

A systematic scoping review of the literacy literature to develop a digital food and nutrition literacy model for low-income adults to make healthy choices in the online food retail ecosystem to reduce obesity risk

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Summary

Adults with lower incomes are disproportionately affected by poverty, food insecurity, obesity, and diet-related non-communicable diseases (NCDs). In 2020–2021 amid the coronavirus disease 2019 (COVID-19) pandemic, the United States Department of Agriculture (USDA) expanded the Supplemental Nutrition Assistance Program (SNAP) Online Purchasing Pilot program to enable eligible participants to purchase groceries online in 47 states. This expansion underscores the need for SNAP adults to have digital literacy skills to make healthy dietary choices online. Currently, a digital literacy model does not exist to help guide USDA nutrition assistance policies and programs, such as SNAP. We conducted a systematic scoping review of the academic and gray literature to identify food, nutrition, health, media, financial, and digital literacy models. The search yielded 40 literacy models and frameworks that we analyzed to develop a Multi-dimensional Digital Food and Nutrition Literacy (MDFNL) model with five literacy levels (i.e., functional, interactive, communicative, critical, and translational) and a cross-cutting digital literacy component. Utilization of the MDFNL model within nutrition assistance policies and programs may improve cognitive, behavioral, food security, and health outcomes and support equity, well-being, digital inclusion, and healthy communities to reduce obesity and NCD risks.

KEYWORDS

digital literacy, food and nutrition literacy, food environment, online food retail

1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic altered where and how people access, purchase, and consume foods and meals. Social distancing requirements, fear of transmission while shopping or eating, enforced restrictions, and state public curfews to reduce COVID-19

transmission were key contributors to Americans' altered eating patterns.^{1,2} These restrictions and safety precautions also contributed to the lockdown and/or closure of many restaurants, meat plants, and other businesses that further altered where and how Americans access food.³ Between 2020 and 2021, United States (U.S.) consumers adopted new shopping and eating behaviors, both in-store and online,

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in response to a food ecosystem transformed by technology-enabled platforms and new interactive relationships between food system actors and customers.^{4,5} This growth in technology, coupled with the health and safety concerns resulting from the COVID-19 pandemic, led to a sharp rise in the use of online food purchasing platforms, food delivery and curbside pickup applications (apps), scan-and-go services using quick response (QR) codes, self-checkouts, and payment apps.⁵ In 2020, American consumers spent more than U.S. \$15 billion dollars on online food and beverage purchases, and this trend is expected to grow in future years.⁶ The International Food and Information Council's 2021 Food and Health Survey found that 42% of Americans shop online for groceries at least once a month and that young consumers, African Americans, and parents with children under 18 years old are the most frequent online shoppers.²

The COVID-19 pandemic led to changes to the U.S. government's safety-net programs, including the United States Department of Agriculture (USDA)-administered Supplemental Nutrition Assistance Program (SNAP), which provides more than 40 million income-eligible individuals and households with monthly monetary supplemental benefits to purchase foods and beverages. Families with a household income of $\leq 130\%$ of the U.S. poverty income level are eligible to receive SNAP benefits.⁷ As a result of COVID-19, the USDA's Food and Nutrition Service allowed waivers to U.S. states to expand the SNAP Online Purchasing Pilot program from five to 47 states and the District of Columbia during 2020–2021.⁸ This expansion allowed participants to use their benefits for online grocery purchases with USDA-approved retailers.⁸ The online food retail growth was coupled with a nearly 50% increase in federal SNAP spending in 2020 provided by the Families First Coronavirus Response Act that expanded the maximum monthly benefit for households.⁹ SNAP Education (SNAP-Ed), a USDA program that provides grants to states to implement nutrition education to SNAP participants, also shifted its face-to-face programming to e-learning platforms.¹⁰ This growing use of digital technology and remote communications has exposed a digital divide; many Americans with lower incomes lack access to digital technology, affordable broadband connectivity, and/or digital literacy skills to use these technologies effectively in their daily lives and to meet basic needs.¹¹

Although SNAP has been shown to help improve food security status of participants, SNAP participants have lower dietary quality, as measured by the Healthy Eating Index, than both SNAP-eligible and non-eligible U.S. adults.¹² SNAP participants are also at increased risk of and are disproportionately affected by obesity and by poverty, low diet quality, food insecurity, diet-related non-communicable diseases (NCDs), including type 2 diabetes, heart disease, and cancers, and related deaths.^{13,14} The risk of severe illness from COVID-19 is further exacerbated by these health conditions.¹⁵ The shift to online food purchasing offers an opportunity to nudge SNAP participants towards healthy food purchases, educate consumers on nutrition and health, and provide individuals in remote and underserved areas with access to fruits, vegetables, and other healthy products.¹⁶ These actions could help reduce SNAP participants' risks of obesity and diet-related NCDs. However, the digital divide and the predatory

marketing practices of some online grocery retailers are key barriers that could instead exacerbate the consumption of unhealthy food and beverage products.^{17,18}

1.1 | Study purpose

The purpose of this study is to build on interdisciplinary literacy concepts and constructs to develop a digital food and nutrition literacy model to support SNAP participants and SNAP-eligible adults (herein after referred to collectively as SNAP adults) to make healthy choices in the post-COVID online food retail ecosystem. The study has two objectives: (1) to review and outline the interdisciplinary evidence for conceptual models and frameworks relevant to food, nutrition, health, media, financial, and digital literacy and (2) to develop a multi-dimensional literacy model that describes the capacities and skills needed for SNAP adults to make healthy online food retail decisions. This study addresses gaps in the literature related to the capacities and needs of ethnically, racially, and culturally diverse SNAP adults to purchase healthy foods and beverages that improve diet quality and reduce obesity risk. Many conceptual models and frameworks have been published that describe components of various types of literacy, but their relevance to SNAP adults has not been reported in the published literature. The USDA does not currently use a literacy model to guide U.S. nutrition and food security policies or programs.

1.2 | Defining literacy

The Oxford Dictionary defines *literacy* as “the ability to read or write” and broader definitions include basic arithmetic skills and the ability to read and understand the meaning of written and printed words. *Functional literacy* represents a “level of minimal competence in reading, writing, and arithmetic essential for daily life and work.”¹⁹

The concept of health literacy has been widely used in clinical care and public health settings over the past two decades. Health literacy recognizes the link between low literacy skills and health practices (e.g., low medication adherence and poor self-care) and outcomes (e.g., greater hospitalizations and higher mortality rate) for individuals and populations.^{20,21} Health literacy is included in Healthy People 2030, in which the U.S. Department of Health and Human Services (HHS) has defined personal health literacy as “the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others.”²²

Food literacy and nutrition literacy are commonly used in the published literature, but these terms have been used in different ways. Krause et al.²³ and Vettori et al.²⁴ identified many definitions for both food literacy and nutrition literacy. On the basis of the work of these authors and Velardo,²⁵ we define *food literacy* as the ability to obtain and apply knowledge, motivation, confidence, and skills to understand and apply government-recommended dietary guidance. Food literacy also involves the influence of one's personal food choices on diet

quality and quantity, the environment, and the economy to support health within a sustainable food system.^{23–25} *Nutrition literacy* is a subset of food literacy that involves the ability of individuals to obtain, understand, and apply nutrition information from food labels and other sources.^{23–25} Vettori et al.²⁴ note that these two types of literacy could be considered one multifaceted concept collectively referred to as “food and nutrition literacy.” Table 1 outlines definitions for food,^{23–25} nutrition,^{23–25} and health literacy^{22,30} described above and other types of literacy, including financial,²⁹ visual,³¹ digital,²⁸ and advertising, marketing, and media literacy,^{26,27} that relate to the food retail environment and therefore informed this study.

2 | METHODOLOGY

This study was guided by two research questions (RQs):

RQ1: What conceptual frameworks and models exist for food, nutrition, health, media, financial, and digital literacy?

RQ2: How can these existing literacy models and frameworks be adapted into a multidimensional model to support SNAP adults to use online e-commerce platforms to make healthy food retail purchases?

The study used a systematic scoping review process to compile and analyze relevant evidence to inform RQ1 and RQ2. A scoping review was chosen given the broad literature that required examination to answer the RQs and to develop a framework with many types of literacy capacities and infrastructure support for SNAP adults. The scoping review was guided by the five steps described by Arksey and O’Malley³² that include (1) clarifying the RQs, (2) identifying relevant evidence that met the inclusion criteria, (3) selecting the evidence, (4) compiling and analyzing the evidence, and (5) synthesizing the results using a narrative format.

The first step defined various types of literacy to guide our search strategy (Table 1). Thereafter, the lead author (K.C.S.) worked with university librarians to design the search strategy (Table 2) that utilized the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist.³³ We did not assess study quality or risk of bias given the exploratory nature of the research questions and objectives.

Title and abstract searches were conducted in four electronic databases (i.e., Academic Search Complete, PsycINFO, PubMed, and Web of Science). Google (first 200 hits) and Google Scholar (first 200 hits) browsers³⁴ were also searched in incognito mode. We used the search terms in Table 2 to identify relevant conceptual models and frameworks. Inclusion criteria were peer-reviewed and gray literature sources published in the English language from database inception to the time of the search (January 2021) that described a visual conceptual model or framework for food, nutrition, health, media, financial, and/or digital literacy antecedents, domains, attributes, and/or outcomes. Detailed exclusion criteria are available in Table S1.

The principal investigator (K.C.S.) conducted the electronic searches and screened and identified relevant full-text articles for consideration. Two co-investigators (K.C.S. and V.I.K.) independently reviewed the full-text articles and met to resolve disagreements about

TABLE 1 Literacy terms defined

Literacy types	Definition
Advertising, marketing, and media literacy ^{26,27}	Ability to use knowledge and skills to understand the purpose of advertisements that promote brands and products through media platforms, mobile apps, and electronic devices.
Digital literacy ²⁸	Ability to use knowledge and skills to find, evaluate, create, and communicate information from various sources using digital technologies and platforms to participate in the digital world. Also called digital learning, digital proficiency, and digital fluency.
Financial literacy ²⁹	Ability to use knowledge and skills to manage financial resources effectively to support financial well-being. It encompasses knowledge of financial concepts; ability to communicate about financial concepts; capacity and skills to manage personal finances and household resources and to make financial decisions; and confidence in planning effectively for future financial needs.
Food literacy ^{23–25}	Ability to obtain and apply knowledge, motivation, confidence, and skills to understand and apply dietary guidance; impact of one’s personal food choices on diet quality and quantity, the environment, and the economy to support health in a sustainable food system.
Functional literacy ¹⁹	Ability to read, write, and perform arithmetic at a minimal level for daily life and work.
Health literacy ^{22,30}	Ability to obtain, process, understand, and use basic health information to make appropriate health decisions. Health literacy is not just the result of individual capacities but also the demands and complexities of the health care system. It includes measurable components, processes, and outcomes and demonstrates linkages between informed decisions and actions.
Nutrition literacy ^{23–25}	Ability to obtain, understand, and apply nutrition information from food labels and other sources.
Visual literacy ³¹	Ability to take in the visual images, cues, and stimulation in the environment to understand how form, shape, and color are used in various contexts, including through social media platforms to market products.

whether evidence sources met the inclusion criteria. One researcher (V.I.K.) conducted the data extraction for the included articles, including extracting each literacy model or framework.

2.1 | Model development

All literacy models and frameworks identified through the scoping review were independently reviewed by the co-investigators. Each

TABLE 2 Search terms used for the scoping review to identify existing literacy models and frameworks for food, nutrition, health, media, financial, and/or digital literacy antecedents, domains, attributes, characteristics, and/or outcomes

Journals and databases searched	Search terms
Academic Search Complete, PsycINFO, PubMed, Web of Science, Google Scholar (first 200 hits), Google (first 200 hits)	<p>((literacy) AND [health OR digital OR nutrition* OR food OR diet* OR media OR financial]) AND (nutrition* OR health OR food OR diet*) AND (model* OR framework* OR scheme* OR conceptual* OR "visual aid" OR graphic)</p> <p>MeSH terms searched (where applicable): literacy; health literacy; health; food; diet</p>

researcher identified a subset of models and frameworks that included components relevant to the literacy skills and capacities of the SNAP adult population and to navigating a food retail environment. The researchers pulled from their own experience researching and working with SNAP populations and digital technology for food and nutrition. The researchers also pulled from a variety of published articles and gray literature sources. These sources included existing models and conceptual frameworks that outline consumer interactions in retail environments,^{35,36} findings from studies on the barriers and motivators for uptake of online food purchasing by SNAP adults,^{37,38} and literature on the digital divide and the needs of low-income populations to fill this gap.^{11,17}

Through virtual discussions, the co-investigators collectively agreed on the features of relevant models and frameworks to synthesize into a digital food and nutrition literacy model. Two co-investigators (K.C.S. and V.I.K.) further analyzed the subset of models and frameworks and their corresponding articles to develop comprehensive definitions and categorizations for inputs, literacy levels, and outcomes relevant to SNAP adults to inform the multidimensional model. All authors provided feedback on multiple model drafts until consensus was reached.

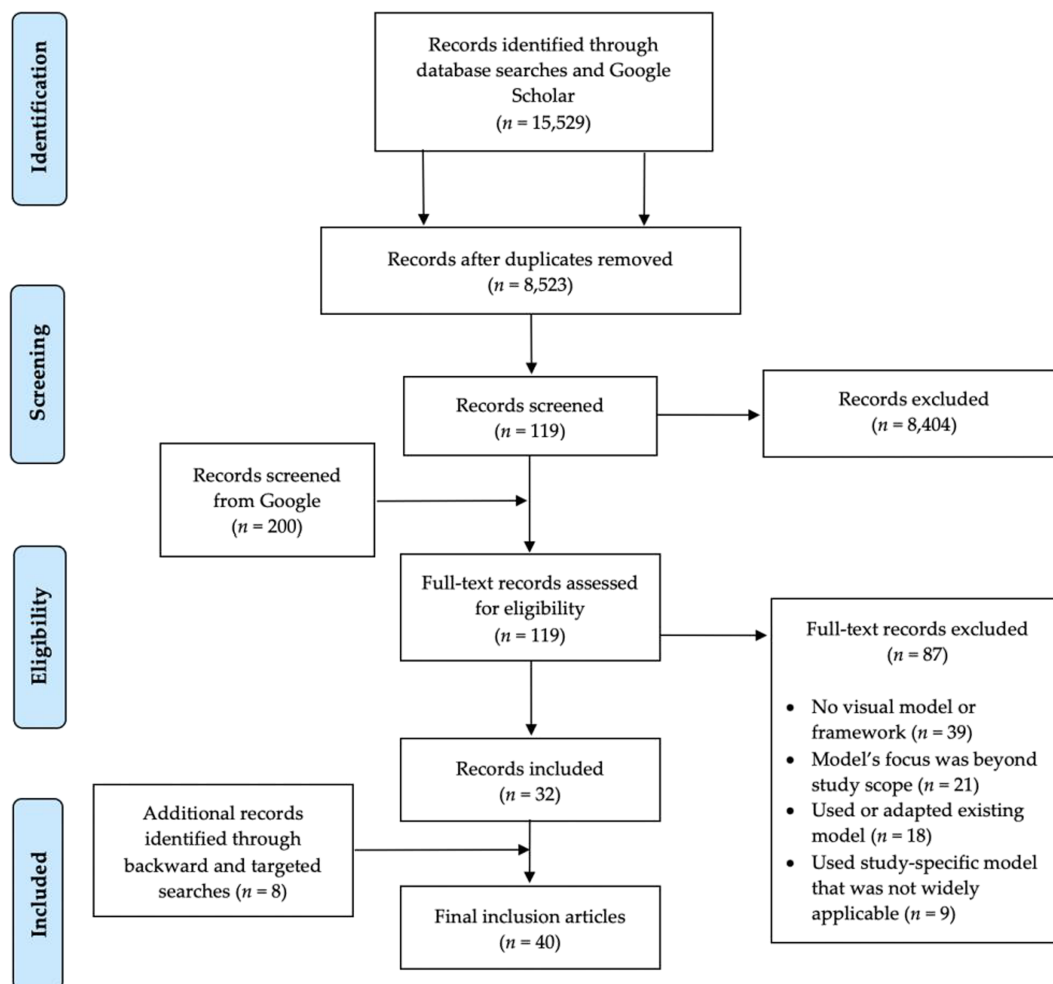


FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for the scoping review of literacy frameworks that influence the diet and health outcomes of individuals and populations

TABLE 3 Conceptual frameworks and models that describe the food, nutrition, health, media, financial, and digital literacy domains and attributes that influence diet and health outcomes identified by the scoping review

Lead author, year	Framework or model
Health literacy frameworks and models (<i>n</i> = 25)	
Al Sayah and Williams ³⁹	Integrated Health Literacy Model for Diabetes
Baker ⁴⁰	Conceptual Model of Individual Capacities, Health-related Print and Oral Literacy, and Health Outcomes
Chin et al. ⁴¹	Process-knowledge Model of Health Literacy (based on Morrow et al. 2006 model)
Edwards et al. ⁴²	The Health Literacy Pathway Model
Geboers et al. ⁴³	Health Literacy Intervention Model
Gilstad ⁴⁴	Comprehensive E-health Literacy Model
Goldsmith and Terui ⁴⁵	Relational Health Literacy Conceptual Model
Harrington and Valerio ⁴⁶	Verbal Exchange Health Literacy Model
Kayser et al. ⁴⁷	e-Health Literacy Framework
Lloyd et al. ⁴⁸	Five-dimensional Framework for the Attributes of a Health Literate Organization
Norgaard et al. ⁴⁹	e-Health Literacy Framework
Norman and Skinner ⁵⁰	e-Health Literacy Lily Model (includes analytical and context-specific models)
Nutbeam ⁵¹	Health Literacy Tripartite Model
Nutbeam ⁵²	Health Literacy Risk and Asset Models
Paasche-Orlow and Wolf ⁵³	Causal Pathways Model Linking Health Literacy to Health Outcomes
Paige et al. ⁵⁴	Transactional Model of E-health Literacy
Pawlak ⁵⁵	Determinants of Health Literacy
Renwick ⁵⁶	3D Literacy Model
Smith and Hudson ⁵⁷	Person–environment–occupational Performance Model to Examine Health Literacy
Soellner et al. ⁵⁸	Theoretical Qualitative Structural Model of Health Literacy
Sorensen et al. ⁵⁹	Integrated Health Literacy Model
Squiers et al. ⁶⁰	Health Literacy Skills Framework
Trezona et al. ⁶¹	Organizational Health Literacy Responsiveness Framework
von Wagner et al. ⁶²	Framework of Health Literacy and Health Action
Yip ⁶³	Health Literacy Model for Limited English-speaking Populations
Food, nutrition, health, and media literacy frameworks and models (<i>n</i> = 10)	
Azevedo Perry et al. ⁶⁴	Food and Nutrition Literacy Framework
Block et al. ⁶⁵	Food Well-being Model
Cullen et al. ⁶⁶	Food Literacy Framework for Action
Malan et al. ⁶⁷	Food Literacy Model for a University Setting
Park et al. ⁶⁸	Food Literacy Framework for Food Systems and Sustainability
Spiteri-Cornish et al. ⁶⁹	Framework for Consumer Confusion Related to Healthy Eating
Truman et al. ⁷⁰	Food, Nutrition, Health, and Media Literacy Outcomes Framework
Truman and Elliott ⁷¹	Food Literacy Proficiency Model
Vettori et al. ²⁴	Framework for Antecedents and Consequences of Food and Nutrition Literacy
Vidgen and Gallegos ⁷²	Food Literacy Model
Media, digital, and advertising or marketing literacy frameworks or models (<i>n</i> = 5)	
Bergsma and Ferris ⁷³	Integrated Health-promoting Media Literacy Model
DQ Institute and Park ^{74,75}	Digital Intelligence Framework
Malmelin ²⁶	Advertising Literacy Model
Montgomery et al. ⁷⁶	Digital Food Marketing Framework
UNESCO ⁷⁷	Digital Literacy Global Framework

3 | RESULTS

Figure 1 depicts the PRISMA flow diagram for the search that collected data to inform RQ1. We identified 40 evidence sources that described and visually depicted a conceptual model or framework for health literacy^{39–63} ($n = 25$); food and nutrition literacy^{24,64–72} ($n = 10$); and digital, advertising, or marketing and media literacy ($n = 5$).^{26,73–77} Although several of the 40 models and frameworks described concepts related to financial and resource management, we did not find an explicit model for financial literacy. Table 3 summarizes the evidence sources for the 40 models and frameworks reviewed, and the visual models and frameworks are included in Figures S1–S40.

3.1 | Overview of seven models and frameworks that guided the model development

To address RQ2, seven of the 40 literacy models and frameworks reviewed were selected^{46,51,54,55,60,63,71} to inform the development a unique typology to address the specific capacities and skills of SNAP adults functioning in the online food retail ecosystem. Figure 2 depicts

the Multi-dimensional Digital Food and Nutrition Literacy (MDFNL) model developed.

The earliest relevant model was a health literacy framework developed in 2000 by the Australian researcher Don Nutbeam that describes health literacy as an outcome of health education and communication programs.⁵¹ Although Nutbeam⁵¹ did not include a visual literacy model, the Health Literacy Tripartite Model that he described has since been visually depicted and adapted by numerous researchers and informed seven other models and frameworks included in our review^{54,56–60,68}; therefore, it was considered.

The five progressive levels in our MDFNL model include: functional, interactive, communicative, critical, and translational literacy. The model presents digital literacy as a cross-cutting theme for all five literacy levels (i.e., functional, interactive, and critical) described in Nutbeam's Health Literacy Tripartite Model⁵¹ and by Paige et al.,⁵⁴ which adapted the three domains to the e-health context and added a fourth level called translational literacy.

Nutbeam⁵¹ defined *functional literacy* as “sufficient basic skills in reading and writing to be able to function effectively in everyday situations” (p. 263). We used this as a foundation for our definition, expanding it to encompass the online food ecosystem. Nutbeam's

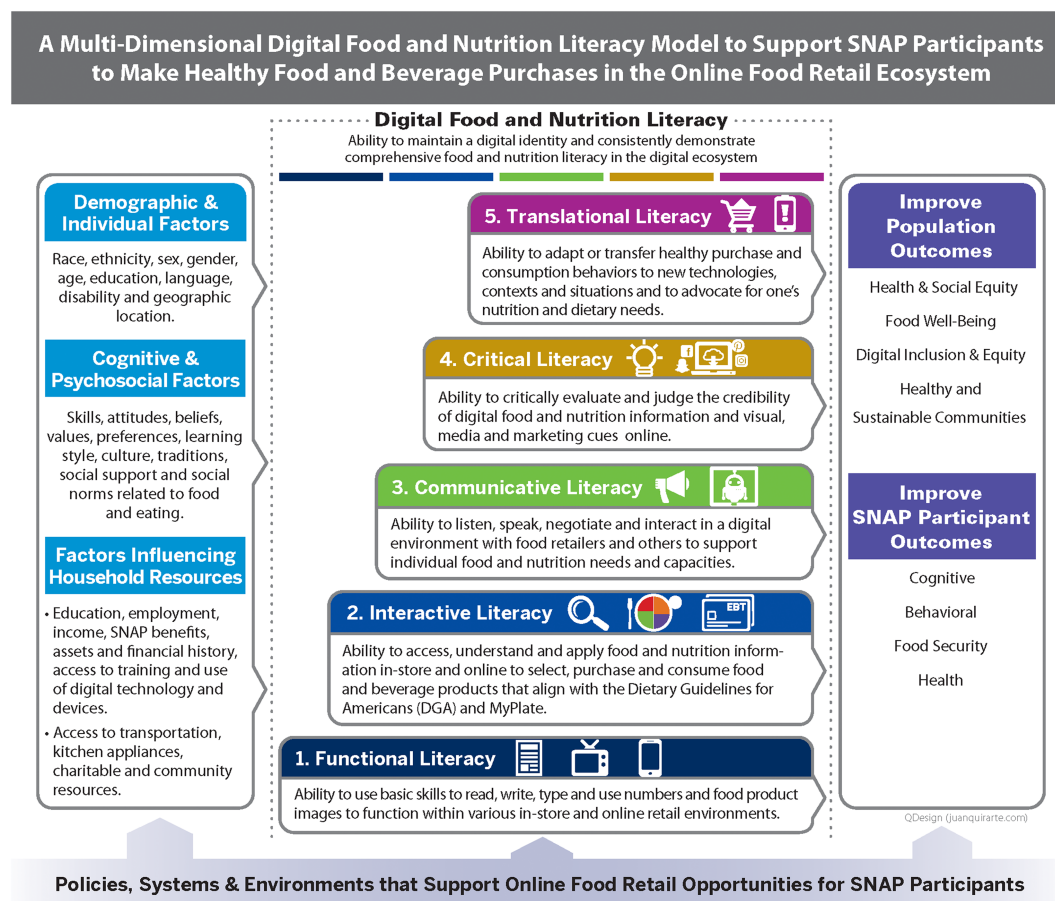


FIGURE 2 Multi-dimensional Digital Food and Nutrition Literacy (MDFNL) model to support Supplemental Nutrition Assistance Program (SNAP) adults to make healthy purchases in the online food retail ecosystem

definition did not address numeracy skills, which was a key component of health literacy in many of the other models and frameworks examined.^{44,46,47,50,60,63} We defined *functional literacy* as the “ability to use basic skills to read, write, type, and use numbers and food product images to function within various in-store and online retail environments.”

Nutbeam⁵¹ and Paige et al.⁵⁴ described *communicative* and *interactive literacy* as one level, defined respectively as “more advanced cognitive and literacy skills which, together with social skills, can be used to actively participate in everyday activities...” (p. 263–264) and “the ability to collaborate, adapt, and control communication about health with users on social online environments with multimedia” (p. 11). These two definitions describe interactions between patients and health care professionals either in person or online. However, the digital retail environment has many complex interactions that consumers must negotiate, including interactions with (1) food and nutrition information available on packages (i.e., nutrition facts panels, front-of-package labels, and product logos); (2) personally tailored advertisements, promotions, and other digital materials displayed on websites; and (3) food retailers, through online retail assistance bots and pickup and/or delivery staff, and SNAP support staff. We therefore divided the communicative and interactive literacy category into two separate levels. We defined *interactive literacy* as “the ability to access, understand, and apply food and nutrition information in-store and online to select, purchase, and consume food and beverage products that align with the Dietary Guidelines for Americans (DGA) and MyPlate.” We defined *communicative literacy* as “the ability to listen, speak, negotiate, and engage in a digital environment with food retailers and others to support individual food and nutrition needs and capacities.”

We adapted the definition of *critical health literacy*⁵⁴ for the online food retail ecosystem context as “the ability to critically evaluate and judge the credibility of digital food and nutrition information and visual, media, and marketing cues online.” Paige et al.⁵⁴ also describes the addition of *translational health literacy* to their e-health-focused model, which the authors define as an individual’s ability to use acquired knowledge and skills in diverse settings and contexts, building the bridge between knowledge and action to achieve health literacy outcomes. For SNAP adults to function effectively within a digital food retail ecosystem, we revised the definition of *translational literacy* to “the ability to adapt or transfer healthy purchase and consumption behaviors to new technologies, contexts, and situations and to advocate for one’s nutrition and dietary needs.”

Table 4 provides illustrative examples of each of the five literacy levels for the digital food retail ecosystem. These literacy levels represent a multitiered approach, with each level building on the previous one. For example, a person cannot achieve interactive literacy without having achieved functional literacy. The goal is to achieve proficiency in digital food and nutrition literacy, which we defined as “the ability to maintain a digital identity and consistently demonstrate comprehensive food and nutrition literacy in the digital ecosystem.”

Digital literacy is represented as a cross-cutting factor in our MDFNL model, which involves an individual learning and acquiring

TABLE 4 Illustrative examples of literacy proficiency level functions and capacities based on the Multi-dimensional Digital Food and Nutrition Literacy (MDFNL) model

Literacy level	Illustrative examples
Translational literacy	The ability to transfer purchasing practices from one food retailer to another to get better prices on food products, lower delivery costs, etc.; the ability to adapt food purchasing patterns to buy food from a retailer’s online platform rather than shopping in-store.
Critical literacy	The ability to recognize when online food retail platforms use algorithms to market unhealthy items (e.g., snack foods, sugary beverages); the ability to identify when retailers use geolocation and personal data to market specific items.
Communicative literacy	The ability to communicate effectively with retailers or retail bots to coordinate curbside pick-up or delivery of food purchases; the ability to navigate online help centers and automated systems.
Interactive literacy	The ability to read a nutrition label and use that information to inform a purchasing decision; the ability to compare similar food products’ nutrition labels and determine which option better aligns with the DGA and MyPlate.
Functional literacy	The ability to use numeracy skills to calculate the price per ounce of a food product; the ability to read a nutrition label to understand basic information, such as the calories per serving size.

digital technology skills to achieve each progressive level. For example, a basic understanding of how to use a computer, smartphone, or other electronic device is needed to achieve functional literacy; achieving critical literacy involves a greater understanding of the capacities, tactics, and outlets used by food manufacturers and retailers to market unhealthy food and beverage products to individuals within the digital ecosystem.

The demographic and individual factors and the cognitive and psychosocial factors in our model were identified primarily from two studies reviewed. Harrington and Valerio⁴⁶ described various characteristics (i.e., demographics, attributes, skills, health system experience, culture, distress, information resources, and psychosocial) that influence health literacy. Pawlak⁵⁵ described health literacy as a determinant of health and portrayed a health literacy model that included individual and population determinants (i.e., age, genetics, language, education, employment, race and ethnicity, socioeconomic status, and environment) that may influence health literacy at an individual or collective level. We also identified several factors that influence household resources (e.g., SNAP benefits, assets, and financial history, etc.) that none of the models reviewed described but that are necessary to consider for SNAP households.

The bottom of the MDFNL model identifies policies, systems, and environments (PSE) that support online food retail opportunities for SNAP adults. The PSE are influenced by many government and

private-sector actors, including USDA and other government agencies, SNAP-authorized retailers, local government bodies (e.g., local zoning boards and banks that provide business and housing loans), community groups, and other stakeholders. These stakeholders may influence the availability of and access to online SNAP-authorized retailers, educational opportunities, and affordable and culturally accepted nutritious food and beverage products.

We considered many barriers and facilitating factors when developing our MDFNL model that may influence SNAP adults' digital food and nutrition literacy skills. These factors include access to broadband services, the internet, and digital devices; the type and quality of interactions with food retailers and SNAP and other social services benefits program staff; confidence in using digital technology; multimedia exposure; and resource constraints. We captured these factors within the PSE element of our model.

The MDFNL model aims to improve individual-level SNAP adult outcomes (i.e., cognitive, behavioral, food security, and health outcomes) and population outcomes (i.e., health and social equity, food well-being, digital inclusion and equity, and healthy and sustainable communities). These outcomes were informed by the model published by Truman and Elliott⁷¹ that outlined food literacy proficiency as a driver of individual nutrition-related outcomes. These authors noted that higher food literacy can contribute to community- and population-level health outcomes.⁷¹

4 | DISCUSSION

This study examined 40 health, food, nutrition, media, and digital literacy frameworks and models, of which seven were used to develop the MDFNL model for SNAP adults. A conceptual framework or model enables one to reflect systematically on specific principles to inform program, policy, or research decisions.⁷⁸ Frameworks or models may serve different purposes. Examples include analytic, causal, and explanatory; intervention and implementation; monitoring and evaluation; and institutional policy and regulatory frameworks and models. This MDFNL model can serve multiple purposes. It can be used as a policy tool to encourage USDA and other government agencies to improve the infrastructure, support systems, and programs delivered to U.S. adults with lower incomes to encourage healthy online food purchases. The MDFNL model is also a resource for decision makers to develop interventions to help Americans make healthy choices in the online food retail ecosystem.

This is the first model, based on our knowledge, that addresses the comprehensive digital food and nutrition literacy characteristics, needs, and outcomes for SNAP adults. The MDFNL model explains how multi-dimensional literacy may impact consumer behaviors and interactions in both the online and in-person food retail environments described by Khandpur et al.³⁵ and Winkler et al.³⁶ The growing digital retail environment represents an opportunity for USDA and other stakeholders to utilize digital platforms to educate and encourage SNAP adults to make healthy food and beverage products. However,

a recent study of states that have implemented the SNAP Online Purchasing Pilot found that state governments provided little health and nutrition information around their communication about the Pilot program.¹⁷ By improving Americans' digital food and nutrition literacy skills, the U.S. government and other stakeholders could support Americans to make healthy decisions that align with the DGA and MyPlate. This MDFNL model is also timely given USDA's recent launch of the artificial intelligence (AI)-driven Alexa digital tool to help parents and caregivers of infants and toddlers aged four to 24 months to receive information about what and how to feed their child based on their age.⁷⁹ This launch further emphasizes USDA's growing reliance on digital technologies for nutrition-relevant policies and programs.

Although the focus of this paper was specific to SNAP adults within the U.S. population, the findings are applicable to low-income populations in other countries. E-commerce for food and beverage products has grown in countries worldwide due to the COVID-19 pandemic. At the same time, many countries continue to face a digital divide that prevents certain vulnerable low-income populations from engaging in e-commerce.⁸⁰ The MDFNL model could be adapted and used to assess the digital capacities and skills of at-risk populations in other countries that must function within growing online food retail ecosystems.

4.1 | Health literacy considerations for USDA and food retailers

In the MDFNL model, we excluded institutional or organizational health literacy, defined in Healthy People 2030 as "the degree to which organizations equitably enable individuals to find, understand, and use information and services to inform health-related decisions and actions for themselves and others."²² However, we identified two publications^{48,61} that suggested steps to create or strengthen health-literate organizations relevant to federal agencies and health care institutions. Lloyd et al.⁴⁸ described five attributes of a health-literate organization: (1) organizational commitment, (2) accessible education and technology infrastructure, (3) an augmented workforce, (4) embedded policies and practices, and (5) effective bi-directional communication. Trezona et al.⁶¹ outlined seven characteristics, practices, values, and capabilities of health literacy-responsive organizations.

The USDA and food retailers could utilize these institutional literacy models to strengthen their internal policies and programs to foster health literacy for their employees and the programs that they support. For example, these organizations could align with the Healthy People 2030 objective of increasing the health literacy of the U.S. population and advance progress towards the 2030 goal to "eliminate health disparities, achieve health equity, and attain health literacy to improve the health and well-being of all."²² This focus could include digital literacy to improve the nutrition security of SNAP adults by helping them to navigate the increasingly online nature of the health care and food systems.

4.2 | Study strengths and limitations

A strength of this study was the extensive interdisciplinary literature searched to develop the MDFNL model. The search parameters for the scoping review were intentionally kept broad in order to capture potentially relevant models and frameworks from a wide array of peer-reviewed and gray literature sources. Another strength was that the authors independently reviewed and assessed each of the 40 frameworks and models before coming to agreement on a subset to inform the development of the MDFNL model. This approach reduced the risk of one researcher influencing another's perception of each model and framework's relevance. Due to time constraints, only one researcher screened articles for inclusion, which could have introduced bias in the evidence synthesis process. A limitation of the study was the extensive literature that describes many models and frameworks for specific populations, disease states, or institutional contexts. An in-depth analysis and explanation of each model was beyond the scope of this study. Future research could characterize each of these frameworks and models and identify the similarities and differences between them as it relates to each type of literacy. Additional research would facilitate our ability to understand the entire landscape of literacy-relevant models and frameworks. Another limitation was that the study scope did not examine the digital literacy needs of children and adolescents, which have been addressed elsewhere.^{81,82}

Future research could test this model and validate metrics to measure progress through a monitoring and evaluation tool to achieve the outcomes. McNamara et al.⁸³ performed a qualitative analysis to understand how the three nutrition literacy domains outlined by Velardo²⁵ (i.e., functional, interactive, and critical) influence the dietary decisions of college students. Future research could perform a similar qualitative study for the MDFNL model to assess how each of the model's five literacy levels and cross-cutting digital literacy domain influence the online grocery purchasing decisions of SNAP adults or another U.S. subpopulation.

5 | CONCLUSION

This study enhances our understanding of the multidimensional digital literacy capacity and skills needed to support SNAP adults to make healthy decisions when shopping on online food retail platforms. Many conceptual models and frameworks have been published that define and describe health, food, nutrition, and media literacy that were used to inform this proposed MDFNL model. However, there was limited published literature on financial and digital literacy models relevant to food and nutrition. Few models or frameworks addressed the needs of the SNAP adult population for digital food and nutrition literacy. Additional research is needed to test this MDFNL model and develop comprehensive tools to guide equitable policies and programs for racially, ethnically, and culturally diverse SNAP adults to function effectively within an e-commerce environment and promote healthy dietary behaviors that reduce obesity and diet-related NCD risks. This research is timely given the growth in online food purchasing during

COVID-19 and the continued rise in this behavior expected for the future. This model offers an outline for key areas that policymakers could use to strengthen the PSE surrounding the online food retail ecosystem to better support SNAP adults' capacities to make healthy food purchases. It could also be used by USDA, including SNAP-Ed, and other government agencies to strengthen the digital food and nutrition literacy skills of SNAP adults.

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CONFLICT OF INTEREST

No conflict of interest statement.

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