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Representations of cancer recurrence risk, recurrence worry, and health-protective behaviours: an elaborated, systematic review

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Abstract

An expanded Common-Sense Model (CSM) contextualised to the self-regulation of cancer recurrence risk identifies risk representational attributes and recurrence worry as primary processes motivating protective behaviours in cancer survivors. A systematic review examined evidence for CSM hypotheses regarding how these processes influence diet and physical activity (PA) among survivors. A research agenda is outlined and used to evaluate the evidence base. Common databases were searched for eligible, peer-reviewed, English language reports, yielding 18 studies quantitatively testing hypothesised relationships among representations of prior cancer, recurrence risk representations, recurrence worry, and diet and PA. The findings provide promising, but mixed and limited evidence for some of the hypothesised associations of specific risk recurrence attributes with recurrence worry, and risk recurrence attributes and recurrence worry with diet and PA. Findings support the distinction of recurrence risk representations and illness representations of the prior cancer, with each showing different relationships with recurrence worry and behaviours. We discuss the status of the evidence base in relation to assessment, design, and analysis priorities and propose strategies that can yield more sensitive, rigorous tests of the CSM for cancer recurrence risk as applied to diet and PA.

Keywords

Self-regulation model; cancer recurrence beliefs; illness representations; cancer recurrence worry; risk perception; diet and physical activity

The Common-Sense Model (CSM) of Illness Self-Regulation (Leventhal, Brissette, & Leventhal, 2003; Leventhal, Phillips, & Burns, 2016) is used to understand how individuals cope with acute and chronic illnesses. In particular, it has been applied in numerous studies to predict how illness representations and emotions shape behaviours and outcomes such as medical care use (e.g., Cameron, Leventhal, & Leventhal, 1993), treatment adherence (e.g., Leventhal, Diefenbach, & Leventhal, 1992), and quality of life (e.g., Boddington, Myers, &

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Newman, 2002). Although less frequently, researchers have also applied this theoretical framework to understand and predict behaviours in response to cues of illness risk such as genetic information (e.g., Cameron, Biesecker, Peters, Taber, & Klein, 2017; Kelly et al., 2005) and risk-related beliefs (e.g., Cameron, 2008; Newby et al., 2017).

Recent years have witnessed growing interest in building on these developments by applying the CSM to understand health-protective behaviours among cancer survivors who have concluded treatment and are progression-free (e.g., Costanzo, Lutgendorf, & Roeder, 2011; Mullens, McCaul, Erickson, & Sandgren, 2004). This health domain is particularly important given the increasing numbers of longterm cancer survivors resulting from advances in treatment (DeSantis et al., 2014; Siegel et al., 2012). Cancer survivorship features novel aspects of disease risk that are likely to elicit specific patterns of illness-related cognitions, affect, and behaviour motivation. In particular, survivors must cope with the salient risk of recurrence (Stanton, Rowland, & Ganz, 2015), a situation that differs from those of individuals coping with an acute illness (e.g., flu) or chronic condition (e.g., diabetes). For example, survivors have few or no symptoms providing salient cues of disease progression, live with uncertainty about recurrence timeline and consequences, and face ambiguities about how lifestyle behaviours may influence recurrence (Hopman & Rijken, 2015; Stanton, Luecken, MacKinnon, & Thompson, 2013). Similarly, the worry of recurrence can influence protection motivations in ways that differ from affect associated with current illness experiences.

In this article, we present a new elaboration of the CSM framework contextualised to the cognitive, emotional, and behavioural dynamics specific to cancer recurrence risk and protective coping behaviours such as healthy diet and physical activity. We first consider the roles of recurrence risk representations and recurrence worry in shaping protective behaviour motivations and their distinctions from cancer representations and worry as delineated by the original CSM. Next, we propose a research agenda highlighting methodological aims and approaches needed to provide valid and rigorous tests of the hypotheses specified by this contextualised CSM for understanding and predicting diet and physical activity for survivors. We then present a systematic review of research examining the relationships of representational and emotional attributes delineated by the CSM of cancer risk recurrence with motivations to engage in these behaviours. Finally, we discuss the findings in within the context of the proposed research agenda, evaluating the status of the research evidence base and highlighting the gaps to be addressed in future research.

The CSM of cancer recurrence risk

The proposed, expanded CSM of cancer recurrence risk (Figure 1) maintains the key features of the more general CSM. It delineates two sets of parallel processes for managing a health threat: (a) a problem-focused arm involving the activation of a mental schema or representation of a health threat (i.e., recurrence risk), which both arouses emotions (e.g., recurrence worry) and guides coping behaviours (e.g., healthy diet, physical activity); and (b) an emotion regulation arm involving coping efforts to manage distress, including through engagement in coping behaviours. Appraisals of the outcomes of coping efforts feed back to

revise representations and emotional arousal. In both arms, cognitive and emotional self-regulation involve both abstract, conceptual processes and concrete, experiential processes.

Risk representations include specific attributes: identity risk (label and associated symptoms or characteristics indicating risk), causal risk (factors responsible for the development of the condition), timeline (beliefs about the acute, cyclical, or chronic nature of the condition, the likely times in one's lifespan for its onset, and its duration), consequences (physical and psychosocial outcomes), and control/cure (whether the condition can be controlled or cured through personal behaviours or medical treatment). They also feature representational coherence (whether the condition 'makes sense' and one has a clear understanding of it), and risk-action link coherence (whether one has a clear understanding of how protective actions work to reduce risk).

The proposed CSM of cancer recurrence risk incorporates theoretical elaborations of illness risk representations and their connections with risk perceptions of illness likelihood and severity (Figure 1; Cameron, 2008). The integration of representational attributes with likelihood and severity perceptions is useful in light of the extensive research on likelihood appraisals and severity estimates in health psychology and related fields (Waters, McQueen, & Cameron, 2014; Weinstein, 2000) and their key roles in a variety of theoretical models such as Protection Motivation Theory (Rogers, 1975) and the Health Belief Model (Strecher & Rosenstock, 1997). Conditional likelihood estimates, or beliefs of illness likelihood conditional on not engaging in a protective behaviour, are particularly potent predictors of protective behaviour (Brewer et al., 2007).

Attributes of identity, cause, and timeline provide the mental contents on which likelihood appraisals are based. Rather than encoding and storing in memory a likelihood perception (e.g., that one has a 60% chance of getting lung cancer), one responds to a question about perceived likelihood by considering one's beliefs about identity (e.g., 'Do I have a troubling cough?'), cause (e.g., 'Do I smoke cigarettes?'), and timeline (e.g., 'Am I at the age when lung cancer is likely to develop'). In contrast, severity estimates are based on beliefs about the consequences of the condition (e.g., 'Is lung cancer highly painful?') and control/cure (e.g., 'Can it be prevented and, if so, how?' 'Can it be cured?'). Assessments of risk representational attributes on which likelihood estimates are expected to be based – identity risk, timeline risk, and causal risk – along with conditional likelihood estimates should yield stronger and theoretically-consistent patterns of relationships with protective behaviours.

The self-regulation processes involved in coping with cancer recurrence risk are expected to reflect those involved in coping with cancer diagnosis and treatment and those involved in coping with cancer risk in the absence of a prior cancer. However, they are likely to differ in terms of the contents and strength of representations and emotions. These distinctive features arise from the direct, vivid experiences during treatment, which can be frightening, extensive, and debilitating; and the appreciation that a remission can revert to cancer progression over time. We consider recurrence risk representations and recurrence worry in turn, with attention to: (1) their implications for modifications in assessment relative to standard approaches for assessing CSM constructs; and (2) predictions about their influence on unhealthy diet and physical activity efforts.

Recurrence risk representations

First, *identity risk* attributes for recurrence differ from identity attributes of active cancer in important ways. Whereas identity attributes such as symptoms tend to be salient and vivid at diagnosis and during treatment, the cancer and its associated symptoms are expected to be 'gone' or halted in their further development when one is deemed to be 'cancer-free'. *Identity risk* is likely to instead incorporate vague or ambiguous symptoms such as fatigue or other somatic experiences that might suggest poor immune functioning, thus risk of recurrence (Petrie, Booth, Elder, & Cameron, 1999; Petrie & Pennebaker, 2004); pain or lumps that could suggest cancer growth and metastatic activity; and physical characteristics indicative of risk (e.g., pale skin as a risk factor for melanoma recurrence). Identity risk attributes might motivate specific behaviours (e.g., bloating and constipation might motivate healthy diet) or they might discourage healthy actions (e.g., fatigue could discourage aerobic exercise). Generally, however, higher identity risk beliefs are expected to enhance recurrence worry and promote healthy diet and exercise behaviours. From this perspective, identity risk assessments should hone in on symptoms and characteristics commonly associated with recurrence risk and their interpretations as signs of cancer recurrence, as opposed to symptoms experienced at diagnosis or during treatment.

Second, *causal risk* beliefs are likely to differ from beliefs about the causes of the original cancer. For example, the cause of the original cancer might be attributed to environmental pollutants whereas a recurrence might be expected to be caused by lifestyle or poor immune function. Measuring both causal factors of the original cancer and causal factors of recurrence would deepen our understanding of their distinct relationships in motivating behaviours and influencing recurrence worry. Beliefs that unhealthy diet and sedentary behaviour influence cancer recurrence are expected to motivate these actions, and they may differ from beliefs about the respective behaviours as causes of the original cancer.

Third, expectations about the *cancer recurrence timeline* can be vague or unknown relative to more definitive beliefs about the timeline of cancer control after diagnosis and through the treatment phase. During survivorship post-treatment, beliefs that the original cancer was acute (as opposed to cyclical or chronic) might be stronger motivators of health behaviours as they evoke expectations that prevention of recurrence is possible. Beliefs about when a recurrence is likely (e.g., within the first 5 years of treatment but not after that) could enhance recurrence worry and protective behaviour motivations during key time periods (e.g., during the first 5 years following treatment, but not later). Assessment of timeline beliefs about both the original cancer and recurrence risk would therefore be optimal to assess how they influence protective behaviour (Cameron, 2008).

Fourth, beliefs about *recurrence consequences* are likely to be seen as more dire (e.g., deadlier, requiring more extensive treatment) than the original cancer experience that one has survived. Recurrence consequence beliefs might be a relatively stronger driver of worry and protection motivations. Targeting recurrence consequences, as opposed to consequences of the initial cancer, could therefore be more predictive for understanding health behaviour and emotion regulation dynamics.

Fifth, *personal and medical control* beliefs are likely to be lower during survivorship relative to during treatment (Mols, Denollet, Kaptein, Reemst, & Thong, 2012). Whereas perceived controllability during treatment might be fostered by experiences of potent, cancer-specific procedures such as surgery or chemotherapy, controllability during survivorship is often limited to standard health behaviours such as diet, physical activity, or sun protection, which might be viewed as having a weak impact on cancer control. This distinction between control beliefs about prior treatment and control beliefs about preventing recurrence highlights the importance of measuring them as separate constructs. Beliefs that recurrence is preventable are predicted to reduce recurrence worry and increase health behaviour motivations.

Finally, in terms of *representational coherence*, survivors are likely to have a good understanding of their original cancer based on their personal experiences of medical care and the easily-grasped connections between the nature of cancer cells and tumours and how they can be removed and destroyed through surgery, chemotherapy, and radiation. In contrast, a cancer survivor may have a less coherent understanding of recurrence risk and how behaviours such as diet and physical activity affect that risk. Both illness coherence and coherence in beliefs about how illness risk is affected by protective actions (i.e., *risk-action link coherence*) predict coping efforts and adaptive outcomes in a variety of illness and illness risk domains (Cameron, Marteau, Brown, Klein, & Sherman, 2012; Hagger, Koch, Chatzisarantis, & Orbell, 2017; Lee, Cameron, Wünsche, & Stevens, 2011; Scharloo et al., 2010). Within the context of cancer recurrence risk, assessments of representational coherence can differ in their focus on the understanding of: (1) the nature of the original cancer; (2) how the behaviours affected the original cancer; (3) recurrence risk, or (4) how the behaviours prevent a recurrence. Of these, the last set of beliefs about recurrence risk-action coherence are likely to have the strongest motivational impact on protective efforts and, by enhancing confidence in the potential to prevent a recurrence, help to assuage worry.

To summarise, the expanded CSM of cancer risk recurrence proposes that higher beliefs of identity risk, timeline risk that recurrence occurs within the near future, and recurrence consequences will fuel recurrence worry whereas higher beliefs of timeline that the prior cancer was cured, recurrence control, and coherence will reduce recurrence worry. Further, likelihood and severity appraisals, which we propose are based on representational contents, will promote recurrence worry. These representational risk beliefs are expected to motivate healthy diet and physical activity during survivorship following treatment. Attributes of representations of the original cancer are expected to have similar, but weaker influences on recurrence worry and protection motivations. Research testing the CSM for recurrence risk should use measures that directly assess risk representational attributes, either alone or along with traditional measures of cancer representations.

Recurrence worry

Cancer-related worry, which is typically high following cancer diagnosis and during treatment (Lebel et al., 2016), does not necessarily dissipate when treatment ends and one is deemed ‘cancer-free’. The experience of cancer can generate a salient, highly accessible representation of recurrence risk that evokes worry in response to cancer-related memories

and cues encountered in daily life. Also known as distress about recurrence, fear of recurrence, or fear of progression (Carver, Smith, Petronis, & Antoni, 2006; Fardell et al., 2016; Thewes et al., 2012), recurrence worry is common and often persists for years following treatment completion. For example, a review of research on long-term survivorship revealed that recurrence worry remained one of the greatest concerns at five years post-treatment (Koch, Jansen, Brenner, & Arndt, 2013).

While recurrence worry can have detrimental effects on well-being (Lebel et al., 2016; Simard et al., 2013; Tewari & Chagpar, 2014), it can also motivate beneficial changes in health behaviours such as smoking cessation and weight loss (Mullens et al., 2004). As delineated in Figure 1, recurrence worry can mediate the relationships between representational attributes and health behaviours. For example, identity risk beliefs can elicit recurrence worry, which in turn motivates healthy lifestyle efforts. Recurrence worry can also have reciprocal influences on recurrence risk representations, such as by magnifying beliefs about the negative consequences of recurrence or undermining control beliefs.

There are likely to be important differences in the roles of absolute worry, or general worry about recurrence, and conditional worry, or recurrence worry conditional upon engaging in an unhealthy behaviour such as poor diet or sedentary behaviour (Fardell et al., 2016; Simonelli, Siegel, & Duffy, 2017). Compared to absolute worry, conditional worry is likely to elicit stronger motivations to engage in the relevant protective behaviour (Anderson, Steele, & Coyle, 2013). Assessments of conditional recurrence worry are particularly critical because they are less likely than absolute recurrence worry to be impacted by the reciprocal effects of health behaviour engagement, which is likely to lower absolute recurrence worry (Brewer et al., 2007).

A research agenda for the CSM of cancer recurrence risk as applied to diet and physical activity

Figure 2 presents a proposed research agenda of aims and priorities for assessment, design, and analytic approaches needed to develop an evidence base for the predictions delineated by the CSM for cancer recurrence risk regarding how risk recurrence representations and recurrence worry influence diet and physical activity in survivorship. This agenda is not meant to be comprehensive or include all principles for conducting rigorous research. Instead, it highlights key principles specific to this research arena that are likely to best advance the evidence base.

The agenda includes six principles for assessment for clear tests of the CSM predictions. In our prior descriptions of the conceptual distinctions between illness representations and recurrence risk representations, illness worry, and recurrence worry, and absolute worry versus conditional worry, we have highlighted the importance of three assessment principles. First, the study must use measures that directly target recurrence risk attributes and recurrence worry. Second, studies designed to test recurrence worry as a predictor of future behaviour should assess conditional worry as opposed to absolute worry of recurrence. Third, the inclusion of measures assessing representation and worry of the original cancer along with measures of recurrence risk representations and worry will enable researchers to

test their distinct associations with health behaviours, thereby providing a strong test of the expanded CSM for recurrence risk.

Additional assessment aims include the need to develop harmonised measures of recurrence risk attributes and recurrence worry that are used consistently in studies. Measure harmonisation is critical for enabling clear comparisons of findings across studies and building cumulative evidence (Michie & Johnston, 2012). Further, objective measures of diet and physical activity behaviours should be used, either alone or in addition to self-report measures. Finally, as the CSM of recurrence risk delineates cognitions and emotions influencing protective behaviour motivations, studies should include measures of motivations or intentions along with measures of behaviour.

The dynamic processes involved with recurrence cognitions, emotions, and behaviours point to design and analysis considerations for rigorous tests of the CSM predictions. Regarding design principles: First, given reciprocal influences of protective behaviours on risk representations and worry, longitudinal survey designs are needed to test how recurrence risk representations and worry predict future behaviour and to provide strong tests of recurrence worry as a mediator of the relationships between recurrence risk representational attributes and health behaviours. Given the differences in physiological, psychological, and social sequelae associated with different phases of survivorship post-diagnosis (Stanton et al., 2015), researchers should recruit survivors and conduct analyses so that the predictions can be tested for survivors within a distinct phase such as post-treatment. Experimental designs of interventions altering recurrence risk representation or recurrence worry are needed to test the model's predictions of causality.

In terms of analysis principles: First, analyses should control for medical factors (e.g., cancer type, stage at diagnosis, time since treatment), demographic, (e.g., age, gender, socioeconomic position) and other personal characteristics (e.g., trait anxiety) that are likely to serve as confounding or 'third variables' in the predicted correlational relationships of recurrence risk representations and worry with health behaviours. Developing and testing hypotheses moderator effects of recurrence risk attributes, recurrence worry, and personal characteristics will provide important tests of generalisability and boundary conditions of effects, which can inform further theory development. Studies are needed to test for the mediating role of recurrence worry in the relationships between illness risk representations and behaviour. Lastly, full tests of the CSM require structural equation modelling (SEM) or other modelling techniques.

A systematic review of studies on the associations of cancer recurrence beliefs and worry of recurrence with healthy diet and physical activity

Despite evidence that healthy diet and physically active lifestyles are linked with better well-being and long-term survival for cancer survivors (Demark-Wahnefried et al., 2015; Pekmezi & Demark-Wahnefried, 2011), many cancer survivors fail to meet dietary and exercise recommendations (Blanchard, Courneya, & Stein, 2008; Zhang, Liu, John, Must, & Demark-Wahnefried, 2015). In a study analysing national data on over 1,500 adults, for example, cancer survivors were less likely than those without a history of cancer to adhere to

dietary guidelines (Zhang et al., 2015). Similarly, a survey of 753 long-term survivors of breast, prostate, and colorectal cancers showed that only 7% met national guidelines for healthy eating habits and on average, they reported only 10 min of moderate to vigorous physical activity per week – starkly under clinical recommendations (Mosher et al., 2009).

While prior systematic reviews have examined research on antecedents of and interventions to promote healthy diet and physical activity among cancer patients and survivors (Goode, Lawler, Brakenridge, Reeves, & Eakin, 2015; Kampshoff et al., 2014; Roberts, Fisher, Smith, Heinrich, & Potts, 2017; Stolley, Restrepo, & Sharp, 2010), none to date have evaluated research on the roles of cancer recurrence risk beliefs or recurrence worry in shaping diet and physical activity efforts. This systematic review addresses this gap while evaluating the evidence within the context of the proposed CSM framework as tailored to cancer survivorship.

This systematic review examined empirical evidence on the relationships of: (1) attributes of cancer and cancer risk representations, along with likelihood and severity appraisals, with healthy diet and physical activity motivations and behaviour; (2) cancer and cancer risk representations with absolute and conditional worry of recurrence; (3) recurrence worry with healthy diet and physical activity motivations and behaviour; and (4) recurrence worry as a potential mediator of the relationships between representations and these health behaviours. The review tallies studies using quantitative methods to test these relationships with cancer survivors who are no longer undergoing primary treatment for cancer. We followed the guidelines suggested by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Search, selection, and review strategies

We searched the electronic databases PsycINFO, PubMed, and Web of Science/MEDLINE using search terms indicating a focus on any cancer (e.g., cancer), survivorship (e.g., patient, survivor), illness representation (e.g., illness representation, illness perception, illness belief) or recurrence worry (e.g., worry, worry of recurrence, fear of recurrence), and protection intentions and behaviours (e.g., diet, exercise, physical activity). The first author and four additional researchers independently searched, screened and assessed abstracts for eligibility.

We conducted searches using the following terms: (a) *cancer* AND *survivor** AND [*belief** OR *perception** OR *representation**] AND [*diet* OR *exercise* OR *physical** *activ**] and (b) *cancer* AND *survivor** AND [*worry* OR *fear*] AND [*diet* OR *exercise* OR *physical** *activ**]. Next, we used prior search patterns and, for [*belief** OR *perception** OR *representation**], we replaced with each of the risk representation attributes (i.e., [*identity belief** OR *cancer identity*], [*cause* OR *causal belief**], [*timeline*], [*consequence** OR *severity*], [*control belief** OR *perceived control* OR *fatalis**], [*coherence*]). We included all peer-reviewed publications in English from the earliest publication date to August 2018. We examined reference sections of articles and reviews to garner additional articles.

We identified 69,762 articles through the database searches of studies conducted internationally (Figure 3). After duplicate records removal, titles and abstracts were excluded if they: (a) did not focus specifically on survivors of cancer (e.g., they focused on people with chronic illness more generally); (b) were grey literature (e.g., conference proceedings, dissertations, non-peer-reviewed reports); (c) utilised qualitative methods solely; (d) focused solely on patients or survivors undergoing treatment for cancer; (e) did not assess *either* the relationships of any beliefs reflecting attributes of cancer or cancer risk representations or perceived risk with cancer-related worry, healthy diet motivations or behaviour, or physical activity motivations or behaviour; *or* the relationships of cancer-related worry with healthy diet or physical activity motivations or behaviour; and (f) diet or physical activity was manipulated in an intervention testing their effects on illness beliefs or cancer worry (Lengacher et al., 2009; Ottenbacher et al., 2013; van den Berg, Gielissen, Ottevanger, & Prins, 2012). In total, 463 articles were identified as potentially eligible for the systematic review. All full-text articles were retrieved and eligibility criteria were re-applied in iterative, independent reviews by the first author and a second rater. From these 463 articles, 445 were excluded because they did not assess associations of cancer or cancer risk representational attributes with recurrence worry or either physical activity or healthy diet motivations or behaviours, or recurrence worry with either physical activity or health diet motivations or behaviours.

Results

In total, 18 studies met the eligibility criteria. Table 1 presents the following study features: (1) main author, publication year (2006–2017); (2) cancer types and sample sizes; (3) time since diagnosis and/or treatment, (4) theory; (5) cancer representation measures; (6) recurrence risk representation measures; (7) worry of recurrence measures; and (8) diet and/or physical activity measures. Table 2 presents information regarding: (1) research design (cross-sectional or longitudinal); (2) method of analysis (bivariate, multivariate, SEM) and covariates; (3) predictors and outcomes; and (4) key findings.

Study characteristics

As detailed in Table 1, the survivors sampled in the 18 studies experienced one of six cancer types: breast (n = 13; Alfano et al., 2006; Brunet et al., 2014; Burris et al., 2012; Charlier et al., 2012; Costanzo et al., 2011; Freeman-Gibb et al., 2017; Green et al., 2014; Kanera et al., 2016; Kelly et al., 2015; McGinty et al., 2012; Moon et al., 2017; Patterson et al., 2003; Rabin & Pinto, 2006), colorectal cancer (n = 2; Kanera et al., 2016; Patterson et al., 2003), childhood (i.e., leukaemias, lymphomas, tumours; n = 3; Cox et al., 2009; Hocking et al., 2013; Paxton et al., 2010), prostate (n = 2; Green et al., 2014; Patterson et al., 2003), gynaecological (i.e., cervical or endometrial, n = 1; Costanzo et al., 2005), head and neck (n = 1; Llewellyn et al., 2008), and other (n = 1; Kanera et al., 2016). In the 3 studies with childhood cancer survivors, 2 reported average time since diagnosis (pooled mean = 113.2 months) and 1 reported average time since treatment (M = 260.9 months). Of the 15 studies with adult cancer survivors, 7 reported average time since diagnosis (pooled mean = 33.1 months) and 6 reported average time since treatment (pooled mean = 22.4 months). Four studies did not report average time since diagnosis or treatment but reported inclusion

criteria of 5 or more years post-diagnosis or treatment (Costanzo et al., 2005; Kelly et al., 2015), six to eight months after treatment (Llewellyn et al., 2008) or at least one year since treatment (Freeman-Gibb et al., 2017).

Most studies (n = 12) specified a theoretical framework. Seven identified Leventhal's Common-Sense Model (CSM; e.g., Llewellyn et al., 2008) or a similar label such as Leventhal's self-regulation theory (e.g., Costanzo et al., 2011) or the Self-Regulation Model (e.g., Kelly et al., 2015). Green et al. (2014) used a combination of the CSM and Prochaska and DiClemente's (1983) Transtheoretical Model. McGinty et al. (2012) guided their study with the extended parallel process model (Rogers, 1975), which is an expanded version of the parallel-process model developed by Leventhal (1970). The others used the Health Belief Model (Hocking et al. (2013), the Interaction Model of Client Health Behaviour (Cox et al., 2009), or a hybrid of social cognitive models (Kanera et al., 2016). Studies not using a theoretical framework focused on instrument validation (Alfano et al., 2006), exploratory research (Burris et al., 2012) and associations of psychosocial factors with diet or physical activity (Brunet et al., 2014; Charlier et al., 2012; Patterson et al., 2003; Paxton et al., 2010).

Authors used a variety of measures and construct labels in assessing cancer representations, recurrence risk representations, and recurrence worry. For conceptual clarity, we refer to these constructs using standard CSM terms (e.g., identity risk, personal control, recurrence worry, etc.) in reporting and discussing the findings.

Five studies assessed the associations of cancer or recurrence risk attributes with recurrence worry without assessing either healthy diet or physical activity motivations or efforts (Costanzo et al., 2005; Freeman-Gibb et al., 2017; Llewellyn et al., 2008; McGinty et al., 2012; Moon et al., 2017). They all examined associations of representational attributes with absolute recurrence worry and none assessed conditional recurrence worry.

Fourteen studies included physical activity as a dependent measure. Of these, nine studies also examined diet as a dependent measure (Alfano et al., 2006; Brunet et al., 2014; Burris et al., 2012; Charlier et al., 2012; Costanzo et al., 2005, 2011; Cox et al., 2009; Green et al., 2014; Hocking et al., 2013; Kanera et al., 2016; Kelly et al., 2015; Patterson et al., 2003; Paxton et al., 2010; Rabin & Pinto, 2006) and five studies did not (Brunet et al., 2014; Charlier et al., 2012; Cox et al., 2009; Hocking et al., 2013; Paxton et al., 2010). All fourteen studies focused on behaviour as opposed to intentions, interest, or other motivational factors.

Of the studies with diet or physical activity as a dependent variable, most (n = 11) examined how one or more representational attributes were associated with one or both protection behaviours. Six studies examined attributes as predictors of diet or exercise without including worry of recurrence as a predictor (Charlier et al., 2012; Costanzo et al., 2011; Green et al., 2014; Kanera et al., 2016; Patterson et al., 2003; Rabin & Pinto, 2006). Five studies included both representational attributes and recurrence worry measures and assessed their relationships with diet and/or physical activity (Alfano et al., 2006; Brunet et al., 2014; Burris et al., 2012; Costanzo et al., 2005; Cox et al., 2009). Three studies focused solely on the relationship of recurrence worry (and no representational attributes) with diet or physical

activity (Alfano et al., 2006; Brunet et al., 2014; Paxton et al., 2010). Only one study tested recurrence worry as a mediator of relationships between cancer or recurrence risk representations and either diet or physical activity (Cox et al., 2009).

Only 5 of the 18 studies utilised a longitudinal design (Brunet et al., 2014; Costanzo et al., 2011; Hocking et al., 2013; Llewellyn et al., 2008; Rabin & Pinto, 2006); all others relied on a cross-sectional design (see Table 2). All studies included multivariate analyses, and all but five studies reported analyses controlling for medical, demographic, or other personal characteristics (Brunet et al., 2014; Burris et al., 2012; Charlier et al., 2012; Moon et al., 2017; Rabin & Pinto, 2006). Only one study utilised SEM (Cox et al., 2009).

Relationships of cancer representations with diet or physical activity

In the 11 studies examining associations of cancer or recurrence risk representations with diet and/or physical activity, the most commonly assessed attribute was control ($n = 8$) followed by consequences ($n = 5$), cause ($n = 5$), timeline ($n = 4$), illness coherence ($n = 3$), identity ($n = 2$), and likelihood appraisals ($n = 2$). No studies assessed severity estimates as predictors of diet or physical activity. Two studies did not test the relationships of specific representational attributes with diet or physical activity. Instead, Kanera et al. (2016) utilised a summary score of attribute ratings for identity, acute versus chronic timeline, consequences, personal control, and coherence, with higher scores reflecting more threatening representations. This summary score was not associated with cross-sectional reports of vegetable consumption, fruit consumption, and physical activity. In addition, Charlier et al. (2012), in a cross-sectional survey of breast cancer survivors, conducted cluster analyses with multiple representational attributes and other psychosocial characteristics that revealed four distinct groups. Overall, groups reporting higher physical activity levels were characterised as having higher beliefs of personal control, treatment control, and illness coherence; lower beliefs of cyclical timeline, chronic timeline, and consequences; and less distressing emotional representations. The next seven subsections summarise the findings from the nine studies testing associations of specific attributes with diet or physical activity.

Identity and identity risk

Only two studies to date, both cross-sectional surveys, have examined the relationships of identity belief with either diet or physical activity behaviour. Cox et al. (2009) used SEM to test the direct and indirect associations of current pain attributed to cancer with physical activity in the previous month for men versus women survivors of childhood cancer. For men, this identity risk belief (pain attributed to cancer) was positively associated with physical activity, with (higher) recurrence worry mediating the relationship. For women, higher pain attributions were associated with lower physical activity with (lower) stamina mediating the relationship.

In a study of prostate or breast cancer survivors (Green et al., 2014), illness identity (more severe symptoms since diagnosis) was associated with reported decreases in physical activity. However, they assessed both identity (symptoms) and behaviour change since

diagnosis and did not assess these constructs within the more specific time frame of post-treatment.

Cause and causal risk

In total, five studies examined cause or causal risk beliefs and their associations with physical activity or diet: three cross-sectionally (Burris et al., 2012; Costanzo et al., 2005; Kelly et al., 2015) and two longitudinally (Costanzo et al., 2011; Rabin & Pinto, 2006). Three studies assessed causal beliefs of their prior cancer (Costanzo et al., 2005, 2011; Rabin & Pinto, 2006) and all five studies assessed causal risk beliefs of a future recurrence. Overall, the findings point to both causal beliefs and causal risk beliefs about diet and physical activity as positively associated with engagement in the respective behaviour.

Burris and colleagues assessed beliefs that recurrence risk of breast cancer can be reduced by a specific diet or exercise behaviour (avoiding meat of any kind, eating five servings of fruits and vegetables daily, limiting food intake to control weight, or exercising at least three times a week). Each belief was positively associated with reported engagement in that behaviour over the past month.

Costanzo and colleagues found that gynaecological cancer survivors tended to report different causal factors for the prior cancer (e.g., hormones) and cancer recurrence (e.g., diet). Improvements in diet were associated with higher beliefs that their cancer was caused by stress and exposure to environmental toxins, and with causal risk beliefs that a healthy diet, exercise, and stress reduction could prevent a recurrence. In contrast, improvements in exercise were predicted only by lower beliefs that the prior cancer was caused by God’s will or injury.

Costanzo and colleagues again found distinctive differences in the factors believed to have caused the original cancer (e.g., hormones) and factors believed to prevent recurrence (e.g., diet). Beliefs that diet played a causal role in the prior cancer and beliefs that a healthy diet could prevent recurrence were both positively associated with concurrent reports of increased fruit and vegetable consumption, although only the former was positively associated with concurrent reports of lower fat intake. Beliefs that physical inactivity caused the prior cancer predicted increases in physical activity 3 months later.

Rabin and Pinto provide further evidence of causal and causal risk beliefs as predictors of healthy diet and physical activity. Breast cancer survivors who attributed their original cancer to an unhealthy diet were more likely than those who did not to make improvements to their dietary habits both concurrently and three months later. Similarly, those who attributed their cancer to insufficient physical activity were more likely than those who did not to report having increased their physical activity levels; however, these causal beliefs did not predict physical activity three months later. Beliefs that a healthy diet could reduce recurrence risk predicted healthy dietary practices both concurrently and prospectively, but causal risk beliefs about physical activity did not predict physical activity.

Contrary to the positive associations of causal and causal risk beliefs about diet and physical activity with diet and physical activity behaviours observed in these four studies, mixed

evidence on these relationships emerged from a study of breast cancer survivors by Kelly and colleagues. They found only a statistically non-significant trend for a positive association between beliefs that a healthy diet can prevent recurrence and healthy food consumption, and no relationship for causal risk beliefs about physical activity and reported physical activity.

Taken together, this research to date provides the strongest support that causal risk beliefs about healthy diet (i.e., as reducing recurrence risk) are positively associated with healthy diet behaviour. In contrast, only one of the five studies found a significant (positive) association of causal risk beliefs about physical activity and physical activity levels. Further, the studies provide mixed evidence for links between causal beliefs about either diet or exercise (i.e., as having contributed to one's prior cancer) and these behaviours.

Timeline and timeline risk

The associations of timeline-related beliefs with diet and physical activity were measured in two studies (Costanzo et al., 2011; Green et al., 2014). In both studies, the measures assessed whether the original cancer was believed to be acute, chronic, or cyclical. However, only Green and colleagues reported any associations approaching significance: They found a trend for chronic timeline beliefs as associated with reports of healthy diet behaviour. Importantly, no studies assessed timeline risk beliefs about the likely onset of recurrence. This small set of studies and their minimal findings suggest that the extent to which acute and chronic timeline beliefs potentially motivate or discourage health behaviours remains largely unexplored. Further, no studies to date have examined whether timeline risk beliefs are determinants of healthy diet and physical activity efforts.

Consequences and recurrence consequences

In total, two studies assessed independent associations of beliefs about consequences of the prior cancer with protection behaviours (Costanzo et al., 2011; Green et al., 2014). No studies have assessed beliefs about consequences of cancer recurrence. Neither of the two studies revealed significant relationships between consequences beliefs and either changes to diet or physical activity levels or meeting recommended guidelines. However, Costanzo and colleagues reported a non-significant trend of consequences beliefs being positively associated with increases in fruit and vegetable intake.

Taken together, these two studies provide little evidence that consequences of prior cancer are linked with healthy diet or physical activity efforts. Whether recurrence consequences beliefs guide these protective behaviours remains unexplored.

Control/Cure and recurrence control

In total, five studies tested associations of beliefs about personal and medical control over the original cancer or else delaying or preventing cancer recurrence with healthy diet or physical activity behaviours. Two studies focused on control/cure of the original cancer (Costanzo et al., 2011; Green et al., 2014) and the other three assessed control over recurrence, although they did so using more general measures related to health locus of

control (Cox et al., 2009; Patterson et al., 2003) and health competence (Hocking et al., 2013).

Costanzo et al. found only a non-significant trend that higher personal control beliefs predict lower dietary fat intake three weeks after treatment; they did not find associations of personal control beliefs with dietary intake three months post-treatment or with physical activity at either time point.

Cox et al. found that lower personal control and higher treatment control were indirectly associated with higher physical activity through recurrence worry. For female survivors, higher personal control was indirectly associated with higher physical activity through its positive relationship with perceived stamina. Treatment control was found to be a weak and distal predictor of physical activity through complex pathways linking recurrence worry, provider interaction, personal control, stamina, and physical activity.

In the study by Green and colleagues, higher personal control beliefs were linked with increased healthy eating and physical activity; and higher treatment control beliefs were associated with increased physical activity. Hocking et al. found that beliefs about personal control in executing health behaviours positively predicted current physical activity, although they did not predict physical activity reported two months later. Finally, Patterson et al. found no associations of internal locus of control with dietary and physical activity.

In summary, two of the four studies reported direct, positive relationships between cancer-specific control beliefs and protective behaviour with a third study revealing a trend in this direction. The other two studies focused on more generic forms of personal and treatment control, and they revealed null or weak, indirect associations with the health behaviours.

Coherence

Only one research team examined illness coherence as a cross-sectional correlate of diet or physical activity (Green et al., 2014). They found that a higher understanding of the cancer was marginally associated with lower adherence to physical activity guidelines ($p = .052$). To date, then, there is no evidence for CSM hypotheses that representational coherence beliefs about the original cancer, representational coherence beliefs about cancer recurrence risk, or risk-action coherence beliefs promote engagement in healthy diet or physical activity efforts.

Likelihood appraisals

Two studies have assessed recurrence likelihood appraisals and their associations with diet or exercise motivations or behaviours, and they assessed absolute likelihood rather than conditional likelihood. Burris et al. (2012) found that likelihood appraisals were negatively correlated with efforts to limit food intake in order to maintain or lose weight, although regression analyses revealed that perceived likelihood did not predict this behaviour after controlling for causal risk beliefs that this behaviour can prevent recurrence. Kelly et al. (2015) found that higher recurrence likelihood appraisals were associated with lower levels of physical activity. Although the CSM predicts that likelihood appraisals positively predict future protective behaviour, this cross-sectional evidence that absolute likelihood appraisals

are negatively associated with protective behaviour suggests that appraisals of coping behaviour feed back to lower appraisals of the likelihood of recurrence. These findings leave open the potential that conditional likelihood is positively associated with protective behaviour.

Relationships of cancer representations with worry of recurrence

Six studies examined relationships between cancer or recurrence risk representations and recurrence worry. All of the studies focused on absolute worry (with items such as 'I worry that my cancer will return/coming back'). None of the studies assessed conditional worry; that is, recurrence worry if one were to not engage in healthy diet practices or physical activity (e.g., 'If I were to eat an unhealthy diet, I would worry that my cancer will return'). Only one study utilised a longitudinal design (Llewellyn et al., 2008).

Costanzo et al. (2005) found that both causal beliefs and causal risk beliefs were associated with recurrence worry and intrusive thoughts about cancer over the prior week. Causal attributions of one's prior cancer to diet, genetics, stress, God's will, hormones, environment, lifestyle, and alcohol/tobacco use were each associated with higher levels of recurrence worry and intrusive thoughts. In terms of causal risk beliefs about factors reducing recurrence risk, beliefs about diet, exercise, and medication were each associated with higher levels of recurrence worry and intrusive thoughts. Beliefs in the protective effects of positive attitude and God's will were also with higher worry of recurrence. Additional analyses showed interactive effects of causal risk beliefs about diet and healthy diet behaviour on intrusive thoughts, which is strongly linked with recurrence worry. Women with strong beliefs about the protective benefits of a healthy diet but who reported low healthy diet behaviours experienced the highest levels of intrusive thoughts about cancer.

Cox et al. (2009) provided evidence on the relationships of three risk representational attributes with recurrence worry. For men, beliefs of higher identity (pain attributed to cancer), lower personal control, and higher treatment control were independently associated with higher recurrence worry. For women, a direct association was found for treatment control beliefs (i.e., a positive relationship with recurrence worry) but not for identity or personal control beliefs.

In a study involving breast cancer survivors one year after treatment, Freeman-Gibb et al. (2017) found that beliefs about identity, chronic timeline, cyclical timeline, consequences and likelihood appraisals were positively correlated with recurrence worry. In contrast, personal and treatment control beliefs were negatively correlated with recurrence worry.[1] Regression analysis demonstrated that beliefs about identity, chronic timeline, and consequences were independently associated with recurrence worry whereas the other representational attributes were not.

[1]. Errors appear in Freeman-Gibb et al. (2017, pp. 1272–1274) for references to consequences and control/cure attributes. In Measures, there are erroneous references to personal consequences and treatment consequences subscale. In the tables, statistics labelled 'personal consequences' are actually those for 'personal control' and statistics labelled 'treatment consequences' are those for 'treatment control'.

Llewellyn et al. (2008) examined the associations of identity, timeline (acute vs. chronic; cyclical), consequences, control/cure, and representational coherence assessed prior to treatment with recurrence worry following treatment for head or neck cancer. Consequences beliefs was the only attribute associated with (greater) recurrence worry at post-treatment.

McGinty et al. (2012) examined associations of beliefs about consequences risk, causal risk factors of diet and physical activity, control (diet self-efficacy and exercise self-efficacy), and likelihood appraisals with recurrence worry. Higher likelihood appraisals and higher recurrence consequences beliefs were associated with greater recurrence worry, but neither causal risk nor control beliefs exhibited bivariate associations with recurrence worry. However, analyses revealed interaction effects of likelihood perceptions, causal risk beliefs about diet, and diet self-efficacy on recurrence worry. Worry was highest among survivors with a combination of high perceived likelihood of recurrence, high beliefs that a healthy diet can reduce recurrence risk, and low diet self-efficacy. The study provides limited evidence for the relationships between control beliefs and recurrence worry due to the assessment of self-efficacy, or perceived control in carrying out the behaviour, rather than personal control over recurrence risk.

Finally, Moon et al. (2017) examined associations of representational attributes and recurrence worry in breast cancer survivors who were taking tamoxifen. The acute-chronic timeline subscale was adapted to directly assess beliefs that the breast cancer was cured, and the cyclical timeline subscale was revised to focus on timeline risk beliefs (e.g., ‘I expect to have a recurrence of cancer in the future’). As predicted, greater beliefs about identity (symptoms attributed to tamoxifen), timeline risk, and perceived consequences of tamoxifen and breast cancer, were positively correlated with recurrence worry. Also as predicted, greater beliefs about cure, personal control, treatment control and representational coherence were negatively correlated with recurrence worry.

Taken together, the six studies provide moderate support for the CSM of recurrence risk hypotheses regarding the relationships of cancer and recurrence risk representational attributes and recurrence worry. Specifically, beliefs about identity, chronic timeline of the prior cancer, and consequences along with likelihood appraisals tend to be positively associated with recurrence worry whereas beliefs about personal control tend to be negatively associated with recurrence worry. The studies provide more equivocal evidence that beliefs about cyclical timeline and treatment control will be positively and negatively associated with recurrence worry, respectively. For coherence, the one study assessing representational coherence found no relationship with recurrence worry whereas the one study assessing risk-action link coherence found the predicted, negative relationship with worry. The study by Llewellyn et al. (2008) provided the evidence most inconsistent with predictions in that no representational attributes except consequences were associated with recurrence worry. This study differed from the others in that it tested cancer representations prior to treatment as predictors of recurrence worry reported months after treatment ended rather than the relationships of cancer representations assessed post-treatment with recurrence worry.

Relationships of cancer recurrence worry with diet or physical activity

Seven studies examined relationships between absolute recurrence worry and diet or physical activity. Only one study utilised a longitudinal design (Brunet et al., 2014). They revealed conflicting evidence about whether recurrence worry promotes these health behaviours. Three studies suggest that recurrence worry is positively associated with physical activity for at least one cohort (Brunet et al., 2014; Cox et al., 2009; Paxton et al., 2010) whereas two studies found no association between recurrence worry with either diet or physical activity (Burris et al., 2012; Kelly et al., 2015) and one study found negative relationships between recurrence worry and improvements in diet and physical activity (Alfano et al., 2006).

Brunet and colleagues found that breast cancer survivors with higher recurrence worry at baseline were more likely than those reporting lower recurrence worry to exhibit increases in physical activity one year later. Similarly, Paxton et al. found positive associations of cancer worry with physical activity; however, this relationship held only for adolescent survivors of childhood cancer and not for the adult cohort. As described earlier, Cox and colleagues found that, for men (but not for women), recurrence worry was positively associated with physical activity.

In contrast to these findings of positive associations between recurrence worry and physical activity, both Burris et al. and Kelly et al. found null associations whereas Alfano et al. found negative associations of recurrence worry with perceptions that the cancer experiences positively influenced diet and exercise activities. With the latter study, it is notable that the participants were long-term survivors of breast cancer whose recurrence risk had diminished considerably over time. Further, the measures indirectly assessed these behaviours given their focus on how the cancer experience impacted the behaviours. Finally, the direction of causality might be reversed; those who made positive changes to diet or exercise over the years since diagnosis may feel more confident about their health and less worried about recurrence.

Overall, the findings support the predicted, positive relationships of recurrence worry with healthy diet and physical activity fairly consistently for physical activity (Brunet et al., 2014; male survivors in Cox et al., 2009; adolescent survivors of childhood cancer in Paxton et al., 2010). However, no evidence supports these relationships for healthy diet and more equivocal evidence holds for long-term survivors (Alfano et al., 2006; Burris et al., 2012; Kelly et al., 2015; adult survivors in Paxton et al., 2010).

Mediational role of recurrence worry in relationships of representations with diet or physical activity

As noted earlier, only one study tested recurrence worry as a mediator of relationships between representational attributes and either diet or physical activity (Cox et al., 2009). This study provided evidence that beliefs about identity (cancer pain), personal control, and treatment control are indirectly related to physical activity behaviour through recurrence worry, although these mediational relationships held only men and not for women. These

relationships were examined through SEM with cross-sectional data, which provides a weak test of mediation.

Discussion

The systematic review yielded a modest number of studies of how recurrence risk representations are linked with worry of cancer recurrence, and how recurrence risk representations and recurrence worry are associated with diet and physical activity. Taken together, the findings provide promising, but often mixed, evidence for some of the relationships predicted by the CSM of cancer recurrence risk. More critically, they reveal substantial gaps in the research evidence base due to the limited number of studies and application of methodological principles delineated in the proposed research agenda (see Figure 2). We discuss key patterns of findings and recommendations for future research in light of the research agenda and status of the research evidence base in the following sections.

General patterns of representations, recurrence worry, and diet and physical activity

In terms of the associations of specific representational attributes with the health behaviours, evidence provides the most consistent support for the potential roles of beliefs about causes of the original cancer, causal risk (factors influencing recurrence risk), and control/cure of the prior cancer. The findings suggest that causal beliefs and causal risk beliefs are distinct and can have independent associations with healthy diet and physical activity. That the associations between causal risk beliefs and behaviour were relatively consistent for healthy diet but not for physical activity suggests potential differences in how these beliefs shape these distinctive behaviours. This discrepancy could arise from barriers or interactive patterns of representational attributes that uniquely affect physical activity efforts. The minimal evidence for links between causal beliefs about either diet or exercise as having contributed to one's original cancer and these behaviours suggests that they might be less motivating than causal risk beliefs. These issues warrant further empirical attention.

Studies that addressed cancer-specific control beliefs as predictors of healthy diet or physical activity provide some evidence that both personal and treatment control beliefs are positively associated with these behaviours. Similar patterns were not observed for more general control-related beliefs such as health locus of control or self-efficacy, which may be due to their lack of specificity in terms of assessing personal or treatment control over recurrence. No studies assessed either personal or treatment control over recurrence (as opposed to the prior cancer or health in general), and so it remains to be determined whether recurrence control beliefs will have relatively stronger associations with recurrence worry and protective behaviours.

Few studies assessed beliefs about identity risk, timeline risk, recurrence consequences, representational coherence for recurrence, or recurrence risk-action link coherence as correlates of healthy diet or physical activity; those that did yielded inconsistent relationships. There is a clear need for research providing direct tests of the predicted relationships of these attributes with diet and physical activity. In addition, research could examine whether the lack of associations of beliefs with protective behaviours observed in

some studies is due to restricted range of beliefs. For example, this issue is likely to be relevant for recurrence consequences beliefs as survivors tend to report high negative consequences of cancer and a potential recurrence (Dempster et al., 2011; Llewellyn, McGurk, & Weinman, 2007); associations of recurrence consequences scores with diet and physical activity scores are thus likely to be limited. Further research on the role of coherence in recurrence risk-action links could also be of particular importance as it can be readily targeted in health communications and intervention aimed at motivating healthy diet and physical activity in cancer survivors. Understanding how a protective behaviour reduces recurrence risk and the processes through which it does so is likely to be a potent motivator to engage in that behaviour (Cameron et al., 2012).

The two studies assessing likelihood appraisals and their associations with the protective behaviours provide some evidence suggesting that, contrary to general theoretical predictions that perceived likelihood promotes protection motivations (Waters et al., 2014), higher perceived likelihood of recurrence was associated with lower levels of healthy diet efforts and physical activity. However, the studies are limited by their use of measures of absolute recurrence likelihood rather than measures of conditional recurrence likelihood. Consequently, the negative associations could be due to reciprocal relationships whereby individuals believe that their lower levels of protective behaviours increase their recurrence risk or that individuals believe that their high levels of healthy diet and physical activity reduce their likelihood of recurrence. That several studies found generally positive relationships of these risk representational attributes with diet and physical activity points to the potential utility of focusing on risk representational constructs, both in research and in designing health communications. Messages might be more persuasive if they address identity risk factors (e.g., being overweight), typical recurrence timelines, and healthy diet or physical activity as preventing recurrence rather than simply conveying likelihood estimates of recurrence.

The CSM of cancer recurrence risk predicts that conditional worry of recurrence is a stronger motivator than absolute worry of recurrence for protective behaviour. This systematic review did not identify any studies assessing conditional worry, however, and so this hypothesis remains untested. Nevertheless, the studies provided support for hypotheses regarding relationships of representational attributes with absolute worry of recurrence. Promising support emerged for its positive associations with beliefs about identity, chronic timeline of the prior cancer, consequences, and likelihood appraisals; and for its negative associations with beliefs about personal control. The Moon et al. (2017) study provides the strongest evidence for the predicted relationships between risk representational attributes and recurrence worry. The subscales in their measure, the IPQ-BCS, are generally contextualised according to the CSM of cancer recurrence risk. We encourage researchers to utilise the IPQ-BCS in further studies with breast cancer survivors and to consider adapting it for use with survivors of other cancer types. In addition, future research, such as studies in which recurrence worry is altered, should examine the proposed, reciprocal influences of recurrence worry on risk representations.

The predicted, positive relationships of recurrence worry with physical activity held primarily for survivors who completed treatment recently (Brunet et al., 2014), suggesting

that these links could fade as years pass. If further research supports these relationships, then one implication could be that interventions targeting recurrence worry as a means of motivating physical activity are likely to be most efficacious when delivered soon after treatment completion. These positive relationships converge with prior evidence that recurrence worry positively predicts avoidance of alcohol and tobacco use (Burris et al., 2012; Costanzo et al., 2005). In contrast, we found no evidence that recurrence worry is linked with healthy diet efforts. Further research is needed to understand the differential relationships of recurrence worry with these and other health behaviours.

Status of the evidence base and the research agenda for future studies

Overall, the systematic review reveals that evidence for the utility of the CSM of Cancer Recurrence Risk in predicting diet and physical activity behaviours remains limited. This status could well be due to the paucity of studies addressing the key methodological issues and aims outlined in the research agenda. We now discuss the status of the evidence base in relation to the assessment, design, and analysis issues and aims.

Assessment

A limited, but growing number of studies have used measures that specifically target recurrence risk attributes or recurrence worry. Yet the wide variety of measures used to assess these constructs impedes progress in accumulating comparable findings across studies. Measure harmonisation for these constructs as well as for conditional recurrence likelihood and conditional recurrence worry and their consistent use in studies will accelerate advances in building the evidence base.

Few studies included both measures of recurrence risk representations or recurrence worry and measures of illness representations and worry of the original cancer. Identifying the distinct influences of the two representational schemata and the two worry experiences will provide important insights for developing both the theory and the contents of healthy diet and physical activity interventions.

All studies have relied on self-reports of healthy diet and physical activity, which are prone to bias, rather than supplementing them with objective measures of food intake or physical activity levels. Objective measures (e.g., wearable cameras or monitors) are likely to improve assessment not only by reducing the potential for biased or inaccurate responses but also by detecting a broader range of dimensions of diet (e.g., consumption of a wider variety of nutrients) and physical activity (e.g., frequency, type, duration of diverse activities). In addition, no studies to date have assessed behaviour motivations or intentions, despite their critical role in behaviour change decisions (Sheeran & Webb, 2016). Assessing both motivations and behaviours will yield a more comprehensive understanding of the behaviour change process.

Design

Most studies were cross-sectional and few studies utilised longitudinal designs (Brunet et al., 2014; Costanzo et al., 2011; Hocking et al., 2013; Llewellyn et al., 2008; Rabin & Pinto, 2006). Evidence regarding the causal or predictive links of attributes and appraisals with

recurrence worry and these behaviours across time thus remains very limited. While a number of studies took phase of survivorship into account in their inclusion and exclusion criteria or in their analyses, substantial research is still needed to understand how the influences of recurrence risk representations and recurrence worry on diet and physical activity behaviours change from post-diagnosis and during treatment, to the early years following treatment cessation, to later phases post-treatment. Finally, research is needed to develop and test interventions that target recurrence risk attributes and worry of recurrence as a means of promoting healthy dietary habits and physical activity to provide evidence of causality for theory testing and promote translation of the CSM model of cancer recurrence risk to practice.

Analysis

Most studies utilised multivariate analyses that controlled for medical (including cancer type, stage at diagnosis, and prior type of treatment), demographic (including ethnicity, gender, and socioeconomic position), or other personal characteristics, thereby providing stronger evidence of the independent associations of recurrence risk attributes, recurrence worry, and the health behaviours. However, only a few tested for how these medical, demographic or other personal characteristics might moderate these relationships (Freeman-Gibb et al., 2017; Green et al., 2014; McGinty et al., 2012). We provide here three examples of the potential for moderating influences of these sets of characteristics. First, cancer type or stage could moderate the associations due to variations in their likelihood of recurrence. Second, the associations of recurrence beliefs and worry with behaviours could be relatively weaker for survivors of low socioeconomic position due to financial, time, and other constraints limiting access to healthy foods and physical activity opportunities. Third, personal history of diet and physical activity behaviours could moderate the relationships of recurrence beliefs and worry with these behaviours, such that survivors who had healthy diet and physically active lifestyles prior to cancer (compared to those who did not) might engage in these behaviours through habit or lifestyle motivations that are irrespective of recurrence beliefs or worry.

The interactive effects of representational beliefs and recurrence worry reported by McGinty et al. (2012), in which worry was highest for those with high beliefs that diet can decrease cancer risk, high perceived likelihood of recurrence, and low diet self-efficacy, offer an example of the potential for this moderation approach to advance CSM theory and research. As another example, worry might motivate physical activity when recurrence control beliefs are high, but have no impact on these efforts when perceived control over recurrence is low.

Finally, the systematic review revealed the paucity of research examining recurrence worry as a mediator of relationships of cancer and risk representations with healthy diet and physical activity efforts. It also found minimal use of SEM or related modelling techniques to test patterns of relationships delineated by the CSM of Cancer Recurrence Risk.

Conclusions

To conclude, we developed an elaborated CSM contextualised to cancer recurrence risk and proposed a research agenda of methodological principles and aims to guide research that

effectively contributes to the evidence base for the model's utility in predicting diet and physical activity behaviour. We then reviewed current evidence regarding the proposed relationships between recurrence risk representations, recurrence worry, and these two lifestyle behaviours. We evaluated the study findings against the research agenda to posit the status of the evidence base. While the present findings point to the need for more research on recurrence risk representations, what is known suggests their potential relevance in guiding recurrence worry and lifestyle behaviours for survivors post-treatment. The distinctions of recurrence risk representations from cancer representations held by cancer patients under active treatment and those held by healthy people stand to broaden our knowledge of how each type of presentation differentially guides emotional responses and protective behaviours. Further research that expands the evidence base for this model can guide efforts to develop interventions for survivors that promote these protective behaviours and, in turn, their wellbeing and survivability.

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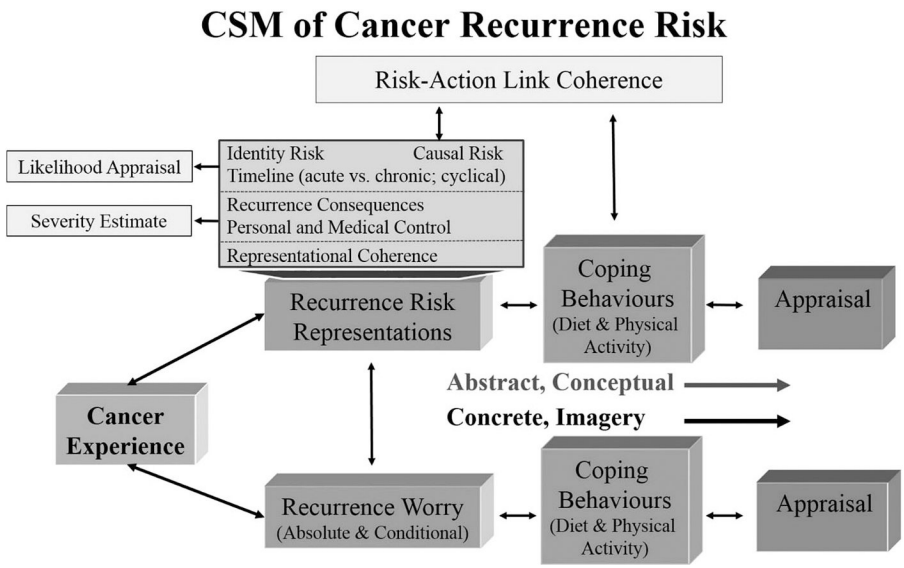

Figure 1.

Expanded Common-Sense Model of self-regulation as contextualised to diet and physical activity for cancer survivors post-treatment for cancer (based on Cameron, 2008).

Research Agenda and Status of Evidence for the Utility of the CSM of Cancer Recurrence Risk in Predicting Diet and Physical Activity Behaviour		
Research Priorities	**Research Agenda**	**Status of Research Evidence Base**
Assessment	• Use measures that assess recurrence risk attributes and recurrence worry.	• Limited: 9 studies for recurrence risk attributes; 11 studies for recurrence worry
	• Use measures that assess conditional recurrence likelihood and conditional recurrence worry.	• Nil: 0 studies
	• Compare the recurrence risk representation and worry measures with measures assessing illness representations and worry of the original cancer in terms of their differential relationships with diet and physical activity.	• Very limited: 4 studies
	• Develop harmonized measures of recurrence risk attributes and recurrence worry for use across studies to facilitate comparisons and accelerate cumulative evidence.	• Nil: 0 studies have used the same measures
	• Include objective measures of behaviour.	• Nil: 0 studies
	• Include measures of health behaviour motivations or intentions as well as measures of behaviour.	• Nil: 0 studies
Design	• Use longitudinal rather than cross-sectional designs for surveys.	• Very limited: 5 studies
	• Recruit survivors who are within distinct survivorship phases	• Limited: 9 studies
	• Use experimental designs with interventions altering recurrence risk representation or recurrence worry to test for causality	• Nil: 0 studies
Analysis	• Apply multivariate analysis with relevant medical, demographic, and other personal characteristics as covariates.	• Moderate: 14 studies
	• Develop and test hypotheses regarding moderator effects of personal characteristics, recurrence risk attributes, and recurrence worry.	• Minimal: 3 studies
	• Conduct tests of mediation for recurrence worry as a mediator between illness risk representations and behaviour.	• Minimal: 1 study provided limited evidence of mediation using cross-sectional data
	• Use SEM or related modelling techniques to test the full CSM of Recurrence Risk.	• Minimal: 1 study utilized cross-sectional data

Figure 2.

The research agenda highlights primary methodological aims for advancing research on the utility of the CSM of cancer recurrence risk in predicting diet and physical activity behaviour. The status of evidence base as affected by each of the research agenda aims is determined by the number of studies from the systematic review that addressed each of the aims using the following status levels: Nil (0 studies), Minimal (1–3 studies), Very Limited (4–8 studies), Limited (9–12 studies), Moderate (12–20), and Strong (over 20 studies). While these levels are subjective and do not take into account the quality of the studies as a whole or the strength of predicted relationships, they highlight the current paucity of rigorous research testing the CSM of cancer risk recurrence in predicting diet and physical activity behaviours.

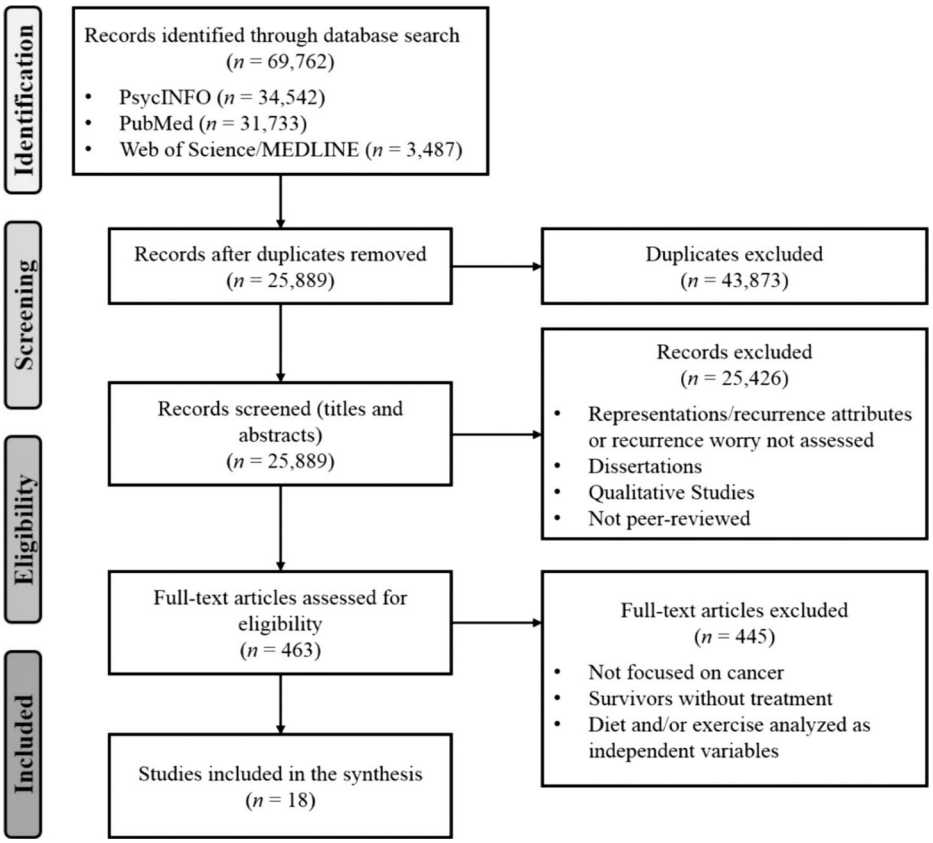

Figure 3.
Flowchart of literature search (based on PRISMA guidelines; Moher et al., 2009).

Table 1.

Overview of Studies on Cancer Beliefs, Worry, and Health Behaviours among Cancer Survivors.

Authors and design	Cancer survivor sample	Time since diagnosis in months	Time since treatment in months	Theory	Cancer representation measure(s)	Recurrence risk representation measure (s)	Worry of recurrence measure	Health behaviour measure(s)
Alfano et al. (2006)	Breast (n = 783)	M = 40.5 (SD = 6.5)	N/A	N/A	N/A	N/A	Fear of recurrence (Hilton, 1989)	Perceived cancer impact on diet AND PA (Brief Cancer Impact Assessment (Ganz et al., 2002)
Brunet, Amireault, Chaiton, and Sabiston (2014)	Breast (n = 199)	N/A	M = 3.9 (SD = 1.9)	N/A	N/A	N/A	Assessment of survivor concern (Gotay & Pagano, 2007)	PA (Godin & Shephard, 1985)
Burris, Jacobsen, Loftus, and Andrykowski (2012)	Breast (n = 200)	M = 49.2 (SD = 3.6)	42	N/A	N/A	Causal risk (avoid meat, 5 fruits and vegetables, limit food to control weight, PA) Likelihood (Perceived recurrence risk)	Breast cancer recurrence worry (Isaacs et al., 2002; Lerman, Daly, Masny, & Balshem, 1994)	Diet (avoid meat; 5 fruits and vegetables limit food to control weight) PA (20–30 min. 3 times/week)
Charlier et al. (2012)	Breast (n = 465)	N/A	M = 60.6 (SD = 32.7)	N/A	Timeline (acute versus chronic; cyclical) Consequences Control/Cure (personal and treatment) Coherence (IPQ-R)	N/A	N/A	PA (Flemish Physical Activity Questionnaire; Matton et al., 2007)
Costanzo, Lutgendorf, Bradley, Rose, and Anderson (2005)	Gynaecological (n = 134)	N/A	≥ 60	CSM	Causes of prior cancer (diet; genetics; stress, environment, alcohol/ tobacco, God's will; hormones; lifestyle; luck/chance, ageing, attitude, injury, germ or virus)	Causal risk (diet, exercise, medication, screenings, positive attitude, prayer, reducing stress, hormones; lifestyle; complementary therapies)	Concerns about Recurrence Scale (Vickberg, 2003) Intrusive thoughts about cancer: Intrusiveness subscale from the Impact of Events Scale (Horowitz, Wilner, & Alvarez, 1979)	Diet (healthy diet) PA (exercise levels)
Costanzo et al. (2011)	Breast (n = 79)	N/A	3	CSM	Causes of prior cancer (diet or eating habits, lack of exercise) Timeline (acute versus chronic) Consequences Control/Cure (personal) (IPQ-R)	Causal risk (diet, PA)	N/A	Diet (rapid food screeners; Block, Gillespie, Rosenbaum, & Jenson, 2000) PA (Kohl et al., 1988)

Authors and design	Cancer survivor sample	Time since diagnosis in months	Time since treatment in months	Theory	Cancer representation measure(s)	Recurrence risk representation measure (s)	Worry of recurrence measure	Health behaviour measure(s)
Cox et al. (2009)	Adult survivors of childhood cancer (*n* = 838)	N/A	*M* = 260.9 (*SD* = 54.5)	IMCHB	N/A	Identity (cancer pain); personal control and treatment control (Health Locus of Control items)	Fear of recurrence, future health, finding health problem at a check-up (3 items)	PA (1-month recall)
Freeman-Gibb, Janz, Katapodi, Zikmund-Fisher, and Northouse (2017)	Breast (*n* = 117)	N/A	≥ 12	CSM	Identity Timeline (acute versus chronic; cyclical) Consequences Control/cure (personal and treatment) (IPQ-R)	Likelihood appraisal	Fear of Recurrence Questionnaire (Northouse, 1981)	N/A
Green, Steinnagel, Morris, and Laakso (2014)	Breast (BC) and prostate (PC) (*n* = 237)	BC: *M* = 53.5 (*SD* = 63.1) PC: *M* = 30.0 (SD = 45.0)	N/A	CSM TTM	Identity Timeline (acute versus chronic; cyclical) Consequences Control/cure (personal and treatment) Coherence (IPQ-R)	N/A	N/A	Diet (past seven days nutrition measure) PA (IPAQ) Self-reported changes in diet and PA
Hocking et al. (2013)	Adult survivors of childhood cancer and healthy controls (*n* = 265)	*M* = 147.6 (*SD* = 58.9)	N/A	HBM	N/A	Control/Cure (personal-Perceived Health Competence Scale)	Perceived health vulnerabilities (worry, health competence beliefs inventory; DeRosa et al., 2011)	PA (Godin & Shephard, 1985)
Kanera et al. (2016)	Breast, colon, other (*n* = 255)	N/A	M = 6.1 (*SD* = 2.9)	SC	Identity, timeline, consequences, personal control, coherence (Brief IPQ; Broadbent, Petrie, Main, & Weinman, 2006)	N/A	N/A	Diet (F&V intake) PA (IPAQ short form; Craig et al., 2003)
Kelly, Bhattacharya, Dickinson, and Hazard (2015)	Breast (*n* = 114)	Group 1: ≤ 12 Group 2: 12 – 60	N/A	CSM	N/A	Causal risk (diet, exercise) Likelihood appraisal	Breast Cancer Recurrence Scale (Kelly et al., 2010; Quach et al., 2009)	Diet (7-day recall: fibre, F&V, grains/legumes, low/healthy fats) PA (week recall: light to strenuous activities and strength building)
Llewellyn, Weinman, McGurk, and Humphris (2008)	Head and neck (*n* = 82)	Baseline: <1	Last follow-up: 6 – 8	CSM	Identity Timeline (acute versus chronic; cyclical) Consequences Control/Cure (personal) Coherence (IPQ-R)		Worry of cancer (Easterling & Leventhal, 1989)	N/A

Authors and design	Cancer survivor sample	Time since diagnosis in months	Time since treatment in months	Theory	Cancer representation measure(s)	Recurrence risk representation measure (s)	Worry of recurrence measure	Health behaviour measure(s)
McGinty, Goldenberg, and Jacobsen (2012)	Breast (n = 155)	M = 17.4 (SD = 4.1)	M = 12.5 (SD = 4.3)	EPPM	N/A	Causal risk (diet and PA) Recurrence consequences (IPQ-R subscale) Control (diet and PA self-efficacy) Likelihood appraisal (Valdimarsdottir et al., 1995)	Cancer Worry Scale (Rabin, Leventhal, & Goodin, 2004)	N/A
Moon, Moss-Morris, Hunter, and Hughes (2017)	Breast (n = 753)	M = 33 (SD = 24)	N/A	CSM	Timeline (cured)	Identity Timeline risk (recurrence beliefs) Recurrence consequences Control over recurrence (personal, treatment) Coherence (risk-action link coherence related to treatment) (Modified IPQ-R for recurrence)	Modified IPQ-R emotional representation subscale	N/A
Patterson et al. (2003)	Breast, prostate, CRC (n = 356)	≤ 24	N/A	N/A	N/A	Control (multidimensional health locus of control instrument; Wallston, Wallston, & DeVellis, 2016)	N/A	Diet (changes to decrease recurrence risk) PA (changes to decrease recurrence risk)
Paxton et al. (2010)	Adolescent and adult survivors of childhood cancer (n = 215)	M = 118.8 (SD = 58.8)	N/A	N/A	N/A	N/A	Worry (PedsQL™ Cancer Worry Module; Varni et al., 2002)	PA (7-day PA recall; Godin, Jobin, & Bouillon, 1986)
Rabin and Pinto (2006)	Breast (n = 62)	M = 8.4 (SD = 3.6)	N/A	CSM	Causes of prior cancer (Rabin, 2002)	Causal risk (healthy diet, fruits and vegetables, high-fat food, high-fibre food, red meat, moderate exercise)	N/A	Diet (1-month recall; Greene et al., 1996) PA (Paffenbarger Activity Questionnaire; Paffenbarger Jr., Wing, & Hyde, 1978)

Note: PA = Physical Activity. CSM = Common-Sense Model of Self-Regulation (Leventhal et al., 2003). The theoretical framework was also classified as CSM when authors used the general CSM framework but referred to it by another label (e.g., the Self-Regulation Model or Leventhal's self-regulation theory). IMCHB = Interaction Model of Client Health Behavior based on Model of Health Behavior (Carter & Kullbok, 1995; Cox, 2003). TTM = the Transtheoretical Model (Prochaska & DiClemente, 1983). HBM = Health Belief Model (Strecher & Rosenstock, 1997). SC = social cognitive models guided by Reasoned Action Approach (Fishbein & Ajzen, 2011), Attitude-Social influence-Efficacy (De Vries et al., 1998), and the Integrated Model for Behavior Change (De Vries et al., 2005). EPPM = the extended parallel process model (Witte, 1996) based on Leventhal's parallel process model (1970) and integrating protection motivation theory (Rogers, 1975) and fear-as-drives models (Janis & Feshbach, 1953). Causal risk refers to beliefs about the efficacy of specific behaviours to reduce the risk of cancer recurrence. Likelihood refers to perceived likelihood of cancer recurrence.

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Table 2.

Summary of Design, Method of Analyses, and, Main Findings of Reviewed Studies on the Associations of Representational Attributes, Recurrence Risk Attributes, and Recurrence Worry with Healthy Diet and Physical Activity (PA).

Authors and design	Method of analysis (covariates)	Cancer representation measure(s)	Recurrence risk representation measure(s)	Worry of recurrence measure	Health behavior measure(s)	Major findings
Alfano et al. (2006) Cross-sectional	Multivariate (cancer stage, anti-depressant, Tx type)	N/A	N/A	Fear of Recurrence	Perceived cancer impact on diet and PA	Lower recurrence worry was associated with greater improvements in healthy diet and PA in response to the cancer Dx.
Brunet et al. (2014) Longitudinal	Multivariate pattern analysis	N/A	N/A	Assessment of Survivor Concern	PA	Survivors with higher recurrence worry were more likely to be consistently and sufficiently active over a 1-year period post-Tx.
Burris et al. (2012) Cross-sectional	Bivariate and multivariate	N/A	Causal risk Likelihood	Breast Cancer Recurrence Worry	Diet PA	Causal risk beliefs positively predicted healthy diet and PA. Likelihood was negatively correlated with weight control efforts, but not after controlling for causal risk beliefs. Likelihood was not associated with any other behaviours. Recurrence worry was not associated with diet behaviours or PA.
Charlier et al. (2012) Cross-sectional	Bivariate and multivariate cluster analysis	Timeline Consequences Control/Cure Coherence	N/A	N/A	PA	Survivors reporting more PA were characterised as higher in personal and medical control beliefs, and illness coherence and lower in cyclical timeline, chronic timeline, consequences, and distressing emotional representations.
Costanzo et al. (2005) Cross-sectional	Multivariate (cancer type, physical well-being, Tx type, age)	Causes of prior cancer	Causal risk	Concerns about Recurrence Scale Intrusive thoughts about cancer	Diet PA	Attributions of prior cancer to all causal factors except God's will and luck/chance were associated with both greater worry of recurrence and intrusive thoughts. Causal risk beliefs about factors reducing recurrence risk that were associated with both greater worry of recurrence and intrusive thoughts included diet, exercise, and medication. Recurrence worry was also associated with higher beliefs in positive attitude and God's will as protective. Healthy diet changes were associated with greater attributions of cancer to stress and environmental toxins but not to diet or unhealthy lifestyle; and to beliefs that diet, exercise, and stress could reduce recurrence risk but not the rest. PA improvements were negatively associated with attributions of cancer to God's will and injury and unrelated to all other causal and causal risk beliefs. Intrusive thoughts were highest when beliefs that diet prevents recurrence were high and healthy diet behaviours were low.
Costanzo et al. (2011) Longitudinal	Multivariate (Tx duration, time since Dx, physical well-being, age, SEP)	Causes of prior cancer Timeline Consequences Control/Cure	Causal risk	N/A	Diet PA	Personal control, timeline, were not related to concurrent or prospective (3 months later) changes in diet or PA. Attributing one's cancer to diet was associated with increased fruit and vegetable consumption concurrently but not prospectively. PA causal attributions were associated with increases in PA over time but not concurrently. Beliefs that diet could prevent recurrence were associated with higher fruit and vegetable consumption (but not fat intake) concurrently but not prospectively. No associations between PA causal risk beliefs and PA emerged.
Cox et al. (2009) Cross-sectional	Multivariate-SEM (PCP familiarity with cancer-	N/A	Identity	Fear of recurrence, future	PA	For men, recurrence worry was directly associated with greater PA in past month; higher identity, lower personal control, and

Authors and design	Method of analysis (covariates)	Cancer representation measure(s)	Recurrence risk representation measure(s)	Worry of recurrence measure	Health behavior measure(s)	Major findings
	related problems, pain, fatigue, discussed recurrence, baseline PA, motivation, age, SEP)		Personal control and treatment control	health, finding health problem at a medical check-up		higher treatment control were indirectly associated with PA through recurrence worry. For women, lower recurrence worry, lower identity, higher personal control, and higher treatment control exhibited complex, indirect associations with higher PA through higher perceived stamina.
Freeman-Gibb et al. (2017) Cross-sectional	Multivariate (time since Tx, Tx type, trait anxiety)	Identity Timeline Consequences Control/Cure	Likelihood appraisal	Fear of recurrence	N/A	All attributes and likelihood appraisal were correlated with recurrence worry in the predicted directions, but regression analysis revealed that only identity, chronic timeline, and consequences beliefs were independently associated with increased recurrence worry.
Green et al. (2014) Cross-sectional	Multivariate (time since Dx, time since Tx, Tx type, age, SEP)	Identity Timeline Consequences Control/Cure	N/A	N/A	Diet PA Changes in diet and PA	Lower identity, higher personal control, and higher treatment control were associated with more self-reported improvements in physical activity after Dx. Higher personal control more improvements in healthy eating, with chronic timeline showing a positive trend ($p = .051$). No CSM attributes predicted absolute levels of healthy eating or PA although coherence was marginally associated with lower PA ($p = .051$).
Hocking et al. (2013) Longitudinal case-control	Multivariate (Tx type, physical well-being, baseline or prior PA, SEP, race)	N/A	Control/Cure	Perceived health vulnerabilities	PA	Higher control beliefs were associated with PA reported concurrently, but not with PA reported 2 months later. Health vulnerability perceptions did not predict PA either concurrently or prospectively.
Kanera et al. (2016) Cross-sectional	Multivariate (mental and physical well-being, attitude toward diet and PA, social support, self-efficacy, intention, SEP)	Identity, Timeline, Consequences, Personal Control, Coherence	N/A	N/A	Diet PA	Scores reflecting threatening cancer representations were not associated with vegetable intake, fruit intake, or PA.
Kelly et al. (2015) Cross-sectional	Bivariate and multivariate (cancer type, Tx status from time since Dx, mental well-being, family cancer history, age, gender, SEP, race)	N/A	Causal risk Likelihood appraisal	Breast Cancer Recurrence	Diet PA	A trend emerged for causal risk beliefs to be positively associated with healthy eating, but not with PA. A trend emerged for higher recurrence risk beliefs to be associated with less PA; they were unrelated to healthy eating. Recurrence worry was not related to either PA or diet behaviour.
Llewellyn et al. (2008) Longitudinal	Multivariate (baseline recurrence worry)	Identity Timeline Consequences Control/Cure Coherence	N/A	Worry of Cancer	N/A	Only consequences beliefs were associated (positively) with recurrence worry.
McGinty et al. (2012) Cross-sectional	Univariate and multivariate (cancer stage, vulnerability, coping appraisal, age)	N/A	Causal risk Recurrence consequences Control Likelihood appraisal	Cancer Worry	N/A	Recurrence consequences beliefs and likelihood appraisals were positively correlated with recurrence worry whereas causal risk and control beliefs were not. Recurrence worry was highest when perceived likelihood was high, belief that diet can decrease cancer risk was high, and diet self-efficacy was low.
Moon et al. (2017) Cross-sectional	Multivariate	Timeline	Identity Timeline risk	Emotional representation	N/A	All recurrence risk representational attributes were correlated with recurrence worry in the predicted directions (positively for

Authors and design	Method of analysis (covariates)	Cancer representation measure(s)	Recurrence risk representation measure(s)	Worry of recurrence measure	Health behavior measure(s)	Major findings
			Recurrence consequences Control over recurrence Coherence			identity, timeline risk, and consequences; negatively for timeline-cured, personal and treatment control, and coherence).
Patterson et al. (2003) Cross-sectional	Multivariate (cancer type, Tx amount, time since Dx, mental well-being, age, SEP)	N/A	Control	N/A	Changes in diet and PA	Health locus of control was not associated with changes to diet or PA.
Paxton et al. (2010) Cross-sectional	Multivariate (cancer type, time since Dx, BMI, age, gender)	N/A	N/A	Worry	PA	Overall, worry of recurrence was associated with greater PA for adolescent survivors, but it was unrelated to PA for adult survivors.
Rabin and Pinto (2006) Longitudinal	Bivariate and multivariate	Causes of prior cancer	Causal risk	N/A	Diet PA	Those who believed unhealthy diet caused their cancer were more likely to report healthy dietary changes at baseline and 3 months later. Beliefs that insufficient exercise caused their cancer were associated with improvements in PA at baseline but not at 3 months. Beliefs that healthy diet reduces recurrence positively predicted healthy diet at baseline and follow-up. Causal risk beliefs about exercise were unrelated to changes in PA at both time points.

Note: BMI = body mass index. Dx = diagnosis. PCP = primary care physician. SEM = structural equation modelling. SEP = socioeconomic position (i.e., education, income, health insurance type, location of residence). Tx = treatment.