27:319–34
113. Pelto GH, Pelto PJ, Lung'aho MS. 1981. Modern and traditional food use in West Finland: an example of quantitative pattern analysis. *Nutr. Res.* 1:63–71
114. Pelto GH, Vargas LA. 1992. Perspectives in dietary change. *Ecol. Food Nutr.* 27:159–61
115. Popkin BM. 1993.The nutrition transition. *ACC/SCN News* (10):13–18
116. Popkin BM.1994.The nutrition transition in low income countries: an emerging crisis. *Nutr. Rev.* 52(9):285–98
117. Rajasekaran B, Whiteford MB. 1993. Rice-crab production in South India: the role of indigenous knowledge in designing food security policies. *Food Pol.* 18(3):237–47
118. Read M. 1938. Native standards of living and African culture change. *Africa* 11(Suppl.):1–64
119. Richards AI, Widdowson EM. 1936. A dietary study in north-eastern Rhodesia. *Africa* 9:166–96
120. Robson JRK. 1980. *Food, Ecology and Culture: Readings in the Anthropology of Dietary Practice.* London: Gordon & Breach
121. Robson JRK, Yen DE. 1980. Some nutrition aspects of the Philippine Tasaday diet. In *Food, Ecology and Culture*, ed. JRK Robson. London: Gordon and Breach
122. Rody N. 1978. Things go better with coconuts: program strategies in Micronesia. *J. Nutr.* Educ. 10(1):19–22
123. Roots F. 1993. Climate change—its possible impact on the environment and the people of northern regions. In *Impacts of Climate Change on Resource Management in the North*, ed. G Wall, pp.

127–51. Waterloo, Ontario, Can.: Univ. Waterloo
124. Sanjur D. 1982. *Social and Cultural Perspectives in Nutrition.* Englewood Cliffs, NJ: Prentice-Hall
125. Savashinshy JS, Hara HS. 1984. Hare. In *Handbook of North American Indians, Sub-Artic*, ed. WC Sturtevant, J Helm, 6:314–45. Washington, DC: Smithsonian Inst. 837 pp.
126. Scott K, Receveur O. 1995. Ethics for working with communities of indigenous peoples. *Can. J. Physiol. Pharmacol.* 73:751–53
127. Scrimshaw NS. 1987. The phenomenon of famine. *Annu. Rev. Nutr.* 7:1–21
128. Scrimshaw NS. 1989. Completing the food chain: from production to consumption. In *Completing the Food Chain: Strategies for Combating Hunger and Malnutrition*, ed. PM Hirschaff, NG Kotler. Washington, DC: Smithsonian Inst.
129. Scrimshaw NS. 1994. The importance of the international network of food data systems (INFOODS). *Food Nutr. Agric. (FNA/ANA)* 12:6–11
130. Scrimshaw NS, Taylor CE, Gordon JE. 1968. *Interactions of Nutrition and Infection.* Geneva: WHO. 329 pp.
131. Shils ME, Olson JA, Shike M. 1994. *Modern Nutrition in Health and Disease,* Vol. 1, 2. Malvern, PA: Lea & Febiger. 8th ed.
132. Shintani TT, Hughes CK, Beckham S, O'Connor HK. 1991. Obesity and cardiovascular risk intervention through the ad libitum feeding of traditional Hawaiian diet. *Am. J. Clin. Nutr.* 53(Suppl.): 1647–51S
133. Sievers ML. 1966. Disease patterns among southwestern Indians. *Public Health Rep.* 81(12):1075–83
134. Sievers ML. 1973. Unusual comparative frequency of gastric carcinoma, pernicious anemia, and peptic ulcer in southwestern American Indians. *Gastroenterology* 65(6):867–76
135. Sievers ML, Fisher JR. 1981. Diseases of North American Indians. In *Biocultural Aspects of Disease*, ed. C Chapman, W Bean, H Rothschild, pp. 191–252. New York: Academic
136. Sugarman JR. 1989. Prevalence of gestational diabetes in a Navajo Indian community. *West. J. Med.* 150: 548–51
137. Sugarman JR, Hickey M, Hall T, Gohdes D. 1990. The changing epidemiology of diabetes mellitus among Navajo-Indians. *West. J. Med.* 153:140–45
138. Teufel NI, Dufour DL. 1990. Patterns of food use and nutrient intake of obese and non-obese Hualapai Indian women of Arizona. *J. Am. Diet. Assoc.* 90(9): 1229–35
139. Thomas WE. 1956. *Man's Role in Changing the Face of the Earth.* Chicago: Univ. Chicago Press
140. Tripp R. 1992. Dietary consequence of changes in trade and agriculture for the Nankane of northern Ghana. *Ecol. Food Nutr.* 27:249–58
141. Turner NJ, Kuhnlein HV. 1983. Camas and riceroot—two lileaceous root foods used by British Columbia Indians. *Ecol. Food Nutr.* 13:119–219
142. Ulijaszek SJ. 1993. Changes in subsistence practices and diet in Papua New Guinea. In *Food, Diet and Economic Change: Past and Present*, ed. C Geissler, DJ Oddy, pp. 183–206. London: Leicester Univ. Press
143. Ulijaszek SJ. 1994. Persistence and change in food use in Papua New Guinea and its effects on nutrition. In *Proc. XVth Int. Congr. Nutr.*, pp. 379–82. London: Smith-Gordon
144. von Braun J. 1989. Commentary: commercialization of small-holder agriculture-policy requirements for capturing gains for the malnourished poor. *IFPRI Rep.* 11(2):1
145. von Braun J, Hotchkiss D, Immink M. 1989. *Nontraditional Export Crops in Guatemala: Effects on Production, Income, and Nutrition, Res. Rep. 73.* Washington, DC: Int. Food Policy Res. Inst.
146. Waugh FW. 1916. *Iroquois Foods and Food Preparation, Memoir 96, No. 12. Anthropol. Ser. Natl. Museum Can., Natl. Mus. Manitoba.* Reprinted 1973
147. Wheatley B, Paradis S. 1995. Exposure of Canadian Aboriginal Peoples to methylmercury. *Water Air Soil Pollut.* 80:3–11
148. Whiting AF. 1939. *Ethnobotany of the Hopi.* Flagstaff, AZ: Northland
149. Wing ES, Brown AB. 1980. *Paleonutrition: Method and Theory in Prehistoric Foodways.* New York: Academic
150. World Bank. 1991. *World Data and Statistics.* New York: U. N. World Bank
151. Young TK. 1988. Are subarctic Indians undergoing the epidemiologic transition? *Soc. Sci. Med.* 26(6):659–71
152. Young TK. 1988. Changing patterns of health and disease. In *Health Care and Cultural Change: The Indian Experience in the Central Subarctic*, ed. TK Young, pp. 32–47. Toronto: Univ. Toronto Press
153. Young TK. 1993. Diabetes mellitus among Native Americans in Canada

and the United States: an epidemiological review. *Am. J. Hum. Biol.* 5:399–413

154. Young TK. 1994. *The Health of Native Americans: Towards a Biocultural Epidemiology*. New York: Oxford Univ. Press. 275 pp.
155. Young TK, Moffat MEK, O'Neil JD. 1993. Cardiovascular diseases in a Canadian Arctic population. *Am. J. Public Health* 83(6):881–87
156. Young TK, Szathmary EJE, Evers S, Wheatley B. 1990. Geographical distribution of diabetes among the native population of Canada: a national survey. *Soc. Sci. Med.* 31(2):129–39