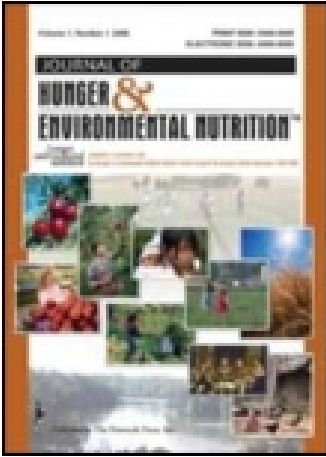


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Food Systems and Food Security: A Conceptual Model for Identifying Food System Deficiencies

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This research briefly describes a conceptual model of hunger and food insecurity that utilizes integrative conceptual work on food systems, identifying key food subsystems and processes involved in the transformation of environmental inputs into individual and population health outcomes. Our model identifies system and individual-level barriers affecting the primary food subsystems, with emphasis on factors influencing the consumer subsystem that may lead to food insecurity. Focusing on food system vulnerabilities and system- and individual-level barriers influencing the consumer subsystem facilitates a more systematic and organized conceptual framework to guide research, practice, and policy relevant to food systems and food security.

KEYWORDS food security, hunger, food systems, conceptual models

INTRODUCTION

Efforts to reduce hunger and increase food security in the United States require systematic understanding of the factors that influence access to adequate food sources and nutrition.^{1,2} *Hunger* is defined by the US Department of Agriculture (USDA) as the uneasy or painful sensation caused by lack of food.³ *Food security* is described by the USDA as a continuum

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TABLE 1 US Department of Agriculture Categories Describing Food Security Status^a

Food secure

High food security: All household members have access at all times to enough food for an active, healthy life.

Marginal food security: Household members are, at times, uncertain of having enough food because they have insufficient money and other resources for food. However, these households rarely need to reduce the quality, variety, or quantity of their food intake.

Food insecure

Low food security (formerly called *food insecurity without hunger*): Household members are, at times, unable to acquire enough food because they have insufficient money and other resources for food. These households report reducing the quality or variety of their diet but rarely need to reduce their food intake.

Very low food security (formerly called *food insecurity with hunger*): The eating patterns of one or more household members are, at times, disrupted and their food intake reduced because they couldnot afford enough food.

^aAdapted from Nord M, Andrews M, Carlson S. Household food security in the United States, 2008. Available at: <http://www.ers.usda.gov/Publications/ERR83/ERR83.pdf>. Accessed December 6, 2009.

of experience ranging from very low food security to high food security (Table 1).³ *High food security* is defined as having consistent access to enough food for all household members to lead an active and healthy life. In 2009, 85.3% of households in the United States were food secure. *Marginal food security* describes households that experience some difficulty in securing adequate food resources. Individuals who experience uncertainty about acquiring enough food to meet their household needs due to insufficient resources are considered *food insecure*.³ In 2009, 17.4 million households (14.7%) in the United States were identified as food insecure.⁴ According to USDA data, households who experience low food security tend to have less varied diets and 57% participated in federal food assistance programs.^{4,5} Households experiencing very low food security often have insufficient resources to obtain food; therefore, consistent eating patterns of one or more household members may be disrupted or substantially reduced.⁵ In 2009, 5.7% of all US households had very low food security.⁴ Rates of food insecurity are substantially higher than the national average among households with incomes near or below the federal poverty line, among households with children headed by single parents, and among Black and Hispanic households.⁴ Food insecurity is also more common in large cities than in rural areas and in suburbs.⁴

The concept of food systems is widely used across a range of disciplines involved in food production and consumption to convey the set of activities and processes involved in the provision of food and nutrients for sustenance and health.^{1,2} The term *food system* describes the processes, required inputs, and generated outputs involved in feeding a population, including growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food. Food systems operate within social,

economic, environmental, and political contexts. Models of food and nutrition systems have been proposed to guide thinking about the agricultural, ecological, social, and industrial factors that may influence health outcomes related to food and nutrition.^{1,2}

Purpose

This research brief describes a conceptual model of food systems and its connection to food security in the United States (Figure 1). Prior conceptual work on food systems synthesizing existing models of food, agriculture, health, and environmental systems into integrated models of food and nutrition systems identifies key food subsystems and processes involved in the transformation of resource inputs into individual and population health outcomes.^{1,2} Our conceptual model adopts and expands this integrative work and presents the processes involved in producer, consumer, and nutrition subsystems as they relate to food security and nutrition-related health outcomes. Our model is grounded in the assumption that it is essential to map the food system as an integrated set of processes to more fully understand the influencing environmental, social, economic, and human factors that shape access to adequate food resources. Our model’s unique contribution to conceptual work in the area of food systems is in its explication

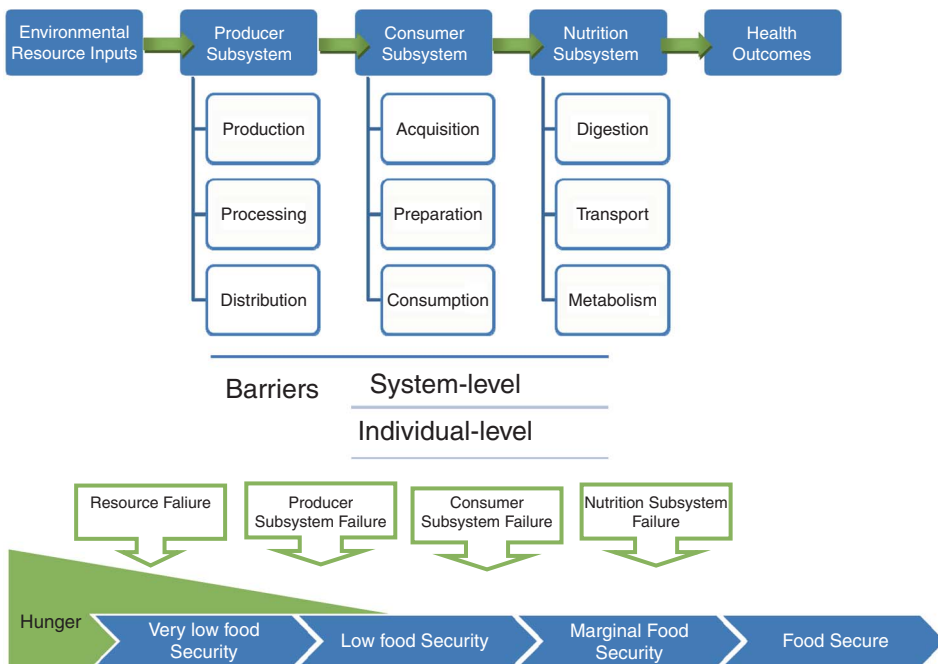


FIGURE 1 Conceptual model of food system and food security (color figure available online).

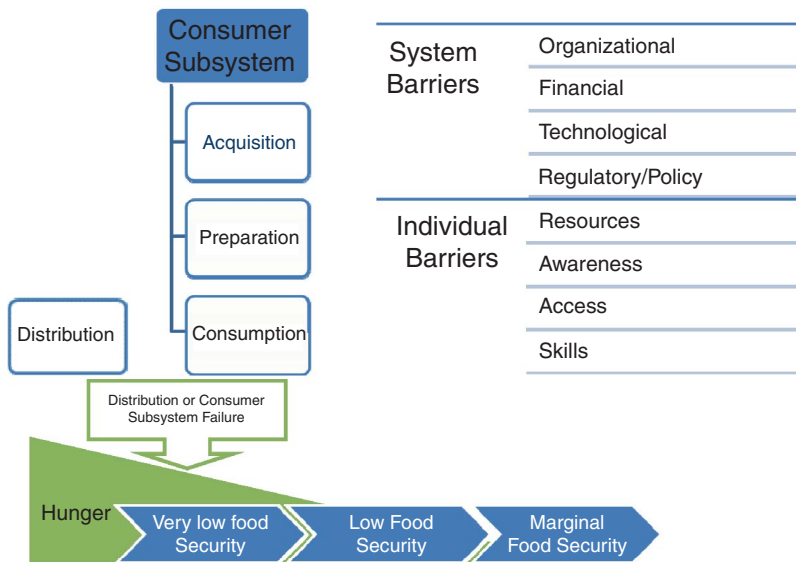


FIGURE 2 Consumer subsystem:system and individual barriers to food access and food insecurity (color figure available online).

of system failures or deficiencies in the food supply chain that may lead to hunger or food insecurity. Additionally, our model expands upon the consumer subsystem to explicate system and individual-level barriers affecting the consumer subsystem that may lead to hunger or food insecurity (Figure 2). Our model identifies points of vulnerability in the food system in general and the consumer subsystem in particular to provide greater conceptual clarity to the ways in which structure and processes of the food system contribute to or protect against food insecurity.

Food Systems and Food Security: Conceptual Model

The continuum of food security experience is shown in Figure 1 as a series of continuous arrows including hunger, very low food security, low food security, marginal food security, and high food security. Although the term hunger is no longer included as a USDA descriptor for household experiences around food security in the United States, we have included it in our models as both an anchor to and an underlying phenomenon of the continuum of food security experience. Though hunger may manifest as severe clinical malnutrition in developing nations with widespread famine, in the United States, discussions of hunger most often refer to levels of food security.³

Figure 1 presents the food security continuum as running parallel to the larger food and nutrition subsystems and processes. To illustrate

the food and nutrition system, we adopted key subsystems and stages identified in previous integrated food system model conceptual works.^{1,2} Our model depicts environmental resource inputs and processes involved with the producer, consumer, and nutrition subsystems that influence health outcomes. Principal dimensions of food insecurity identified in previous research,⁶ including food availability, access, and utilization, broadly capture the consumer facing experience of the food system as we have presented it in Figures 1 and 2.^{6,7} Food *availability* refers to the supply of food to a given community or geographic region and hinges on the success of the producer subsystem.⁶ Food *access* points to the consumer subsystem and describes the ability of individuals or households to acquire or produce food.⁶ *Utilization* refers to the physiological process of converting food to nutrients and is captured in our conceptual model in the nutrition subsystem.⁶ Throughout the food and nutrition subsystems and processes, there is potential for system deficiencies or failures that may result in varying degrees of hunger or food insecurity. Drawing on prior conceptual work,^{2,8} our model proposes that system deficiencies or failures are influenced by system-level and individual-level barriers including organizational, financial, technological, regulatory/policy, and consumer barriers or disincentives that may inhibit access to adequate foods of sufficient nutritional adequacy at each point in the food supply chain resulting in the continuum of food security experience depicted in the model.

Food and Nutrition System

RESOURCE INPUTS

Our model identifies resource inputs as the raw materials, biophysical factors, and social factors that are available in a given environment for input into the food system. System failure or vulnerability at the point of resource inputs results in widespread population hunger if resources are scarce or if there is a broad-reaching food production failure (eg, lacking human and/or technological resources to produce adequate food resources).

PRODUCER SUBSYSTEM

The connection between resource inputs and the consumer subsystem is the producer subsystem. The stages of the producer subsystem include food production, processing, and distribution. System failure or deficits in the producer subsystem may occur at any of the phases in the producer subsystem. *Food production* refers to the process of transforming resource inputs into raw agricultural goods for processing. *Food processing* involves the transformation of production output agricultural goods into food for distribution; for instance, harvesting tomatoes and processing into various products such

as whole tomatoes, sauce, ketchup, mixed dishes, etc. Production failure due to lack of human or technical resources for transformation of resource inputs into raw agricultural goods may also lead to widespread population hunger. Failures or deficiencies in food processing result in limited food availability, which could consequently result in hunger or very low food security. Although we have recently had food safety issues that have arisen in the United States (eg, tainted products) that have affected overall production of specific food items for specific time periods (eg, *Escherichia coli* in spinach), this has not resulted in an overall halt in production or processing of all foods. Food distribution is the vital link to consumer acquisition in the consumer subsystem through multiple channels or points of access, including wholesale or retail entities, the foodservice industry, and public and private food assistance programs. This link to the consumer subsystem is illustrated in Figure 2 to highlight the key role of distribution. Failures in distribution of processed food through appropriate channels may also result in low food security. Many low-income populations live in “food deserts,” wherein failures in distribution result in geographic areas devoid of supermarkets and other retail establishments offering healthy food options, thereby limiting access to affordable, nutritious food.⁹

CONSUMER SUBSYSTEM

Appropriate distribution of food resources provides inputs to the consumer subsystem through processes of food acquisition, preparation, and consumption. Our conceptual model highlights the vital linking pin of the distribution phase of the producer subsystem with components of the consumer subsystem to elucidate key barriers to food access and resultant food insecurity frequently encountered in the US food system (Figure 2). System barriers including organizational, financial, technical, or regulatory disincentives may create vulnerabilities in the consumer subsystem that lead to failures in acquisition, preparation, or consumption, resulting in food insecurity. Organizational, financial, or technical inequities resulting from unfair regulatory mandates may result in systematic disparities in food access. Individual-level barriers may also be encountered, wherein individuals lack the necessary resources, awareness, access, and/or skills to obtain adequate and consistent access to nutritious food.

ACQUISITION

Acquisition involves consumer procurement of food resources through available distribution channels. Organizational, financial, technical, or regulatory factors may create an inhospitable food environment wherein food acquisition is rendered more difficult. Individual barriers to acquisition may include

lack of purchasing power due to inadequate financial resources, lack of transportation to points of access (eg, supermarkets tend not to be located in low-income areas),⁹ and barriers to access to food assistance programs, including lack of awareness and barriers to applying (eg, illegal immigrant status, illiteracy), which can result in less utilization or uptake, even if these programs are available. Acquisition failure in our conceptual model results in very low or low food security.

PREPARATION

The preparation phase of the consumer subsystem refers to the processes involved in preparing food for consumption through cooking or other methods of preparation. Organizational, financial, or technical factors may inhibit the development of the necessary skills for food preparation. For instance, individuals living in transitional housing may not have access to proper cooking facilities or tools (eg, pots and pans). Individual-level barriers to preparation, including lack of appropriate resources, energy, or skills for food preparation, result in low or marginal food security in our model.

CONSUMPTION

The final phase of the consumer subsystem, consumption, is the linchpin to the nutrition subsystem. *Consumption* refers to the selection and ingestion of food. Barriers to selection and ingestion of nutritious food can be numerous and build upon the barriers of acquisition and preparation wherein consumer choices are shaped by monetary resources, access/convenience, and knowledge of both availability and nutritional content of food, as well as other factors such as taste, cultural influences, or religious practices.

NUTRITION SUBSYSTEM

Phases of the nutrition subsystem include digestion, transport, and metabolism. These phases describe the physical, biochemical, and metabolic breakdown for consumed food. Deficiencies or failures at this juncture in the food system can lead to undernutrition if essential food components or nutrients are lacking or if the body is not able to properly digest and metabolize necessary nutrients.

CONCLUSION

The proposed food system and food security model has potential for application to identify system- and individual-level barriers to food resources to inform efforts to reduce hunger and improve food security. The proposed

model draws attention to the areas of vulnerability within the food system that can result in food insecurity, clarifying important avenues for intervention research. Broadly, identification of system and individual vulnerabilities allows us to consider the intricacies of the larger food and nutrition system and their relationship to health outcomes. The model illustrates the potential for failure in and between key food subsystems and processes and can be used to rigorously evaluate existing food systems and to identify key areas of deficiency where individuals, subpopulations, or populations may be falling through the cracks. In particular, our model focuses on barriers encountered in the consumer subsystem that may lead to food insecurity. Efforts to reduce hunger and alleviate food insecurity require clarification and prioritization of community needs through critical evaluation and research. Our model is a first effort to integrate conceptual work in food systems with food security to create a framework to guide research, practice, and policy relevant to understanding the complex interplay of food systems and food security to inform efforts to increase population food security.

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