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Authors

Miller, Lisa M Soederberg
Cassady, Diana L

Publication Date

2015-09-01

DOI

10.1016/j.appet.2015.05.029

Peer reviewed



HHS Public Access

Author manuscript

Appetite. Author manuscript; available in PMC 2016 September 01.

Published in final edited form as:

Appetite. 2015 September 1; 92: 207–216. doi:10.1016/j.appet.2015.05.029.

The Effects of Nutrition Knowledge on Food Label Use: A Review of the Literature

Lisa M. Soederberg Miller, PhD and

Department of Human Ecology, University of California, Davis, One Shields Avenue Davis, CA 95616; USA, Tel 530-752-3955, Fax 530-752-5660, lmsmiller@ucdavis.edu

Diana L. Cassady, DrPH

Department of Public Health, Sciences University of California, Davis, One Shields Avenue, MS-1C, Davis, CA 95616; USA, Tel 530-754-5550, Fax 530-752-3239 dlcassady@ucdavis.edu

Abstract

Nutrition information on food labels is an important source of nutrition information but is typically underutilized by consumers. This review examined whether consumer nutrition knowledge is important for communication of nutrition information through labels on packaged foods. A cognitive processing model posits that consumers with prior knowledge are more likely to use label information effectively, that is, focus on salient information, understand information, and make healthful decisions based on this information. Consistent with this model, the review found that nutrition knowledge provides support for food label use. However, nutrition knowledge measures varied widely in terms of the dimensions they included and the extensiveness of the assessment. Relatively few studies investigated knowledge effects on the use of ingredient lists and claims, compared to nutrition facts labels. We also found an overreliance on convenience samples relying on younger adults, limiting our understanding of how knowledge supports food label use in later life. Future research should 1) investigate which dimensions, or forms, of nutrition knowledge are most critical to food label use and dietary decision making and 2) determine whether increases in nutrition knowledge can promote great use of nutrition information on food labels.

Keywords

nutrition knowledge; food label use; nutrition labels; claims; ingredient lists

Correspondence to: Lisa M. Soederberg Miller.

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Declaration of Interest

The authors have no relevant interests to declare.

Introduction

Nutrition information on food labels could be a cost-effective method of communicating nutrition information to consumers because the information appears at the point of sale for most packaged foods (Campos, Doxey, & Hammond, 2011). Although consumers value nutrition when deciding which foods to buy (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998), nutrition information on food labels is complex and does not always live up to its potential to communicate effectively (Drichoutis, Nayga, & Lazaridis, 2009; Golan, Kuchler, & Krissoff, 2007; Hager et al., 2009; Hieke & Taylor, 2012; Lin & Yen, 2010; Wills, Schmidt, Pillo-Blocka, & Cairns, 2009). Prior knowledge has been shown to support performance on complex tasks in the cognitive literature; however, its role in food label use is less clear. In this review, we examine the literature surrounding the effects of nutrition knowledge on food label use to examine the state of literature on whether knowledge is important for food label use.

We draw on the cognitive science literature to illustrate how knowledge could support food label use. In particular, we assume that food label use relies on a set of interrelated processes centered on comprehension: attention, comprehension and memory, and decision making (see shaded portion of Figure 1). Consumers pay attention to information on a food label, comprehend it, and store the information at least long enough to apply it to a food-related decision.

Knowledge has been credited with providing the power to perform these key cognitive processes. The phrase “knowledge is power,” often credited to Sir Francis Bacon, has been used widely to convey the centrality of knowledge to human and artificial intelligence (Feigenbaum, 1989). The Long-Term Working Memory model (Ericsson & Kintsch, 1995) describes how knowledge supports cognition. Specifically, the model states that knowledge facilitates cognition by providing retrieval structures which link information in working memory (a limited attention buffer) with long-term memory (stored knowledge), so that newly learned information can be integrated with existing knowledge stores for later use. This results in a long-term working memory system, which represents the speed of access, associated with working memory, with the durability and capacity associated with long-term memory. Knowledge is powerful because it renders attention, comprehension, memory, and decision making processes more efficient (Chiesi, Spilich, & Voss, 1979; Ericsson & Kintsch, 1995).

Based on this work, as well as findings surrounding the effects of knowledge on perceptual processes and information overload (Charness, Reingold, Pomplun, & Stampe, 2001; Jacoby, Speller, & Berning, 1974), nutrition knowledge could support the use of nutrition information on food label use in at least three ways. First, prior knowledge could enable consumers to pay attention to important information on a food label, and to ignore marketing features that do not reflect salient nutritional qualities, which in turn minimizes information overload. Second, prior nutrition knowledge can facilitate comprehension of, and memory for, food label nutrition information. (e.g., determining whether 700mg represents a little or a lot of sodium). Third, prior nutrition knowledge could support the application of the comprehended and remembered information to food choice.

Nutrition knowledge could be important for dietary choice in other ways, for example, by having direct effects on food choice, without food label information, or by impacting attitudes or beliefs. In addition, food label use could be a moderator of the association between nutrition knowledge and dietary behaviors (Cooke & Papadaki, 2014; Fitzgerald, Damio, Segura-Pérez, & Pérez-Escamilla, 2008; Satia, Galanko, & Neuhouser, 2005). There have been excellent reviews conducted in the past 5 years addressing knowledge effects on dietary intake (Spronk, Kullen, Burdon, & O'Connor, 2014) as well as a broad range of consumer attributes and behaviors such as attitudes, perceptions, and food choice (Bonsmann & Wills, 2012; Campos et al., 2011; Drichoutis, Lazaridis, & Nayga, 2006; Hieke & Taylor, 2012; Lähteenmäki, 2013; Mhurchu & Gorton, 2007; Nocella & Kennedy, 2012; Wills, Storcksdieck genannt Bonsmann, Kolka, & Grunert, 2012). However, in this review, we limit the focus of our inquiry to the effects of knowledge on food label use in an attempt to better understand whether and how knowledge supports food label use.

Food Label Use Constructs and Information Type

We review the literature on food label use related to three types of food label information that are most central to conveying nutrition and health information: nutrition labels, ingredient lists, and claims. Typically, food label use studies focus on nutrition labels; however, ingredient lists and health/nutrient claims also play important roles in conveying the products' diet and health information to consumers and, for this reason, are regulated in the US by the Food and Drug Administration (FDA). The European Commission's regulation of food labels was limited to claims until very recently, although food producers voluntarily provided nutrition labels and ingredients lists on most packaged foods (Bonsmann & Wills, 2012). Drawing on past research (Campos et al., 2011; Mhurchu & Gorton, 2007), we adopt two broad categories to organize the literature on food label use: whether or how often food labels are used (frequency) and the ability to understand labels (comprehension). Frequency of use and comprehension measures can be further subdivided into subjective (e.g., self-reported assessment of frequency, self-ratings of ability to locate and/or apply information) and objective measures (e.g., experimenter's observation of consumer food label consultation or experimenter's assessment of comprehension using questions scored for accuracy).

Nutrition Labels—Over 98% of FDA-regulated processed, packaged foods have Nutrition Facts panels (NFPs) in the US (Legault et al., 2004) and roughly 84% of products in Europe have nutrition labels (Bonsmann, Celemin, & Grunert, 2010). Nutrition labels typically contain information on calories, serving size, and amounts and/or daily values of several macronutrients, vitamins, and minerals (e.g., fats, carbohydrate, calcium). In the US, the content of NFPs is government regulated and must include serving size, calories, nutrients, and percent of daily values of each nutrient. Close to two-thirds of respondents in a survey report using NFPs to make purchasing decisions (Ollberding, Wolf, & Contento, 2010). Most individuals are able to understand at least some basic nutrition information on food labels (Graham & Jeffery, 2011; Grunert & Wills, 2007; Levy & Fein, 1998; Miller, Probart, & Achterberg, 1997). However, comprehension accuracy decreases for more complex tasks. For example, Levy and Fein (Levy & Fein, 1998) found that most consumers (78%)

accurately identified nutrient differences between two products; however, far fewer (20%) were able to calculate the contribution of a single food to a total daily intake.

Ingredient lists—In addition to non-nutrition information (e.g., additives), ingredient lists contain important nutrition information that can contribute to the consumer's assessment of a food's healthfulness. The US Dietary Guidelines 2010 states that: “The ingredients list can be used to find out whether a food or beverage contains synthetic trans fats, solid fats, added sugars, whole grains, and refined grains.” Ingredient lists provide an account of ingredients within a product in descending order of proportion by weight (i.e., ingredients at the end of the list are present in smaller quantities). The FDA recommends that lists conform to a variety of specifications to enable consumers to be informed (Food and Drug Administration, 2014). For example, basic components of foods must be listed and products containing ingredients consisting of several components must list the components in parentheses. Font size and presentation should conform to federal regulations to maximize readability, but even when they do, font size is a frequent problem for consumers’ use of ingredient lists (Mackey & Metz, 2009). Consumers frequently consult the ingredient list portion of food labels. For example, self-reported frequency of ingredient list use (as well as use of nutrition labels and claims) was 52% in one study (Ollberding et al., 2010) and even higher (78%) in another (Norazmir, Norazlanshah, Naqieyah, & Anuar, 2012).

Health and Nutrient Claims—Health claims are intended to communicate scientifically proven health benefits associated with consuming a particular food (Ippolito & Mathios, 1991; Williams, 2005), for example, “low fat diets rich in fiber may reduce the risk of some types of cancer.” One goal of nutrient content claims is to communicate the value or relative amount of a specific nutrient within a food product (e.g., good source of fiber, fat free, low calorie). Claims have been shown to impact how other food label information is processed and to influence other dietary behaviors (Mathios & Ippolito, 1999; Williams, 2005). For example, consumers sometimes use claims in place of NFPs (Labiner-Wolfe, Jordan Lin, & Verrill, 2010). On the other hand, claims sometimes have little impact on product evaluations (Garretson & Burton, 2000) and may even be misleading and confusing (Hasler, 2008). However, claim comprehension is higher among those with greater experience and education (Dean, Lähteenmäki, & Shepherd, 2011; Verbeke, Scholderer, & Lähteenmäki, 2009).

Nutrition Knowledge Construct

Nutrition knowledge, broadly defined, refers to knowledge of concepts and processes related to nutrition and health including knowledge of diet and health, diet and disease, foods representing major sources of nutrients, and dietary guidelines and recommendations (Axelson & Brinberg, 1992; McKinnon, Giskes, & Turrell, 2014; Moorman, 1996; Parmenter & Wardle, 1999). Although some have argued that a narrower definition of nutrition knowledge may be desirable (Axelson & Brinberg, 1992; Li, Miniard, & Barone, 2000), Parmenter and Wardle (1999) suggest that a broad definition of nutrition knowledge is needed to capture the complex and wide-ranging nature of the information used to inform dietary choice. We make a similar argument that the ability to use food labels draws on a wide range of situations and behaviors that could potentially draw on many areas of

nutrition knowledge. For example, knowledge of the relationship between diet and cancer may enable consumers to focus on fiber information presented on the nutrition label and whole grains in the ingredient list. Knowledge of dietary recommendations may support applying these pieces of nutrition information to decide whether the food product represents a healthful choice within the context of other foods the individual consumes that day. Consistent with the cognitive literature, the various dimensions of nutrition knowledge may be connected in such a way that they support each other, as an integrated semantic network. In this review, we categorize the literature in terms of the number of dimensions included in the nutrition knowledge assessment.

Materials and Methods

The review was restricted to empirical, English-language, peer-reviewed studies examining knowledge effects on food label use. Searches were conducted in electronic databases (CINAHL, Cochrane, PubMed, Proquest, Psychinfo, ScienceDirect, Web of Science) and reference lists of relevant articles and reviews, that were published between June 1999 and June 2014 (including in online first print in 2015). The Nutrition Labeling and Education Act of 1990 mandated compliance with a new set of regulations by May of 1994. We used this time frame to allow a sufficient gap in time for consumers to become familiar with the new labels and researchers to examine consumers' familiarity with labels, which is important factor for label use (Bialkova & van Trijp, 2010). Similarly, we omit studies investigating relatively new forms of nutrition information, namely, front-of-package symbols, which appear on some products (Hawley et al., 2013; Hersey, Wohlgenant, Arsenaault, Kosa, & Muth, 2013; Vyth et al., 2012).

The following key word combinations to search each database: "knowledge" AND "consumer" OR "label use" OR "use of *labels" OR "attention" OR "comprehension" AND "nutrition * panel OR nutrition* label OR food label*" OR "ingredient list" OR "health claim" OR "nutrition claim" yielded 55 abstracts. Articles were screened for quality in terms of clarity of the descriptions of measures, methods, and findings. We excluded studies that did not include sufficient details of the nutrition knowledge measure to evaluate whether it assessed nutrition knowledge rather than another type of knowledge (e.g., functional foods, diabetes), did not differentiate between nutrition knowledge and constructs such as beliefs, confidence, or attitudes, did not describe in detail or provide examples of food label use questions, or did not differentiate between nutrition knowledge and food label use (n=13). We also excluded studies with adequate measures of nutrition knowledge and food label use when associations between the two measures were not reported (n=8). We coded food label use measures in terms of frequency of use and comprehension, and within that, self-reported and objective measures; we coded nutrition knowledge assessments in terms of self-reported and objective measures. These criteria were coded by the authors; agreement between raters was good (over 95%), and discrepancies were resolved through discussion.

Results

The final pool of articles (n=34) is shown in Table 1. Each was coded in terms of the location, sampling method, food label area examined, and dimensions included in the

nutrition knowledge assessment as well as the source of the measure. We found wide variation in sampling methods and thus representativeness of the samples, including convenience samples from college students, online panels, random samples of food shoppers in one or more stores, as well as random selections of households representing the entire country. We also found a variety of nutrition knowledge assessments, ranging from a single-nutrient focus to a multidimensional approach, most typically employing Parmenter and Wardle's (1999) measure. Table 2 summarizes the findings in terms of which studies reported a positive association between nutrition knowledge and food label use by type of measure. In the sections that follow, we present the findings for each food label area. At the end of each section, findings pertaining to aging are presented. Although we did not exclude studies based on age, none of the studies included individuals under the age of 17.

Nutrition Labels

Our search of the literature identified 32 papers that examined nutrition label use and nutrition knowledge. The majority of these studies (n=28) reported significant associations between nutrition knowledge and nutrition label use. For example, in a mail survey of 1,162 Swiss adults, Hess et al. (2012) found that both subjective and objective measures of nutrition knowledge were significantly associated with self-reported nutrition label use, even after accounting for demographic and health-related variables in a multivariate model. An online survey of a randomly selected group of 500 college students in the UK also found that prior nutrition knowledge was associated with self-reported food label use (Cooke & Papadaki, 2014).

However, four of the 32 studies reported no effects. For example, Norazlanshah and colleagues (2013) found that nutrition knowledge was unrelated to self-reported frequency of use that was assessed for specific areas within the nutrition label (e.g., serving size, fat). Another study reported only indirect effects of nutrition knowledge, showing that knowledge influenced self-reported nutrition label use through its influence on attitudes (Misra, 2007).

It could be that measures assessing self-reported frequency of label use are somewhat less able to detect the effects of nutrition knowledge, perhaps because they are assessed more remotely in terms of time, or do not include an indication of how well the information on the food label was understood. In support of this, two of the four studies showing null effects of nutrition knowledge on frequency of use also included nutrition label comprehension measures and in both cases, the associations between knowledge and comprehension were positive (Drichoutis, Lazaridis, Nayga, Kapsokefalou, & Chryssochoidis, 2008; Norazmir et al., 2012).

Although it could be that the type of knowledge assessment may also influence the relationship to self-reported frequency of use, this does not appear to be the case. One study using both subjective and objective measures of nutrition knowledge reported a significant relationship with food label use when the subjective - but not objective - measures were used (Petrovici & Ritson, 2006). However, the majority of studies that used self-reported knowledge measures found a positive association with frequency of nutrition label use

(Burton, Garretson, & Velliquette, 1999; Hess et al., 2012; Jacobs, deBeer, & Larney, 2011; Orquin, 2014).

The literature reviewed here fairly consistently shows that knowledge is related to how *well* consumers are able to use food labels. In 18 studies, knowledgeable consumers were more likely to comprehend nutrition labels better than those with lower levels of knowledge (see Table 2). Some of the findings, however, are complex. For example, the effects of knowledge were found on a comprehension task requiring participants to use nutrition labels to determine which of two products was more healthful. However, knowledge effects were not evident on a task requiring participants to evaluate the healthfulness of a single label (Miller, 2014). These findings could suggest that knowledge is particularly useful when comparing two products in order to find nutrition differences between them.

Our search yielded only one, relatively small study, reporting no associations between nutrition knowledge and comprehension of nutrition labels (Block & Peracchio, 2006). In study 1 (studies 2 and 3 did not meet inclusion criteria), researchers provided a definition of dietary reference values to participants and then administered a brief exercise that asked, and then provided, the daily recommended intake of various vitamins and minerals, including calcium. Next, participants were asked, “How many milligrams of calcium are in the container?” based on the information provided in a nutrition label that provided the percent daily value of calcium per serving for a one-serving container. Very few (2 of 37) were able to answer the question correctly, and those with higher scores on the general nutrition knowledge test did not perform better. However, given the narrow range of label comprehension, the probability that the general knowledge test could provide support is low. Indeed, the initial assessment of calcium knowledge (recommended daily value) showed that most individuals did not have this prior knowledge and therefore would have to remember it from the subsequent task (because daily value of calcium in grams is not provided on the nutrition label). Thus, from this relatively small study, it is unclear whether consumers were unable to perform the calculation or failed to recall the required missing piece of information needed to perform the calculation.

The use of eye tracking to examine associations between food labels and food choice is becoming more common (Bialkova et al., 2014; Jones & Richardson, 2007; Miller, 2014; Miller & Cassady, 2012; Miller et al., 2015; Nelson, Graham, & Harnack, 2014). Within our conceptual framework, attention is a form of frequency of use (how much or how often food label information is consulted) that is objectively assessed. However, by itself, eye tracking data (or attention) does not indicate how well the information is understood or used to make decisions. That is, high levels of attention to information can indicate comprehension failure (e.g., confusion) as well as comprehension success (e.g., connecting the information to other information and integrating it so that it can be used to make a decision). To interpret the quality of attention devoted to food label information, eye tracking studies often include a comprehension task so that quality (i.e., accuracy) of understanding can be assessed. However, only one study assessed the association between nutrition knowledge and attention (Miller & Cassady, 2012). In this study, decision-making strategies were inferred from patterns of attention as individuals compared the two nutrition labels to determine which was more healthful. Researchers examined the relative frequency with which

individuals engaged in compensatory strategies, in which one nutrient value compensates for another (lower amounts of fat may compensate for higher amounts of sodium) and noncompensatory strategies (e.g., amount of fat in one product versus another product). Results showed an effect of nutrition knowledge on attention (specifically, relatively greater use of noncompensatory strategies) but only among those who reported having dietary goals. Food label use was also objectively assessed in terms of comprehension (accuracy of the healthfulness decision). Across all individuals, comprehension was positively related to nutrition knowledge.

Ingredient Lists

Three studies included an investigation of this area of the food label. Given their importance in communicating nutrition and health information, it is surprising how little attention ingredient lists have received in the literature. In a notable exception, Walters and Long (2012) examined the effects of expertise on types of information used to evaluate product quality and purchase intention. Experts, defined as completion of an upper division nutrition course, were more likely to use ingredient list information rather than an “all natural” label claim. Novices, on the other hand, did the opposite. In another study, greater knowledge gained through nutrition education surrounding trans fatty acids (verified through a self-reported measure of knowledge) was associated with increased food label comprehension based on the ingredient list (Pletzke, Henry, Ozier, & Umoren, 2010). This new knowledge was successfully applied to subsequent food choice; participants in the newly acquired knowledge group purchased foods lower in trans fatty acid (assessed using grocery receipts) two weeks later. Finally, researchers found an association between self-reported knowledge and accurate use of food label information that included ingredient lists, as well as nutrient information and nutrient claims (Jacobs et al., 2011).

Although the number of studies that included ingredient lists is very small, the findings are consistent with the notion that knowledge helps individuals use ingredient lists. Because ingredient lists can be long and contain complex terms, nutrition knowledge could help consumers engage in deliberative processing, avoid superficial information, and cross-check nutrition information in the nutrition label. One study relied on expertise differences which relied on an assessment of knowledge administered prior to the study (required to pass a nutrition course), another manipulated knowledge within an intervention context, and the third relied on subjective measures of nutrition knowledge. Each approach yielded a positive association between nutrition knowledge and ingredient list use. Although, ingredient list use was assessed together with the use of other areas of the food label, the assessments are consistent with how ingredient lists are designed to be used, with other nutrition information on the food label rather than as a standalone tool.

Health and Nutrient Claims

Although prior knowledge has been shown to influence attitudes toward claims (Jacobs et al., 2011; Lähteenmäki, 2013; Leathwood, Richardson, Sträter, Todd, & van Trijp, 2007; Nocella & Kennedy, 2012; Žeželj, Milošević, Stojanović, & Ognjanović, 2012), there are only a handful of studies investigating the influence of knowledge on the comprehension of claims on food labels. In general, these studies show that nutrition knowledge supports

understanding of claims on food labels. For example, Howlett et al. (2008) investigated the effects of trans fat knowledge on use of claims and nutrition labels in two studies by inducing trans fats knowledge through the exposure to educational materials prior to the rating task. Participants rated the healthfulness of a food package that fell into one of four conditions: presence of a “low trans fat” claim crossed with high (4 grams) or low (1 gram) trans fat levels in the nutrition label. Study 1 showed that high-knowledge individuals were sensitive to trans fat levels on nutrition labels, whereas low-knowledge individuals made similar ratings regardless of trans fat levels. However, this pattern was not observed for the trans fat claim manipulation. Study 2 showed large effects of manipulated knowledge for those who use labels frequently, but less so for those who do not. Although no means or figures were presented, the authors indicated that a similar pattern was found for trans fat claims. In general, this study provides support for the notion that nutrition knowledge supports nutrition label as well as claim understanding. An unsettling finding, however, was that among those who did not receive trans fat information (i.e., low-knowledge consumers) but were frequent label users, ratings of healthfulness were high for both the low and high trans fat levels. This suggests that frequent use of nutrition labels does not promote understanding of trans fat levels.

Barreiro-Hurle et al. (2008) examined food choice based on food label characteristics including nutrition labels and claims. They found that nutrition knowledge was higher among those who primarily used nutrition labels, relative to those who used claims. In a later study, researchers showed a positive association between nutrition knowledge and self-reported frequency of nutrition label use, but not claim use (Barreiro-Hurlé, Gracia, & de-Magistris, 2010). Other work indicates that the effects of nutrition knowledge on claims depends on the claim type, with positive associations for health claims and but not nutrition claims (Petrovici, Fearné, Nayga, & Drolias, 2012).

A few studies assessed comprehension of claims with nutrition labels and/or ingredient lists (Jacobs et al., 2011; Orquin, 2014; Walters & Long, 2012), without an independent assessment of claim use. All of these studies reported that nutrition knowledge was related to comprehension of food label information. For example, Orquin (2014) asked participants to view a variety of food products (containing nutrition labels and claims) and rate the healthfulness of each. Results showed that participants with higher nutrition knowledge scores had higher healthfulness accuracy scores. Overall, there is some suggestion that knowledge may play a greater role in nutrition label use than claim use. However, the number of studies investigating knowledge effects on claim use is small and the findings do not present a clear picture.

Discussion

These data are consistent with the notion that long-term working memory afforded by nutrition knowledge supports both label use frequency and food label comprehension. The more consumers know about nutrition, the more likely they are to consult- and understand- nutrition information on food labels. The majority of studies reviewed here focused on knowledge effects on nutrition label use, with fewer studies on claims, and even fewer on

ingredients lists. The finding that ingredient lists are neglected in this literature is surprising given they contain information surrounding diet and health.

Interestingly, food label use as defined by frequency (*how often*) is the most common assessment of food label use, with 26 of the studies including this type of measure. It is possible that nutrition knowledge provides more or less support for food label use depending on whether food label use is defined in terms of *how often* the label is used versus *how well* the information in the label is understood and used to make decisions. However, this distinction was largely confounded with self-reported versus objective assessment types across these studies. Thus, it is unclear whether knowledge effects are qualified by quantity/quality or self-reported/objective factors.

Consistent with the knowledge-is-power position, we found a positive association between knowledge and food label use for 6 of 6 studies using self-reported measures of knowledge and 21 of 33 studies using objective measures of knowledge. All but one (Jacobs et al., 2011) of the studies with self-reported measures also included objective measures. In these 5 studies, one study showed a difference in the pattern of findings (Petrovici et al., 2012) such that only the self-reported measure showed an association with food label use. In general, however, both approaches showed associations with food label use, despite possible differences in social desirability biases or underlying constructs (Palmer, Graham, Taylor, & Tattersson, 2002).

Only a few studies (Howlett et al., 2008; Pletzke et al., 2010; Walters & Long, 2012), examined the effects of newly acquired knowledge on food label use, with half of the participants to be assigned to a knowledge group and half to a control group. This approach is important because, through random assignment, groups should be comparable in all ways but knowledge levels. This approach could also be used as part of an intervention to determine the amount of additional nutrition knowledge required to affect incremental change in food-choice behaviors. However, initial levels of nutrition knowledge are also critical. Past work has found that baseline levels of knowledge were more predictive of weight loss among obese, low-income mothers than were changes in knowledge due to the intervention (Klohe-Lehman et al., 2006).

The model in Figure 1 suggests that nutrition knowledge supports healthful food choices through information processing associated with food labels. However, we recognize that knowledge could play a broader role in food choice by supporting dietary intake regardless of food label use. Many studies have shown associations between nutrition knowledge and dietary behaviors (Ahmadi, Torkamani, Sohrabi, & Ghahremani, 2013; Bonaccio et al., 2013; Dickson-Spillmann & Siegrist, 2011; Drichoutis, Lazaridis, & Nayga, 2005; Fitzgerald et al., 2008; McKinnon et al., 2014; Wardle, Parmenter, & Waller, 2000; Worsley, 2002).

We also recognize that some consumers are uninterested in eating healthful foods or using food labels, regardless of their nutrition knowledge. Although the present review does not address this issue, motivation may be an important factor in encouraging consumers to think about the importance of nutrition in food choice (Coulson, 2000; Lin, Lee, & Yen, 2004;

Petrovici & Ritson, 2006; Suter & Burton, 1996; Žeželj et al., 2012). Although it is unclear where motivation originates, it is possible that motivation and knowledge co-evolve such that motivation predicts knowledge (Miller & Cassady, 2012) and knowledge predicts motivation (Miller, Gibson, & Applegate, 2010).

Directions for Future Research

The majority of studies presented here relied on convenience samples. Future research should focus on including a wider, more representative sample. College students, while important for understanding this group, but may not inform the literature on other populations in terms of income, education, acculturation, and race/ethnicity. Moreover, few studies included age ranges that would enable an examination of age differences in the effects of knowledge. This is surprising for two reasons. First, food label use may be even more important for older adults because of their higher risk of diet-related chronic diseases (Post, Mainous, Diaz, Matheson, & Everett, 2010). Second, past work has shown the advantages of knowledge in later life on a variety of cognitive tasks (Salthouse, 2003) including comprehension and memory for nutrition texts (Miller, Gibson, Applegate, & de Dios, 2011; Miller, Zirnstein, & Chan, 2013; Olson & Sim, 1980).

Another area of research that warrants greater attention is the conceptualization and measurement of the nutrition knowledge construct. Axelson and Brinberg (1997) have stated that the multifaceted nature of nutrition knowledge may limit the ability of researchers to test associations with behaviors. Others, however, have argued that nutrition knowledge needs to be broadly defined in order to capture the complex nature of dietary behaviors (Parmenter & Wardle, 1999). Research investigating whether some dimensions of the construct are relatively more important than others, or whether the number of dimensions is more important than which dimensions in predicting food label use as well as dietary intake.

There is another potentially fruitful approach to conceptualizing and measuring nutrition knowledge. Cognitive researchers have also argued that the distinction between declarative and procedural knowledge is important, particularly in the area of skill development (Anderson, 1982). However, with some exceptions (Dickson-Spillmann & Siegrist, 2011), this distinction is rarely applied to nutrition knowledge and, as far as we know, no studies have included procedural and declarative nutrition knowledge as separate constructs. Based on the cognitive literature, procedural and declarative knowledge can facilitate each other. So, for example, learning how to select healthful foods (procedural) should be easier when consumers have a foundation of declarative knowledge (e.g., what sodium does to blood pressure, which foods are high in saturated fat, recommended daily intake of fiber), and both of these could support food label use. More work is needed to develop procedural and declarative nutrition knowledge, and examine their associations with food label use.

Finally, more research is needed to understand the causal links among nutrition knowledge, food label use, and dietary intake among different populations of consumers in order to design more effective educational programs. Although we found no evidence to support this in the present review, there could be some individuals for whom nutrition knowledge could lend a false sense of security that would lead to ignoring food labels, a form of maladaptive behavior (Szykman et al., 1997). More research is also needed to understand how to

encourage those who make poor dietary choices to think about nutrition when deciding which foods to eat. It may be the case that providing bursts of nutrition knowledge to some groups of consumers would initiate a positive cycle of motivation and knowledge growth. Research is needed to understand how to sustain the growth of nutrition knowledge so that it leads to meaningful improvements in dietary behaviors.

Conclusions

Consistent with the notion that knowledge-is-power, the findings of this review suggest that nutrition knowledge supports food label use. Although the literature surrounding the use of ingredient lists is limited, evidence from studies investigating nutrition labels and claims suggests that these areas of food label use benefit from prior knowledge. Drawing from the cognitive literature, nutrition knowledge likely helps by directing attention to salient information, promoting comprehension, allowing more accurate information to be stored in memory and used in decision making situations. Although the review highlights gaps in the literature, especially surrounding the role of knowledge among older consumers, findings could suggest that increasing consumers' nutrition knowledge levels may improve nutrition communication through food labels.

Acknowledgements

Funding and Sponsorship

The preparation of this manuscript was supported by National Institutes of Health, R01CA159447.

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Highlights

- Support was found for the knowledge-is-power position relating to food label use.
- Most studies focused on nutrition labels, few included claims and ingredient lists.
- Nutrition knowledge supported food label use across a range of knowledge measures.
- More research with representative samples and wider age ranges is needed.

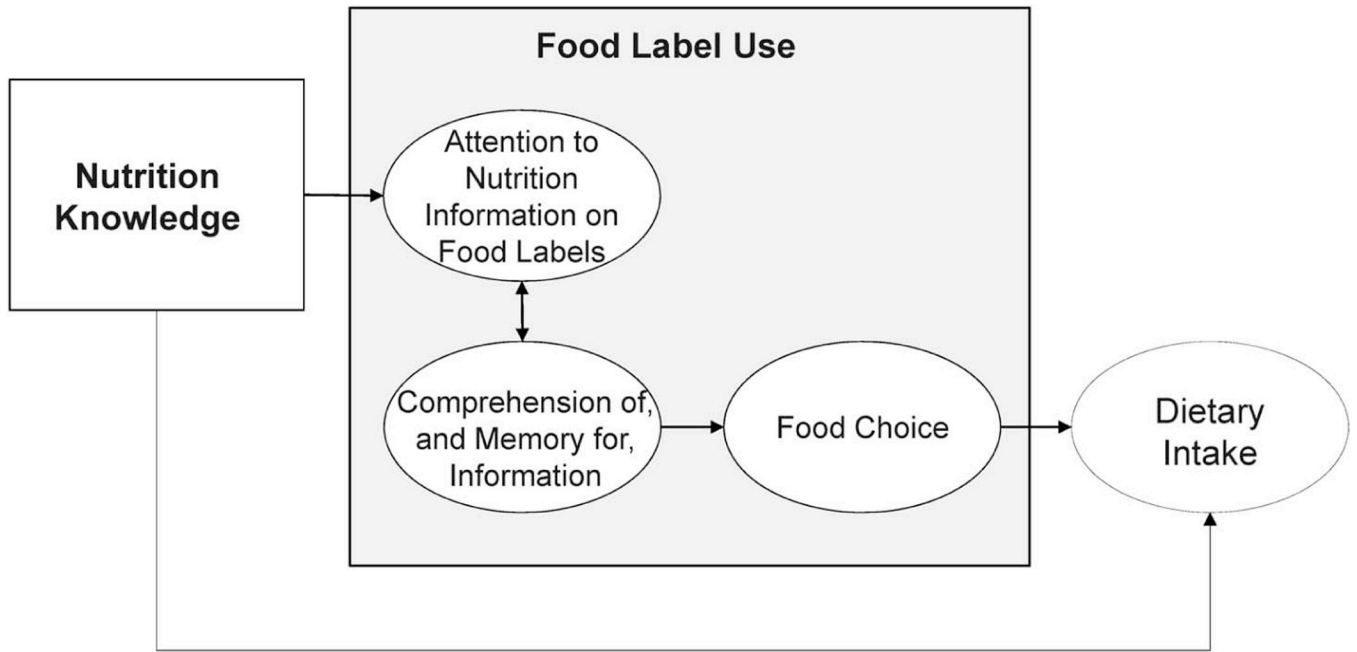


Figure 1.
Cognitive Processes Underlying Use of Food Labels

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Table 1
 Studies of Nutrition Knowledge and Food Label Use for Nutrition Labels (NL), Claims (CI), and Ingredient Lists (IL)

Studies	Location	Sampling Method	Food Label Area			Knowledge Assessment Characteristics (for objective measures)			
			NL	CI	IL	Dimensions	Number of items	Source of items (or dimensions)	Used some or all items from source
1	Iran	convenience	x			not defined	7	Parmenter & Wardle, 1999	Some
2	Spain	random	x	x		not defined	2	None	NA
3	Spain	random	x	x		not defined	2	None	NA
4	USA	convenience	x			not defined; calcium only	1	Moorman, 1996	None
5	USA	representative of state	x			not defined	12	None	NA
6	Mauritius	random sample	x			dietary recom, sources of nutrients, diet-disease	not reported	Parmenter & Wardle, 1999	Not Reported
7	Spain	purposive convenience	x			dietary recom, sources of nutrients	21 questions (multiple items)	Parmenter & Wardle, 1999	Some
8	UK	convenience	x			dietary recom, sources of nutrients, choosing foods, diet-disease	110	Parmenter & Wardle, 1999	All
9	Greece	random	x			not defined	7	Parmenter & Wardle, 1999; Blaylock, 1999	Some
10	Greece	random	x			dietary recom, sources of nutrients, choosing foods, diet-disease	9	Parmenter & Wardle, 1999; Blaylock, 1999	Some
11	USA	random	x			not defined; dairy products only	10	Elbon et al., 1996	Some
12	USA	convenience	x			dietary recom, sources of nutrients, diet-disease	20	Sheard, 1994	Not Reported

	Studies	Location	Sampling Method	Food Label Area			Knowledge Assessment Characteristics (for objective measures)				Used some or all items from source
				NL	CI	IL	Dimensions	Number of items	Source of items (or dimensions)		
13	Grimes, Riddell, and Nowson (2009)	Australia	convenience	x			not defined; sodium/salt only	2	None	None	NA
14	Hess et al. (2012)	Switzerland	random	x			not defined; 1 item on calories in food	1	Dickson- Spillman, 2011		Some
15	Howlett et al. (2008)	USA	convenience	x	x		manipulated trans fat k; diet-disease, acceptable levels	na	None	None	NA
16	Jacobs et al. (2011)	South Africa	random	x	x	x	subj measures only	NA	NA	NA	NA
17	Jasti and Kovacs (2010)	USA	convenience	x			not defined; trans fats only	6	None	None	NA
18	Li, Miniard, and Barone (2000)	USA	convenience	x			positive/ negative nutrients, DVs and %DV's,	NA	Moorman, 1996 (dimensions only)		None
19	Liu, Hoefkens, and Verbeke (2015)	China	convenience	x			dietary recom; sources of nutrients; salt and energy recom	59	Grunert et al., 2010		Some
20	Macon et al. (2004)	USA	random	x			not defined; fat only	15	CSFII and DHKS		Not Reported
21	Marietta, Welshimer, and Anderson (1999)	USA	convenience	x			not defined	9	None	None	NA
22	Miller and Cassidy (2012)	USA	convenience	x			diet-health, sources of nutrients, procedural	38	Miller et al., 2011		Some
23	Miller (2014)	USA	convenience	x			diet-health, sources of nutrients, procedural	35	Miller et al., 2011		Some
24	Misra (2007)	USA	random	x			not defined; fat and cholesterol only	9	CSFII and DHKS		Not Reported
25	Nayga (2000)	USA	convenience	x			not defined	8	None	None	NA
26	Norazlanah et al. (2013)	Malaysia	convenience	x			not defined	4	None	None	NA
27	Norazmir et al. (2012)	Malaysia	convenience	x			not defined	22	None	None	NA

	Studies	Location	Sampling Method	Food Label Area			Knowledge Assessment Characteristics (for objective measures)			
				NL	CI	IL	Dimensions	Number of items	Source of items (or dimensions)	Used some or all items from source
28	Orquin (2014)	Denmark	random	x	x		not defined	6	Andrews et al., 2009	Not Reported
29	Pérez-Escamilla and Haldeman (2002)	USA	random	x			food fat content, food groups, obesity-health	20	CSFII and DHKS	Not Reported
30	Petrovici and Ritson (2006)	Romania	random	x			diet-disease, nutrition principles, food nutrient density	11	Blaylock et al., 1999 (dimensions only)	None
31	Petrovici et al. (2012)	UK	convenience	x	x		not defined	4	Drichoutis et al., 2005	Some
32	Pietzke et al. (2010)	USA	random			x	not defined; trans fats only	9	None	NA
33	Rasberry, Chaney, Housman, Misra, and Miller (2007)	USA	convenience	x			not defined	11	Marietta et al., 1999	Some
34	Walters and Long (2012)	USA	convenience		x	x	not defined	NA	None	NA

Notes: NL=nutrition label; CI=claims; IL=ingredient list; NA=not applicable; NR=not reported; recom=recommendations; articles were coded with "not defined" when the no information was provided on the dimensions of nutrition knowledge included in the assessment.

Table 2

Nutrition Knowledge and Food Label Use Assessment Types

Types of Assessment	Description	Identified studies	Knowledge-Food Label Use Association
Nutrition Knowledge			
Self-reported	Self-rated nutrition knowledge	5, 14, 16, 28, 30, 32	YES: 5, 14, 16, 28, 29–31; NO: none
Objective	Accuracy of responses on nutrition knowledge test	1–15, 17–34	YES: 1–3, 5–15, 17–23, 27, 28 31–34 NO: 4, 10, 24–27, 29, 30
Food Label Use			
Frequency			
Self-reported	Self-reported frequency of use (e.g., how often do you use food labels?)	1, 3, 6–17, 19–21, 24–27, 29–33	YES: 1, 3, 6–9, 11–17, 19–21, 29, 30 (subj K), 31–33 NO: 10, 24–27, 29, 30 (obj K)
Objective	Observation of label use via a coding or tracking system	22	YES: 22
Comprehension			
Self-reported	Self-rated comprehension of food label information	6, 16, 19, 20, 31	YES: 19
Objective	Accuracy of responses on comprehension test (e.g., identifying presence or levels of nutrients)	2, 4, 5, 7, 10, 13, 15, 16, 18–20, 22, 23, 27, 28, 32, 34	YES: 2, 5, 7, 10, 13, 15, 16, 18–20, 22, 23, 27, 28, 30–32, 34 NO: 4

Notes. Subj = subjective; obj=objective; K=knowledge; articles could receive a YES and a NO rating if one measure showed knowledge-food label use association and another did not.