REVIEW

Nutrition and Cancer Prevention: Why is the Evidence Lost in Translation?

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ABSTRACT

With the high burden of cancer worldwide, primary prevention has been identified as a key cancer control strategy to reduce this burden. Diet and nutrition are important modifiable factors that may alter the risk of developing cancer, because several dietary components including alcohol consumption, fruit and vegetable intake, and dietary fiber have been shown to significantly impact cancer risk. Consequently, a number of organizations have developed cancer prevention guidelines that highlight the importance of nutrition (and related factors including body size and physical activity) to reduce the risk of cancer. However, there are barriers to the uptake of these guidelines, particularly with respect to diet and nutrition including awareness, communication, and other factors that influence eating behavior. Improved knowledge translation (KT) of recommendations may help facilitate uptake. The purposes of this narrative review are: *1*) to examine issues and challenges related to KT of diet and nutrition evidence in the context of cancer prevention, including public awareness and attitudes towards cancer prevention, engagement in cancer prevention strategies, and effects of KT on diet-cancer preventive behaviors; *2*) to discuss examples of effective and ineffective KT of diet and nutrition evidence; and *3*) to provide recommendations for improving KT to help move the field of diet, nutrition, and cancer prevention forward. Evidence shows that adherence to nutrition recommendations for cancer prevention significantly reduces the risk of cancer; however, engagement in nutrition-based preventative behaviors is low. Skepticism and confusion around evidence linking diet and nutrition with cancer may arise, in part, through ineffective media KT; the primary source of health information for many people. Simple, tailored, targeted KT communication strategies aimed at increasing the general public's awareness, attitudes, and engagement in cancer preventive behavior should be emphasized to encourage cancer control. *Adv Nutr* 2019;10:410–418.

Keywords: knowledge translation, diet, obesity, body size, physical activity, cancer risk

Introduction

The International Agency for Research on Cancer estimated that 14.1 million new cancer cases were diagnosed, and 8.2 million cancer deaths occurred worldwide in 2012 (1). In the United States an estimated 1,735,350 new cases of cancer will be diagnosed in 2018 and nearly 40% of men and women will be diagnosed with cancer during their lifetime (2). The high burden of cancer illustrates the critical need for strategies to address this public health problem. Several agencies, including the World Health Organization (3), the International Agency for Research on Cancer (4), World Cancer Research Fund (WCRF), and the American Institute for Cancer Research (AICR) (5), have identified primary cancer prevention as a key strategy to reduce the burden of cancer.

There is overwhelming evidence that lifestyle factors including nutrition impact cancer risk. For example, alcohol intake >2 drinks/d (1 drink = 350 mL of beer, 150 mL of wine, or 44 mL of spirits), fruit and vegetable consumption <5 servings/d (1 serving = 125 mL of whole fruit or vegetables; or 125 mL of fruit or vegetable juice; or 250 mL of leafy vegetables), dietary fiber intake <25 g/d, and red and processed meat consumption, among other dietary components are associated with increased cancer risk (5). This evidence has led to the development of cancer prevention guidelines that provide recommendations on diet (along with other factors) to reduce the risk of cancer (5). Following these recommendations may reduce the risk of some cancers by upwards of 30% (6).

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Abbreviations used: ACS, American Cancer Society; AIRC, American Institute for Cancer Research; KTA, Knowledge-to-Action; KT, Knowledge Translation; WCRF, World Cancer Research Fund.

However, there are significant barriers to nutrition and more broadly, lifestyle changes that align with cancer prevention, including awareness of recommendations, food skills, such as knowledge (e.g., about food, label reading, food safety), planning (e.g., organizing meals), conceptualizing food (e.g., adjusting recipes) and techniques (e.g., preparing meals), and access to the means required to follow guidelines, as well as environmental and sociodemographic factors (7). Knowledge translation (KT), a process that includes dissemination and exchange of knowledge between researchers and knowledge users such as the general public (8) may also impact the uptake of cancer prevention guidelines. Despite generally consistent messaging around healthy eating (9) in recent decades, evidence supporting the role of diet and nutrition in cancer prevention is perceived as inconsistent by health professionals and the general public (10). Effective KT is especially important with respect to diet and nutrition evidence because spurious reporting may impact public policy, such as dietary guidelines, and individual behavior through advocacy of select nutrients, foods, or diets by non-experts (11). Thus, understanding breakdowns in KT and how KT can be improved may help to facilitate the dissemination and implementation of cancer prevention guidelines to relevant knowledge users including public health organizations, primary care providers, and the public. The objectives of this narrative review are: *1*) to examine the issues and challenges of KT of diet and nutrition evidence in the context of cancer prevention including KT-related outcomes for cancer prevention; *2*) to examine effective and ineffective KT strategies for diet and nutrition evidence; and *3*) to provide recommendations for improving KT to help move the field of diet, nutrition, and cancer prevention forward.

Literature Search

A narrative review was used to identify relevant research. Embase and Medline/Pubmed were used to identify articles. As the area of KT with respect to cancer prevention is narrow, no limits were set on the type of literature included in the search, populations examined, or dates of the articles. Key terms included lifestyle, diet, nutrition, cancer, education, motivations, facilitators, knowledge translation, implementation, and dissemination. The references of articles identified were also reviewed to capture additional articles. Articles were selected for inclusion in the review at the discretion of the research team.

Development of Nutrition Guidelines for Cancer Prevention

It was not until the 1980s that scientific evidence linking diet and cancer began to develop. In 1981, Doll and Peto (12) estimated that ~35% of cancer deaths could be attributed to diet, although they noted most evidence was indirect and conceded that the estimate could range from 10% to 70%. In 1982, the US National Academy of Science published the *Diet, Nutrition, and Cancer* report, concluding that there was a link between dietary components and cancer risk and suggested dietary guidelines (13). The 1988 *Surgeon General's Report on Nutrition and Health* (14) and the US National Research Council of the National Academy of Sciences report, *Diet and Health: Implications for Reducing Chronic Disease Risk* (15) led to the creation of the WCRF/AICR *Food, Nutrition and the Prevention of Cancer: A Global Perspective* document. The first expert report was published in 1997, the second in 2007, and the third in 2018 (9). The WCRF/AICR reports provide a summary of the current global literature on how diet, nutrition, physical activity, and weight affect cancer risk and survival. The reports include judgments on the strength of evidence as to whether links are causal and include terminology such as "strong" and "limited," and ranges within each category from "convincing to substantial effect on risk unlikely" and "limited to no conclusion." The evidence summary is updated regularly as part of the WCRF/AICR Continuous Update Project (5), an ongoing review and synthesis of evidence that is based on over 9000 studies (5). Since 1997, the advice from the WCRF/AICR has remained generally consistent with updates that reflect changes to the food supply (limit fatty foods in 1997 to limit processed foods including fast food in 2007 and 2018) and additional evidence (limit red meat in 1997 to limit red meat and avoid processed meat in 2007 and 2018).

The American Cancer Society (ACS) also provides guidelines on Nutrition and Physical Activity for Cancer Prevention (16). The guidelines are similar to the WCRF/AICR recommendations in the emphasis on eating a plant-based diet, maintaining a healthy body weight, avoiding alcohol, and limiting red meat consumption, but the WCRF/AICR includes recommendations for legumes and grains, limiting energy-dense foods and sodium intake, whereas the ACS recommends consuming wholegrains (16) and a different amount of physical activity. The variation likely reflects the ACS alignment with guidelines for prevention of coronary heart disease and diabetes and general health from the Dietary Guidelines for Americans and Physical Activity Guidelines for Americans.

Adherence to Nutrition Guidelines and Cancer Risk

Since the introduction of nutrition guidelines for cancer prevention, several studies have examined whether adherence to the WCRF/AICR or ACS guidelines for cancer prevention impacts cancer risk (17–29). In general, studies assign adherence scores to participants based on the number of recommendations in which they engage for all aspects of the cancer prevention guidelines quantifiable in the respective study (17–29). A 2016 systematic review (17) of 12 observational studies from 10 different cohorts, 11 countries, and over 1.6 million participants found high versus low adherence to either WCRF/AICR or ACS guidelines was associated with a significant reduction (10–61%) in overall cancer incidence and mortality (18–25). For every 1-point increase in adherence score, which in general accounted for 1 additional guideline followed, a 5–9% reduction in cancer risk was observed (23, 24). The small number of

studies on cancer-specific outcomes make it difficult to draw conclusions about possible variable impacts of prevention guidelines. For breast, endometrial, and colorectal cancers, higher adherence is associated with a 19–60% (19, 20, 22, 24–29) lower incidence, whereas lung, prostate, and ovarian cancers demonstrate unclear or null associations (19, 20, 22, 24). However, more recent studies continue to suggest that greater adherence to prevention guidelines is associated with lower cancer incidence among diverse populations including older adults (30, 31), as well as Mexicans (32) and African Americans (31).

Comparisons across studies are also limited by the variable interpretation of the guidelines because clearcut points do not exist for all recommendations such as sedentary time, wholegrains, legumes, sodium, and energy-dense foods. Rather the recommendations are to "limit" or "consume sparingly," which lend themselves to different interpretation. Both the WCRF/AICR and ACS guidelines do not consider the relative importance of recommendations and thus studies have assigned an equal weight to each recommendation in the calculation of an overall adherence score. Although it would be a large undertaking, some consideration of the strength of the evidence and attributable risk for each factor may help facilitate comparable surveillance information.

Engagement in Cancer Preventive Behaviors

Despite established nutrition guidelines for cancer prevention and evidence demonstrating reduced cancer risk with greater adherence to the guidelines, engagement in preventive behaviors is low. A study of nearly 25,000 adults found that only 14% adhered to $\geq$5 cancer prevention recommendations out of the 7 assessed by the study, and $<$1% adhered to all recommendations (33). When individual diet recommendations were assessed, adherence to recommendations for fruit and vegetable consumption occurred in $<$10% of participants (34, 35). This may be related to the pervasive fatalistic attitude that "everything causes cancer" (7). Numerous surveys (7, 36, 37) have reported that $>$50% of respondents believe that everything causes cancer and $>$25% believe that there's not much people can do to lower their chances of getting cancer. Participants who had fatalistic beliefs were, unsurprisingly, less likely to consume $\geq$5 servings of fruits and vegetables/d (7), and less likely to seek cancer-related information (37).

The reasons for this fatalism are likely multifaceted. There is some evidence of confusion about the recommendations as ~75% of survey respondents reported that "there are so many recommendations about preventing cancer, it's hard to know which ones to follow" (7, 36). Other studies have found that the majority of people are aware that cancer is related to lifestyle behavior including diet (36, 38), but nearly half did not know what could be done to reduce cancer risk (38). This suggests a lack of awareness around specific actionable dietary recommendations.

A study investigating the use of cancer-related information by the American public (39) reported that 50% of people listed "healthy eating" as a cancer prevention strategy, second only to "not smoking." When people were asked for specific dietary strategies to prevent cancer, the 5 most common responses were "eat more vegetables" (51%), "eat less fat" (34%), "eat more fruit" (35%), "eat more fiber" (18%), and "eat less red meat" (14%) (39). However, people also reported consuming only about 2 servings of fruit and vegetables/d (39), well below the recommended levels of $\geq$5 servings/d (5). It is possible that this disconnect reflects a lack of awareness of 5 servings as the target, misconceptions about perceptions of a healthy diet (34), or the well-established gap between knowledge and behavior change (40).

KT for Cancer Preventive Behaviors

KT may be used interchangeably with translational science, knowledge transfer and exchange, and dissemination science among other terms, that have slightly different meaning. Regardless of the term used, transferring evidence-based knowledge into action has been identified as a key component that can improve cancer control through influencing implementation, policy, and uptake of prevention and screening strategies (41).

In 1994, the National Cancer Institute of Canada (42) developed a framework to guide research into practice that was modified from the United States cancer control research strategy (43). This framework identified 5 categories in which all cancer control activities could be assigned: fundamental research, intervention research, knowledge synthesis and decision making, surveillance and monitoring, and program delivery (42). Fundamental research expands knowledge of the mechanisms and systems that underlie effective cancer control strategies, by answering the question "What do we know?" Intervention research assesses the efficacy and effectiveness of interventions and addresses the question "What works?" Program delivery is a 6-stage process for development and implementation of specific cancer control programs. This category of activity also includes evaluation of these programs and answers the question "How should programs be delivered?" Surveillance and monitoring includes the collection, review, and analysis of data describing cancer incidence, prevalence, morbidity, or mortality to answer the question "Where are we?" Finally, knowledge synthesis and decision making is the hub around which all of the other categories are orchestrated. This category draws on conclusions and recommendations from all other activities to answer the question "What is next?"

More recently, the framework has been adapted to incorporate processes that are part of KT and indicators of successful KT within cancer control (44). "Knowledge integration," which is the incorporation of knowledge into decisions, practices, and policies of organizations and systems was added to the framework. There are 2 principles of knowledge integration that should be considered by people using the framework in their KT activities: situational issues that influence individual research settings, and the idea that the mechanisms, actions, and activities that move knowledge forward may differ depending on the situation. Indicators of successful KT are situation-dependent and may include

the reach and engagement of the KT activity such as the number of tools distributed, or downloaded, or indicators of usefulness, such as user satisfaction with a tool, changes in views, attitude, and intention (45, 46). Success may be indicated by the use of a particular tool or piece of information, or policy, program, and service changes (45, 46). These frameworks can be used as a tool to guide KT across the broad spectrum of cancer control activities, although we are not aware of any efforts to apply these frameworks to reconceptualize how nutrition information or cancer preventive lifestyles can be more effectively disseminated.

Within the literature, Graham's Knowledge-to-Action (KTA) cycle is commonly cited (47, 48) and may be an effective model to improve KT of nutrition guidelines for cancer prevention, although it is important to note that a KT model should be selected for its relevance in a particular context (49), as no KT model has been identified as superior to the others. The KTA cycle is separated into 2 main phases: knowledge creation, in which new knowledge is generated, and the action stage, in which the knowledge is implemented in a particular situation. Knowledge creation begins with an initial question, after which available knowledge is synthesized, and practical tools, resources, and products may be developed. Throughout knowledge creation "knowledge" is continuously being refined as more information becomes available. This is referred to as "knowledge tailoring" (47). The action stage, begins by identifying a problem, followed by review, selection, and adaptation (if needed) of the appropriate knowledge, tools, resources, and products from the knowledge creation stage that may help solve the identified problem. Barriers that may impede the uptake of knowledge, tools, resources, and products are assessed with subsequent refinement before implementation. Once a particular piece of knowledge has been refined, the outcomes of the KT activities to implement the knowledge are evaluated. Following evaluation, the cycle can then begin again to continue to improve knowledge and KT activities. An example of the implementation of this model in cancer control can be found in the success of enhanced colorectal cancer screening in Canada (50). In this example, the creation stage included synthesis of information on attitudes, knowledge, and behaviors towards screening. The action stage included identifying a low rate of fecal occult blood tests (the problem), and the means to monitor different screening implementation plans and knowledge gaps (barriers) that impeded screening such as a physician's beliefs about acceptance of screening by patients. One KT strategy that emerged included educating physicians about the disconnect between their beliefs and the public's comfort with screening through a family practice journal publication, national press releases, and online resources.

The cyclical nature of the KTA model may be ideal for nutrition and cancer prevention, because of the evolving evidence base on nutrition and cancer but use of the KTA framework in this context is relatively limited. A citation analysis of the KTA framework across all health disciplines identified 146 studies in which the KTA framework was referenced, but only 10 studies used it as an integral component of their study design (48). Specific to nutrition, a scoping review of all KT theories, models, and frameworks, used to guide evidence-based intervention for prevention and management of cancer and chronic disease identified 159 different theories, models, and frameworks, that have been used across 569 studies (51). The majority (87%) of the models identified were used in $\leq$5 studies, whereas 60% of models were used once (51). With the vastness of the KT strategies used, it is difficult to assess which models and frameworks are most successful. Although these frameworks may be referenced by studies, inform planning, and make intellectual contribution to the literature, their use has yet to truly be incorporated into the greater scientific literature (48). The lack of information and consensus on KT practice in nutrition for cancer prevention may, in part, be attributed to incomplete evaluation of smaller KT activities, in that these activities may be ongoing; however, the evaluation of their success is incomplete (52). In terms of larger-scale interventions, both Canada and the US have added nutrition to the national health agendas, health recommendations, and grassroots initiatives (53–55). In general, these large-scale community and workplace interventions to improve nutrition, at best, provided moderate changes (55–59). For example, in *Healthy People 2010*, a US nationwide health promotion and disease prevention agenda, there were 22 objectives in the focus area of Nutrition and Overweight. Data on health indicators showed that only 2 objectives approached the target, whereas 15 moved away from the target (55). The other 5 targets had been removed from the agenda during previous program evaluations (55). Taken together, this highlights the need for increased education of researchers on effective KT strategies and frameworks, as well as improved evaluation of these strategies.

The Media: An Influential KT Player

Broadcast and print media are the major sources of health information for the general public (60), and as such are the focus of this section, although we acknowledge that social media is increasingly influential. Health is the eighth most common topic covered by the news media, and cancer receives the greatest amount of coverage within health (60). The news media thus has a significant ability to impact the public's awareness, attitude, and knowledge regarding health-related behaviors. This has proven to be helpful in some aspects of cancer preventive behavior including increased mammography for breast cancer screening, decreased smoking for cancer prevention, and increased colon cancer screening (61, 62). However, news media coverage may also have unintended and negative impacts on health behaviors, which has often been true for nutrition and cancer prevention.

Media coverage has the capability to frame public opinion about health problems by emphasizing some aspects of issues over others and by shaping perceptions about who is responsible for health problems and their solutions (60, 63–67). Media coverage is often complex, contains conflicting

information, and often does not consider the limitations of the results being reported (60). This may lead to confusion, frustration, and even disengagement with cancer control activities (60). Media agencies may rely on anecdotes to personalize stories to make a story "newsworthy," even if those anecdotes contradict the prevailing literature (60). To understand the evidence framing media reports on cancer prevention, Atkin and colleagues (68) examined the content of 231 breast cancer media stories that appeared in major newspapers, newsmagazines, and on television networks. Only 4% of news items reported on risk behaviors related to lifestyle, such as obesity, eating patterns, and exercise (68). Personal narratives appeared in twice as many media stories as did statistical figures and only two-thirds of news items cited expert medical professionals, researchers, or organizations (68).

Ineffective and/or misleading nutrition KT by media sources may contribute to low prevalence of engaging in cancer preventive behaviors. More than 75% of adults report medium to high levels of exposure to contradictory nutrition information in the media (69). Those who report contradictory exposure are more likely to be confused about nutrition recommendations and less likely to adhere to healthy lifestyle recommendations (69). The reasons for confusion may stem from the journalist norm of "2-sided" coverage, which presents both sides of a story versus a "1-sided" approach, which presents only a single viewpoint or arguments. It has been argued that presenting both sides of a scientific consensus creates "false balance," as the opposite side is often unsupported in the literature (70, 71). In 2013, Chang (72) demonstrated that exposure to 2-sided nutrition information, compared to 1-sided nutrition information, increased ambivalence about consuming the food/supplement in question, increased negative attitudes, and decreased intentions to consume the advocated food/supplement (72). In a follow-up study, Chang (73) also demonstrated that exposure to 2-sided information increased uncertainty and negative attitudes about health research (73).

A recent striking example of why effective KT from researchers and media is vital for informing the public comes from publications in *Science* in 2015 and 2017, in which 2 scientists described their research on inherited or environmental factors as causes of cancer (74, 75). They concluded that two-thirds of the variability in cancer risk across different tissues could be explained by "bad luck" mutations. Widespread misinterpretation of the findings occurred. At the extreme end, media stories reported cancer was caused by bad luck (76). Others stated that two-thirds of cancer could be explained by random mutations (77, 78), rather than the true results, which estimated that two-thirds of mutations are random; a nuance that understandably led to confusion (74, 75). The reports overemphasized the randomness of cancer and did not recognize the importance of exposures known to impact cancer risk, including diet and nutrition. Given the importance of cancer control, communicating clear and accurate evidence that encourages preventive behavior is of the utmost importance.

Barriers to KT of Nutrition Recommendations for Cancer Prevention

The complexity of healthy eating and eating behavior and barriers to knowledge and engagement creates the need for multiple, tailored KT strategies that go beyond media communication. For example, health literacy, the ability to obtain, process, and apply information to health-related decision making (79), is directly related to cancer prevention beliefs (80) and engagement in cancer preventive behaviors, including fruit and vegetable consumption (81). Although not directly assessed, health literacy may have contributed to the disconnect in the high self-reported engagement in healthy eating (80% of participants) and concurrent low (<10%) prevalence of meeting fruit and vegetable recommendations in a prior study (34).

There are also several sociodemographic factors that may contribute to poor uptake of the cancer prevention guidelines. In a survey which asked the public to identify cancer prevention strategies, factors related to health literacy (low income and education levels) were associated with lower identification of preventive guidelines, as were demographic factors (age ≥65 y and Hispanic ethnicity) (39). There is also some evidence that women, people with a family history of cancer, and people aged 35–64 y may have greater awareness of cancer preventive strategies (39). However, this is likely related to differences in health-seeking behavior and eating behavior rather than direct effects (82).

KT strategies and/or frameworks for cancer prevention nutrition messages may also need to consider barriers to healthy eating including time, irregular working hours, taste preferences (83, 84), cooking skills, and motivation to change dietary habits (85). Social support, availability, affordability, and access to healthy options are also well-known barriers to healthy eating (86).

Improving KT of Nutrition Recommendations for Cancer Prevention

Increased awareness of the importance of KT of nutrition evidence and nutrition recommendations for cancer prevention is needed at multiple levels (institutional/organizational, researcher, and media) to generate a movement towards improvements in KT. It is important to note that in general, researchers engage in KT, which includes presentation for academic and non-academic audiences, consulting with research users, working with advisory committees, writing reports, and meetings with policy makers (87). Increasingly, grant agencies are emphasizing KT activities for scientists and encouraging incorporation of non-traditional KT activities beyond peer reviewed articles and scientific presentations (88, 89). Moving beyond traditional activities may be challenging. Training and support for prioritizing KT needs to be available at the institutional level. There are also several tools that may help researchers incorporate KT into their research programs such as *The Knowledge Translation Toolkit* (90), *Planning for Knowledge Translation: A Researcher's Guide* (91), the Canadian Institutes for Health Research *Guide*

to Knowledge Translation Planning at CIHR: Integrated and End-of-Grant Approaches (92), which addresses KT strategies while the research is being conducted as well as after the study conclusion, and *A Guide to Researcher and Knowledge-User Collaboration in Health Research* (93).

Given the influence of the media on dissemination of health information, educational support is needed for the media to facilitate effective KT. Most literature and training resources focus on educating researchers on how to effectively communicate with media, with comparably less resources for members of the media. Previously, the National Institutes of Health offered a "Medicine in the Media" workshop, which aimed to address the challenges of reporting on medical research (94) but it was de-funded in 2013. Nutrition-specific workshops are also lacking. For example, there are no nutrition-specific resources available from the Association of Health Care Journalists, a nonprofit organization with the aim of advancing public understanding of healthcare issues through improved reporting (95). By only training 1 member of the KT information chain, there may be significant deficits in communication. Integration of training on sound, effective communication of nutrition evidence into the curriculum of higher education may be helpful in this regard, particularly if this was embedded into science, health-related, and journalism course curricula. Indeed, educational institutes have begun to recognize this need and degree programs are offered that merge nutrition science and health communication (96).

Approaches are needed to help the general public understand scientific evidence. Beyond presenting the accurate scientific research clearly and effectively, resources to help people distinguish "junk" science from credible science should be developed to further facilitate uptake of these behaviors, such as the Food and Nutrition Science Alliance's "10 Red Flags of Junk Science" (97). This list was designed to help people critically evaluate nutrition recommendations from various sources (e.g., articles, books, or product labels) by identifying common flags of nutrition misinformation. It includes flags such as claims that sound too good to be true and recommendations based on a single study, among others. This importantly may encourage self-efficacy with respect to nutrition recommendations. Open access research publications may improve KT of nutrition information by providing direct access to research findings rather than third-party summaries. However, limited health literacy among the general public is likely a barrier to prevalent use of open access publications for information (80). When developing KT strategies, evidence suggests that simple messages in which the content is tailored and targeted to be relevant and applicable to the target audience are most effective for the general public as well as for public health policies and programs (98, 99). Development of such strategies could be informed by applying frameworks such as the KTA cycle described above. Comparably, KT strategies that are passive, such as access to preprocessed research evidence or general print material summaries, may be less effective (98).

With respect to cancer prevention, messages that are inclusive, relevant, and explain the consequences of unhealthy behaviors in terms that are valued are needed for populations with the lowest knowledge of preventive guidelines (i.e., men, older individuals, non-white populations, those with lower education and income). Parallels can be drawn from KT within successful cancer control efforts, such as warnings and health information around tobacco products that were part of a comprehensive approach to tobacco reduction (100). KT approaches included coordinated strategies through healthcare providers, policies, communities, and individuals that were tailored to the target audience. For example, graphic warning labels on cigarette packages with images relevant to smokers (as determined through focus groups) are more effective for smoking prevention than non-graphic warning messages (101).

It is important to recognize that dissemination and uptake of knowledge does not necessarily equate to changes in behavior (102). Perceived consequences of the behavior, attitudes and belief about the behavior, the skills required to perform/complete behaviors that meet nutrition recommendations, confidence to perform these behaviors, and the social, physical, cultural, internal, and external environment in which these behaviors take place may all contribute to uptake of nutrition recommendations (103). How the message is framed may also impact the uptake of information. The WCRF/AICR and ACS recommendations focus on what is needed for good health rather than what is needed for engaging in the behavior. Recommendations considering both aspects and strategies that empower individuals may be helpful. It is also unclear whether any input from knowledge users was considered in developing the specific messages in the recommendations. The high percentage of people who report being overwhelmed by information on cancer prevention identified in numerous studies (80, 104, 105) suggests a need for new KT methods and closer engagement with knowledge users to help shape messages that resonate and encourage more positive behaviors.

Conclusions

Multilevel strategies are needed for successful implementation of cancer prevention. Nutrition is 1 of the few ubiquitous, modifiable risk factors for cancer and thus a critical piece of prevention strategies and policy. However, despite the development of nutrition guidelines for cancer prevention and demonstrated benefits of adherence to these guidelines, engagement in preventive behaviors is low. Efforts at promotion of cancer preventive dietary practices can be advanced through KT strategies that present clear, accurate evidence, that are relevant to the public and other knowledge users. The burgeoning field of research on KT methods and frameworks will be important for informing best practices for KT in support of this goal.

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wrote the manuscript; GM, KLC, and SD: critically evaluated and provided feedback on the manuscript; and all authors: read and approved the final paper.

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