

BMJ Open Approaches to improving symptom appraisal: a systematic literature review

Ling Xiang ^{1,2} Sungwon Yoon,³ Andrea H L Low,^{1,4} Ying Ying Leung,^{1,4} Warren Fong,^{1,4} Tang Ching Lau,^{2,5} Dow Rhoon Koh,^{2,5} Julian Thumboo^{1,2,4}

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¹Department of Rheumatology and Immunology, Singapore General Hospital, Singapore
²Yong Loo Lin School of Medicine, National University of Singapore, Singapore

³Health Services and Systems Research, Duke-NUS Medical School, Singapore

⁴Duke-NUS Medical School, Singapore

⁵Department of Medicine, National University Hospital, Singapore

Correspondence to

Professor Julian Thumboo; julian.thumboo@singhealth.com.sg

ABSTRACT

Objectives Poor symptom appraisal (detection, interpretation and response to symptoms) plays a major role in prolonged prediagnosis interval in various health conditions. Theories and models have been proposed to study the symptom appraisal process but how they could be employed to improve symptom appraisal remains unclear. We therefore aimed to review approaches to improving symptom appraisal in the literature and to develop a theoretical framework that could guide the development of approaches to improving symptom appraisal among individuals in the general population.

Design Systematic review.

Data sources Medline, Web of Science, PsycINFO, Embase, CINAHL and Scopus were searched from inception to 30 March 2021.

Eligibility criteria We included original articles in English in which approaches to improve the detection, interpretation or response to symptoms for symptomatic individuals were described. We excluded articles in which approaches were developed to improve symptom appraisal among healthcare professionals.

Data extraction and synthesis A predefined data extraction form was used to extract the development, characteristics and evaluation of approaches to improving symptom appraisal. This formed the basis for the narrative synthesis.

Results Of 19046 publications identified from the literature search, 112 were selected for full-text review and 29 approaches comprising provision of knowledge of symptoms/signs and additional components (eg, symptom self-examination and comparison) for symptom appraisal were included in the synthesis. Less than half (41.4%) of these approaches were developed based on theories/models. Interestingly, despite the variety of theories/models adopted in developing these approaches, the components of these approaches were similar.

Conclusion Symptom appraisal is an essential process in a patient's journey that can be targeted to facilitate early diagnosis but is largely unstudied. Building on the literature, we proposed a theoretical framework and approaches to improving symptom appraisal. This could facilitate early identification of a variety of health conditions in the general population.

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INTRODUCTION

Prolonged prediagnosis interval between symptom onset and diagnosis, also referred to as diagnostic delay, remains an unmet need

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This systematic review was built on a comprehensive search strategy, which was developed and refined iteratively using multiple preliminary searches.
- ⇒ A narrative analysis allowed for deeper insights into (1) the development, implementation and evaluation of approaches to improving symptom appraisal and (2) the adopted theories and models in the literature.
- ⇒ A theory-based framework was proposed, which can provide guidance for the development of approaches to improving symptom appraisal.
- ⇒ Only free-text search was conducted in Web of Science and Scopus, which do not have controlled vocabularies.

among patients with various health conditions such as cancer and autoimmune rheumatic diseases (ARDs) and results in poor patient outcomes.¹⁻⁸ Prediagnosis interval comprises largely the symptom appraisal interval between symptom onset and the first visit to healthcare professionals. Using the general model of total patient delay proposed by Andersen and Cacioppo, symptom appraisal interval constituted the majority (more than 60%) of the total duration of delay among patients with various cancers.⁹ In a systematic review of prediagnosis interval among patients with rheumatoid arthritis (RA), the most common ARD, by Barhamain *et al*, symptom appraisal interval was found to be longer than intervals between the first visit to healthcare professionals and diagnosis (weighted average: 3.4 vs 2.1–2.9 months).¹⁰

Symptom appraisal is a process an individual undertakes when symptoms (bodily changes) are noticed till a decision is made on whether an action needs to be taken in response to the symptoms (bodily changes).¹¹ During the symptom appraisal interval, symptoms are being appraised and misperception of symptoms (bodily changes) may occur. Individuals may not perceive their symptoms as a health concern that requires prompt medical attention, and hence may not seek help from healthcare professionals or do so in a timely

manner.¹² Poor symptom appraisal has been shown to be a major cause of prolonged symptom appraisal interval and prediagnosis interval.^{13–17} In the meta-analysis by Petrova *et al*, poor symptom knowledge, wrong interpretation of symptoms, and negative beliefs about cancer were significantly associated with longer symptom appraisal/help-seeking intervals among patients with various cancers.¹⁶ In the systematic review by Stack *et al*, many patients with recent-onset RA reported that they were unaware of the significance of their symptoms before they were diagnosed and that they would have sought help earlier if they had more knowledge of RA and its symptoms.¹⁴

It is thus important to develop approaches to improve symptom appraisal among symptomatic individuals in the general population to address the unmet need to shorten the prediagnosis interval. Many theories and models have been proposed to study the symptom appraisal process among patients with various chronic and acute health conditions,^{11 18–27} however, how these theories and models could be employed to improve symptom appraisal remains unclear. We, therefore, aimed to review approaches to improving symptom appraisal in the literature, and to develop a theoretical framework that could guide the development of approaches to improving symptom appraisal among individuals in the general population to facilitate early diagnosis.

METHODS

We conducted a systematic literature search of existing approaches developed to improve symptom appraisal among individuals with any health conditions. We first performed preliminary searches in Medline using the concepts of symptom and appraisal, based on which the definitions of symptom and symptom appraisal for use in this study were developed, and search terms for the concepts of symptom, appraisal and patient education were refined (online supplemental file 1).^{11 12 18–20 22–31}

We performed the final literature search with the refined search terms in the following six electronic databases: Medline, Web of Science, PsycINFO, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Scopus. We included all articles published from inception to 30 March 2021.

This systematic review was registered with the PROSPERO International prospective register of systematic reviews and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist was followed in the reporting (online supplemental file 2).³²

Inclusion and exclusion criteria

One main reviewer (the first author) screened the title and abstract of all articles identified from the final literature search, with any uncertainty resolved by discussion with the other authors. We examined the references of all review articles to identify relevant publications. We included articles for full text review if they met the following three criteria: (1) original articles in which

approaches (or their components) to improving symptom appraisal were described, (2) approaches (or their components) aimed to improve the detection, interpretation or response to symptoms, and (3) approaches were developed for individuals with bodily changes/symptoms. We excluded articles in which approaches were developed to improve symptom appraisal among healthcare professionals such as medical trainees and nursing students.

Quality assessment

Quality assessment was conducted using the Joanna Briggs Institute (JBI) critical appraisal tools primarily by the first author, with any uncertainty resolved by discussion with the other authors.^{33 34} A raw score was calculated for each of the selected studies by dividing the number of positive responses by the total number of applicable statements in the JBI critical appraisal tools. High risk of bias was defined as a raw score of 49% or lower, moderate risk of bias was defined as a raw score between 50% and 69%, and low risk of bias was defined as a raw score of 70% or above.

Data extraction and synthesis

Data on study design, participants and the development, characteristics (type, format and components), and evaluation of approaches were extracted using a predefined data extraction form primarily by the first author, with any uncertainty resolved by discussion with the other authors. Due to the great heterogeneity in study design and outcome measures of the developed approaches, a narrative synthesis was performed.

Patient and public involvement

Patients and/or the public were not involved in the design, conduct, reporting or dissemination of this research.

RESULTS

Study selection

Among the 19046 records identified from the final literature search, 10613 were screened the title and abstract after removing duplicates, 196 were assessed for eligibility and 112 were included in the full text review (figure 1). An additional 67 eligible records were identified from citation searching, yielding a total of 179 eligible publications from 160 unique studies.

After reviewing these 160 studies, we excluded 131 (81.9%) studies in which approaches comprised only provision of knowledge of symptoms/signs of a given health condition. We included the remaining 29 (18.1%) studies in which approaches comprised provision of both knowledge of symptoms/signs and additional components (such as demonstration and/or hands-on practice of self-examination and comparison of symptoms) to improve symptom appraisal in the synthesis (table 1). This was based on the consideration that provision of knowledge (of symptoms/signs) alone might not be sufficient to produce the desired behaviour (ie, detection,

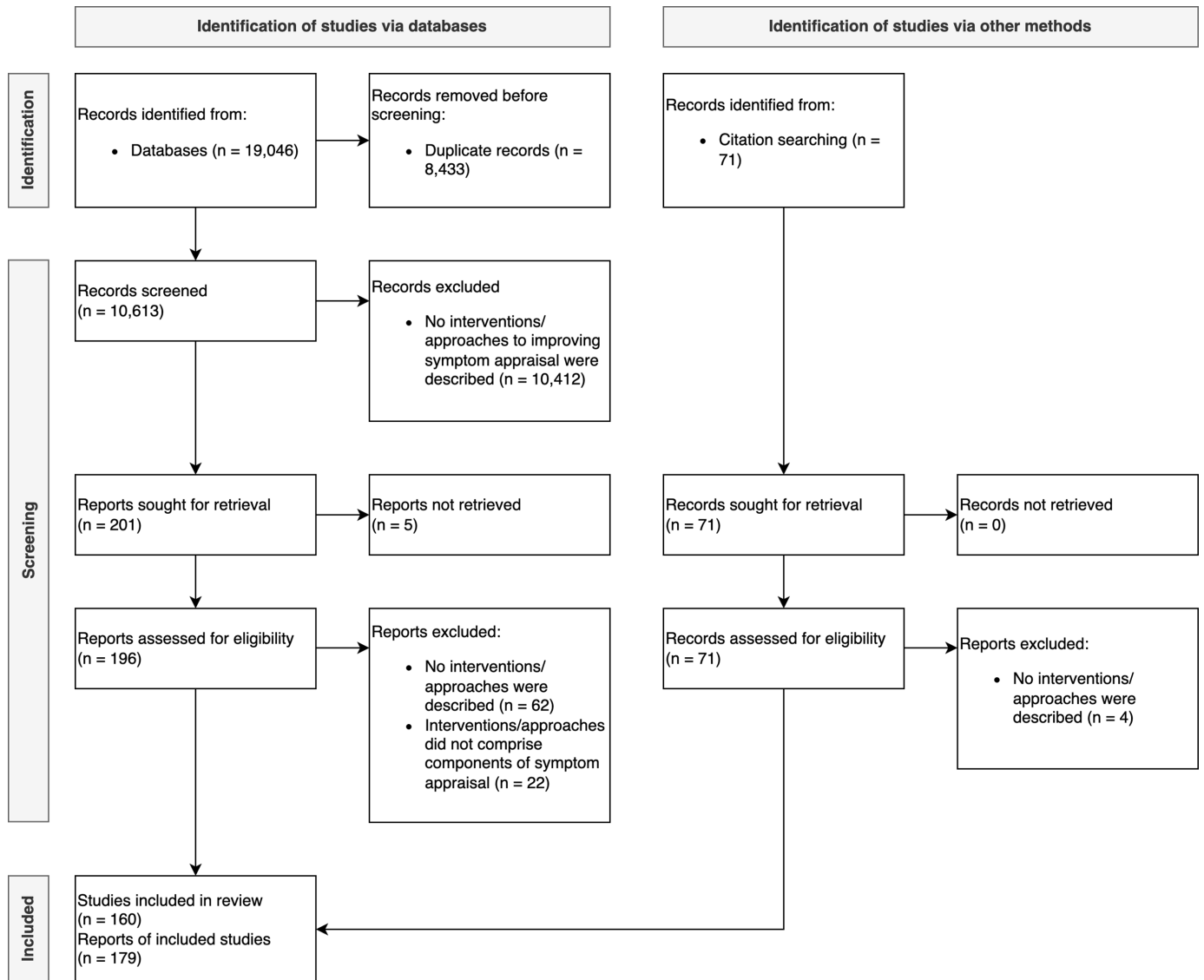


Figure 1 PRISMA chart. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

interpretation and response to symptoms),³⁵ and that we aimed to develop similar approaches to help individuals recognise and respond promptly to their symptoms/signs.

Of these 29 studies, 13 were categorised as having low risk of bias,^{36–48} 10 were categorised as having moderate risk of bias,^{49–58} and 6 were unable to be assessed due to a lack of detailed evaluation of the developed approaches.^{59–64} The raw scores of these studies were shown in online supplemental file 3. We included all 29 studies in the synthesis as our focus was the development instead of the evaluation of approaches.

Characteristics of approaches included in the synthesis

Of the 29 studies included in the synthesis, 16 focused on cancer,^{36–42 49–54 59–61} 5 on respiratory diseases,^{43 44 55 62 63} 3 on cardiovascular diseases^{45 46 64} and 1 each on other health conditions including concussion,⁵⁶ labour,⁵⁷ malaria,⁴⁷ neonatal illness⁴⁸ and RA.⁵⁸ Six were community-based studies engaging various parties (eg, educators and

women leaders) in the communities and employing different outreach efforts (eg, flyers and radio advertisements),^{37 39 47 52 61 64} among which two involved training of both laypersons and health providers.^{47 64} Five studies reported only the development of approaches,^{59 60 62–64} while the remaining 24 reported both the development and evaluation of approaches using quantitative and/or qualitative measures (online supplemental file 4).^{36–58 61}

The most common type of approaches was a combination of education sessions and education materials (n=15), followed by education sessions alone (n=8), education materials alone (n=5), and education applications/devices (n=1) (table 2). The majority (n=18) of these approaches used both text and audio visual aids or multimedia to describe and illustrate symptoms/signs. All approaches comprised provision of knowledge of target symptoms/sign, 14 comprised demonstration and/or hands-on practice of symptom self-examination, 12 comprised comparison or target symptoms/signs

Table 1 Characteristics of studies included in the synthesis

Study	Health conditions	Type and format of approaches	Constructs of symptom appraisal addressed	Underlying theories/models
Cancer				
Dine <i>et al</i> , 2011 ⁵⁹	BCLE	Education sessions	Detection (demonstration) and response	Nil
Brailey <i>et al</i> , 1986 ³⁶	Breast cancer	Education sessions and materials (film, pamphlet)	Detection (demonstration and hands-on practice)	PRECEDE Model ⁶⁵
Burgess <i>et al</i> , 2008 ⁶⁰	Breast cancer	Education sessions and materials (booklet with graphics and illustrations, photographs of symptoms)	Detection (demonstration) and response (role modelling)	SRT, ⁷⁴ TPB, ⁶⁶ Implementation Intentions ⁸¹ and SCT ⁶⁷
Byrne and Robles-Rodriguez, 2009 ⁶¹	Breast cancer	Education sessions and materials (pictures or illustrations)	Detection (demonstration and hands-on practice) and response	Nil
Craun and Deffenbacher, 1987 ⁴⁹	Breast cancer	Education sessions and materials (pamphlet)	Detection (demonstration and hands-on practice)	HBM ⁷⁰
Khokhar, 2009 ⁵⁰	Breast cancer	Education sessions and materials (video clip and pamphlet)	Detection (demonstration and hands-on practice)	Nil
McLendon <i>et al</i> , 1982 ⁵¹	Breast cancer	Education sessions (one-to-one)	Detection (hands-on practice) and response	Nil
Shepherd and McInerney, 2007 ⁵²	Breast cancer	Education sessions and materials (multimedia: radio)	Detection (demonstration) and response	Orem's Self Care Nursing Model ⁸²
Sørensen <i>et al</i> , 2005 ³⁷	Breast cancer	Education sessions (video)	Detection (demonstration)	Nil
Stratton <i>et al</i> , 1994 ⁵³	Breast cancer	Education sessions and materials (film and booklet)	Detection (demonstration)	Nil
Styrd, 1982 ³⁸	Breast cancer	Education sessions and materials (film and publication)	Detection (demonstration)	Nil
Luther <i>et al</i> , 1985 ³⁹	Breast and testicular cancer	Education sessions and materials (films)	Detection (demonstration)	Nil
Cornell <i>et al</i> , 2015 ⁴⁰	Melanoma	Education materials (photographs)	Interpretation (comparison)	Nil
Robertson <i>et al</i> , 2014 ⁴¹	Melanoma	Education materials (video and images of skin lesions)	Interpretation (comparison)	Nil
Scott <i>et al</i> , 2012 ⁴²	Oral cancer	Education sessions and materials (leaflet)	Detection (hands-on practice) and response	SRT, ^{18 75} SCT ⁶⁷
Brooks <i>et al</i> , 2001 ⁵⁴	Skin cancer	Education materials (pictures of skin lesions)	Interpretation (comparison)	Nil
Respiratory diseases				
Butz <i>et al</i> , 2005 ⁵⁵	Asthma	Education sessions	Identification, interpretation (comparison) and response	MSM ²²
Colland <i>et al</i> , 2004 ⁴³	Asthma	Education sessions	Identification, interpretation (comparison) and response	Nil
Gardner, 2016 ⁶²	Asthma	Education sessions and materials (binder with large pictures)	Recognition, interpretation (comparison) and response	HBM ⁷⁰
Hendricson <i>et al</i> , 1996 ⁴⁴	Asthma	Education sessions and materials (flip cards with illustrations, videotape, pamphlet)	Recognition and response (role modelling)	SLT, ⁷⁸ SCT ⁶⁸

Continued

Table 1 Continued

Study	Health conditions	Type and format of approaches	Constructs of symptom appraisal addressed	Underlying theories/models
Brandt, 2013 ⁶³	COPD	Education sessions	Recognition, interpretation (comparison) and response	Collaborative Model for Self-Management of Chronic Disease ⁸³
Cardiovascular diseases				
Davis <i>et al</i> , 2019 ⁴⁵	ACS	Education sessions and materials (pamphlet and pocket card)	Recognition, interpretation (comparison) and response	Nil
Raczynski <i>et al</i> , 1999 ⁶⁴	AMI	Education sessions and materials (flyers/brochures, posters, magnets and other “tokens”; video)	Recognition and response (role modelling)	SCT, ⁶⁹ SRT, ⁷⁶ CO, ⁷¹ DIT, ⁷² SMT ⁷³
Jurgens <i>et al</i> , 2013 ⁴⁶	HF	Education sessions and materials (booklet)	Detection, interpretation (comparison) and response	Theory of HF Self-Care, ⁸⁴ TUS, ^{28 77} UIT, ^{85–88} SRT ⁷⁵
Other health conditions				
Hunt, 2015 ⁵⁶	Concussion	Education materials (video)	Detection, interpretation (comparison) and response	Nil
Bonovich, 1990 ⁵⁷	Labour	Education sessions and materials	Detection, interpretation (comparison) and response	Flanders’ Analysing Teaching Behaviour, ⁷⁹ Redman’s Principles of Patient Education ⁸⁰
Eriksen, 2010 ⁴⁷	Malaria	Education sessions	Detection, interpretation and response (role modelling)	Nil
Matin, 2020 ⁴⁸	Neonatal illness	Education apps/devices (audio, images of danger signs)	Detection, interpretation (comparison) and response	Nil
Ziadé <i>et al</i> , 2021 ⁵⁸	RA	Education materials (video)	Detection (demonstration)	Nil

ACS, acute coronary syndrome; AMI, acute myocardial infarction; BCLE, lymphedema secondary to breast cancer treatment; CO, community organisation theory; COPD, chronic obstructive pulmonary disease; DIT, diffusion of innovation theory; HBM, health belief model; HF, heart failure; MSM, model of symptom management; Nil, no theories/models were adopted; PRECEDE, predisposing, reinforcing, and enabling causes in educational diagnosis and evaluation; RA, rheumatoid arthritis; SCT, social cognitive theory; SLT, social learning theory; SMT, social marketing theory; SRT, self-regulation theory; TPB, theory of planned behaviour; TUS, theory of unpleasant symptoms; UIT, uncertainty in illness theory.

with symptoms/signs of other health conditions and 3 comprised other components such as role modelling of the detection, interpretation and response to target symptoms/signs.

Theories/models adopted in the development of approaches

Despite the apparent similarity of components in the approaches, less than half (n=12) were developed based on theories/models and a variety of theories/models were adopted in the development of these approaches (table 2). The adopted theories/models could be grouped into four categories:

1. Health behaviour theories/models, including Predisposing, Reinforcing and Enabling Causes in Educational Diagnosis and Evaluation Model,⁶⁵ Theory of Planned Behaviour (TPB),⁶⁶ Social Cognitive Theory (SCT),^{67–69} Health Belief Model (HBM),⁷⁰ Community

Organisation (CO),⁷¹ Diffusion of Innovations Theory (DIT)⁷² and Social Marketing Theory.⁷³

2. Symptom appraisal theories/models, including Self-Regulation Theory (SRT),^{18 74–76} Model of Symptom Management²² and Theory of Unpleasant Symptoms.^{28 77}
3. Educational theories/models, including Social Learning Theory,⁷⁸ Flanders’ Analysing Teaching Behaviour⁷⁹ and Redman’s Principles of Patient Education.⁸⁰
4. Other theories/models, including Implementation Intentions,⁸¹ Orem’s Self Care Nursing Model,⁸² Collaborative Model for Self-Management of Chronic Disease,⁸³ Theory of Heart Failure Self-Care⁸⁴ and Uncertainty in Illness Theory.^{85–88}

The most common theories/models underlying the approaches were SCT and SRT, adopted in four studies each,^{42 44 46 60 64} among which three studies adopted

Table 2 Characteristics of approaches developed for various health conditions

	Cancer (n=16)	Respiratory diseases (n=5)	Cardiovascular diseases (n=3)	Other health conditions* (n=5)	Total (n=29)
Type of approaches, n (%)					
Education sessions	4 (25.0)	3 (60.0)	0 (0.0)	1 (20.0)	8 (27.6)
Education materials	3 (18.8)	0 (0.0)	0 (0.0)	2 (40.0)	5 (17.2)
Education sessions and education materials	9 (56.3)	2 (40.0)	3 (100.0)	1 (20.0)	15 (51.7)
Education apps/devices	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)	1 (3.5)
Format of approaches, n (%)					
Text	4 (25.0)	3 (60.0)	2 (66.7)	2 (40.0)	11 (37.9)
Audio visual aids	11 (68.8)	2 (40.0)	1 (33.3)	3 (60.0)	17 (58.6)
Multimedia	1 (6.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.5)
Components of approaches, n (%)					
Knowledge of symptoms/signs	16 (100.0)	5 (100.0)	3 (100.0)	5 (100.0)	29 (100.0)
Demonstration and/or hands-on practice of symptom self-examination	13 (81.3)	0 (0.0)	0 (0.0)	1 (20.0)	14 (48.3)
Symptom comparison	3 (18.8)	4 (80.0)	2 (66.7)	3 (60.0)	12 (41.4)
Other components: role modelling	0 (0.0)	1 (20.0)	1 (33.3)	1 (20.0)	3 (10.3)
Underlying theories/models adopted in the development of approaches, n (%)					
No	11 (68.8)	1 (20.0)	1 (33.3)	4 (80.0)	17 (58.6)
Yes	5 (31.3)	4 (80.0)	2 (66.7)	1 (20.0)	12 (41.4)

*Other health conditions included concussion (n=1), labour (n=1), malaria (n=1), neonatal illness (n=1) and rheumatoid arthritis (n=1).

both SCT and SRT.^{42 60 64} The second most common theory/model was HBM, adopted in two studies.^{49 62} The remaining theories/models were adopted in only one study.^{36 44 46 52 55 57 60 63 64}

Evaluation of the developed approaches

Evaluation of the developed approaches focused primarily on their effectiveness in the majority of these studies,^{36–43 45–58} while the reach, adoption and implementation of these approaches were evaluated in five studies,^{39 44 45 48 61} based on the Reach, Effectiveness, Adoption, Implementation and Maintenance framework.⁸⁹ The outcome measures included the following:

- ▶ Knowledge, attitudes and beliefs about the given health conditions and symptoms/signs (n=11).^{36 39 42 43 45 46 48 49 51 55 56}
- ▶ Skills, attitudes and practice of symptom self-examination via self-reporting (n=8),^{36–39 42 49–51} observation by examiners (n=3),^{48 52 53} or qualitative interview (n=1).⁵⁸
- ▶ Accuracy comparison of target symptoms/signs and those of other health conditions (n=4).^{40 41 54 57}
- ▶ Confidence and delay in help-seeking (n=3).^{42 46 48}
- ▶ Severity of health conditions (n=3).^{43 46 47}
- ▶ Satisfaction of educators (n=1)³⁹ and satisfaction of patients and caregivers via self-reporting (n=2)^{44 45} or qualitative interview (n=1).⁴⁸

- ▶ Implementation of approaches such as reviewing of education materials and appointment-making for clinical screening services (n=2).^{44 61}

DISCUSSION

In this study, we reviewed existing approaches to improving symptom appraisal in the literature. Provision of symptom knowledge, self-examination and comparison as well as demonstration/illustration of symptom appraisal using role modelling were common approaches identified from the literature search. We found significant heterogeneity in whether theories/models were employed and the choice of theories/models employed in the development of these approaches. Only a small number of studies involving provision of both knowledge of symptoms/signs and other approaches were found in the literature search, highlighting the need for such studies with the goal of improving symptom appraisal and reducing prediagnosis interval among individuals in the general population.

Approaches that were developed in the vast majority (81.9%) of studies identified from the literature search comprised only provision of knowledge of symptoms/signs of a given health condition. While knowledge acquisition is a precondition for performing symptom appraisal (a given behaviour), knowledge alone does not lead to the desired behaviour (symptom appraisal).³⁵ For example,

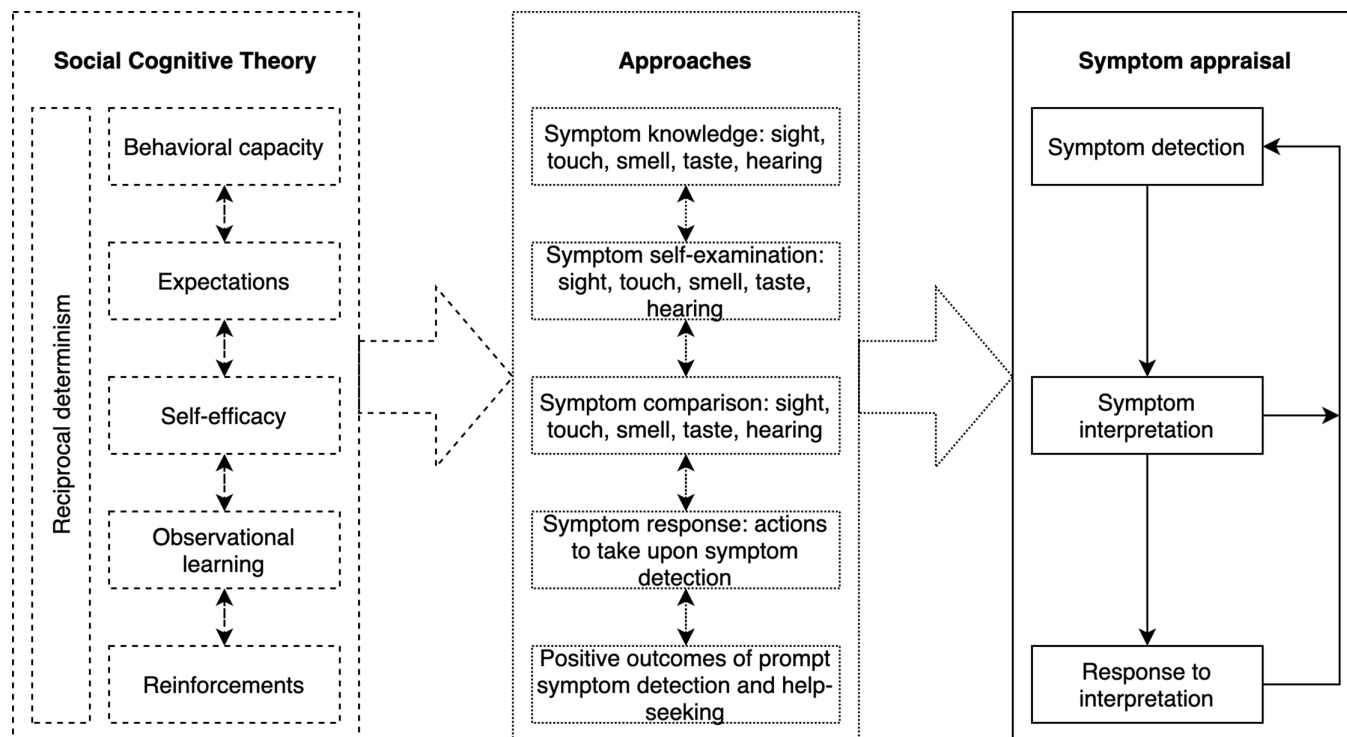


Figure 2 Proposed framework for improving symptom appraisal dashed boxes and arrows: concepts from Bandura's social cognitive theory, dotted boxes and arrows: approaches to improving knowledge, skills, attitudes and beliefs about symptom appraisal using various formats including text, photos and videos, solid boxes and arrows: constructs from Whitaker's synthesis of symptom appraisal models. The up down arrows denote interacting relationship between different components.

in the literature review by Teuschl and Brainin, a discrepancy was observed between the theoretical knowledge of and response to stroke symptoms, with only one-quarter to one-half of the patients who had been educated on stroke signs recognised their symptoms as stroke and in turn responding promptly.⁹⁰ As such, only approaches comprising both provision of the required knowledge and skills and additional components to enable personal, behavioural and environmental factors for symptom appraisal were included in the synthesis.

Theories and models present a systematic way of understanding complex issues (including symptom appraisal) by specifying the interrelationships among associated factors, which could provide a holistic framework for developing, implementing and evaluating interventions to address such issues.⁹¹ In addition to symptom appraisal theories/models, health behaviour theories/models were also commonly adopted in the development of approaches identified in the literature. Depending on the given health problem and its social context, health behaviour theories/models at different levels could be adopted.⁹¹ Since all of the three main constructs of symptom appraisal (ie, detection, interpretation and response to symptoms) are influenced by social environment such as access to health resources,^{92 93} health behaviour theories/models at interpersonal level (SCT) would be more appropriate for use in the context of symptom appraisal and was thus adopted more frequently compared with theories/models at individual/intrapersonal (eg, HBM and TPB) or community level (eg, CO and DIT).^{66-72 78} Health

behaviour theories/models at interpersonal level provide the psychosocial mechanisms through which personal cognitive, behavioural and environmental factors interactively influence a given behaviour, while theories/models at individual/intrapersonal level do not address the environment that the person and behaviour interact in and theories/models at community level focus more on the engagement of communities.^{66-72 78} Multiple theories and models that complement each other are often adopted to guide the development of different components of a given approach. This was seen in half of the studies in which theories/models were adopted.^{42 44 46 57 60 64} Of note, health behaviour and symptom appraisal theories/models were adopted together in three of the four studies where they were used.^{42 60 64}

Building on these studies, we propose an integrated conceptual framework from the major concepts of SCT (reciprocal determinism, behavioural capacity, expectations, self-efficacy, observational learning and reinforcements) and main constructs of symptom appraisal (figure 2), in which approaches were proposed based on SCT to improve symptom appraisal.^{11 67 68} Reciprocal determinism, the reciprocal interaction of person, environment and behaviour, highlights the importance of a multipronged approach to enhance not only a given behaviour (behavioural capability and reinforcements) but also its associated personal (self-efficacy and expectations) and environmental (observational learning and social support) influences (table 3). To enhance the behavioural capacity to perform symptom appraisal, one

**Table 3** Proposed approaches to improving symptom appraisal

Concepts of the social cognitive theory	Definition of the concepts	Approaches to improving symptom appraisal in screening tools
Reciprocal determinism	Dynamic and reciprocal interaction of person, environment and behaviour	► Provision of knowledge and skills (person and behaviour) and supportive environment required for symptom appraisal, for example, social support
Behavioural capacity	Ability (knowledge and skills) to perform a behaviour	► Provision of symptom knowledge (sight and touch etc)
		► Demonstration of symptom self-examination (sight and touch etc)
		► Illustration of symptom comparison: differences between target symptoms/signs and symptoms/signs of other conditions (sight and touch etc)
Expectations	Anticipated consequences of a behaviour	► Instructions on symptom response, namely actions to take upon symptom detection
		► Demonstration of positive outcomes of prompt symptom detection and help-seeking
Self-efficacy	Confidence in one's ability to perform a behaviour	► Adoption of various formats such as text, photo and video to enhance symptom knowledge, self-examination, comparison, and response
		► Demonstration of symptom self-examination, comparison and response using role models
Observational learning	Learning through observation for example, modelling of behaviours	► Demonstration of symptom self-examination, comparison and response using role models
Reinforcements	Responses to a behaviour that affect the likelihood of reoccurrence	► Demonstration of positive outcomes of prompt symptom detection and help-seeking

must possess the knowledge of the target symptoms/signs (eg, through sight, touch, hearing and scent/smell) and the skills of how to detect, interpret and respond to the target symptoms/signs. This could be achieved through provision of essential knowledge of target symptoms/signs (symptom knowledge), demonstration of symptom self-examination, illustration of differences between target symptom/signs and symptoms/signs of other health conditions (symptom comparison), and instruction on actions to take on detection of target symptoms/signs (symptom response). Expectations, the anticipated consequences of symptom appraisal, could be enhanced by demonstration of positive outcomes of symptom appraisal, or more specifically, prompt symptom detection and help-seeking. The positive outcomes of symptom appraisal could also work as *reinforcements* of symptom appraisal behaviour. Self-efficacy, the confidence of performing symptom appraisal, could be increased by adopting various formats such as text, photo and video to enhance the knowledge and skills (behavioural capacity) required for symptom appraisal and by demonstrating symptom appraisal, namely symptom self-examination, comparison and response using role models, the latter could enhance symptom appraisal through observational learning.

The proposed framework and approaches could be incorporated into the development of self-administered screening tools (online supplemental file 5), which are cost-effective in facilitating early disease identification in the general population.⁹⁴ Many existing screening tools, however, might be too challenging for individuals

with lower health literacy to answer as they often assess only the presence of target symptoms/signs of a given health condition without any explanations of what target symptoms/signs are and how these might look, feel, etc. While providing a description/explanation of target symptoms/signs could, to some extent, aid comprehension and improve the accuracy of self-reporting on screening tools, many symptoms/signs cannot be easily explained using text and would require illustrations such as photos and videos. For example, the three phases of colour changes in Raynaud's phenomenon, a common symptom seen among patients with ARDs, could be illustrated more clearly in the form of video instead of text. Such illustrations could prompt symptomatic individuals to notice the deviations from normality and enhance symptom appraisal by providing the context for interpretation, extralingual information, clarifying examples and redundancy to aid comprehension of the text.⁹⁵ In the literature review by Levie and Lentz, increased understanding was observed in 98% of the experiments using different illustrations.⁹⁶ Furthermore, other approaches such as demonstration of symptom self-examination and response using role models could be better illustrated using photos and videos.

There are three main limitations in this study. First, only free-text search was conducted in Web of Science and Scopus due to a lack of controlled vocabularies in these two databases. However, in consultation with a medical librarian with expertise in literature searches, a list of comprehensive free-text search terms were developed based on preliminary literature searches and both

controlled vocabulary search and free-text search were used in other databases (Medline, PsycINFO, Embase and CINAHL), which would be sufficient to identify most of the important articles in the literature. Second, five reports identified in the literature search were unable to be retrieved, which might contain theories/models and approaches that differ from those reviewed in this study. However, based on their title and abstract, these reports comprise mainly self-examination of symptoms/signs of breast, skin and testicular cancer and macular degeneration, and similar approaches had been included in our review and synthesis. Finally, the proposed framework is conceptual and requires empirical data to support it. Qualitative interviews with patients with ARDs are planned in our future work to further validate the framework by understanding the experience of symptom appraisal and approaches that could help the patients detect, interpret and take prompt actions in response to symptoms/signs. A screening tool comprising approaches to improving symptom appraisal will then be developed. Furthermore, the proposed framework and approaches target mainly knowledge, skills, attitudes and beliefs about symptom appraisal (behaviour) among symptomatic individuals (person). The environment with which person and behaviour interact such as cultural beliefs, social support, healthcare system and healthcare professionals also plays an important role in promoting or inhibiting symptom appraisal among these individuals. These environmental factors, however, could not be easily incorporated into screening tools but rather into large-scale public health screening programmes, which is a potential focus for our future work.

CONCLUSION

Symptom appraisal is an essential process in a patient's journey that can be targeted to facilitate early diagnosis but is largely unstudied. Building on the literature, we propose a theoretical framework and approaches to improving symptom appraisal. This could facilitate early identification of a variety of health conditions in the general population.

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ORCID iD

Ling Xiang <http://orcid.org/0000-0002-2883-6614>

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