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The effects of health behaviors and beliefs based on message framing among chronic disease patients: A systematic review

Short running title: Message Framing for Health Behaviors and Beliefs

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Abstract

Objective: The effectiveness of integrating message framing into educational interventions to promote the health behavior of chronic diseases patients is still being debated in nursing research. The objective of this study is to assess the impact of educational interventions based on gain and loss frames on the health behaviors and beliefs of patients with chronic diseases and identifies the frame that achieves better outcomes.

Design: Systematic review was based on PRISMA guidelines for comprehensively searching, appraising and synthesizing research evidence. Data were extracted from PubMed, Web of Science, PsycINFO, and CINAHL databases from their inception until March 26th 2021. Intervention studies with adult patients of chronic disease, intervention methods, or contents involved in the implementation of message framing were all considered. Health behaviors or beliefs, such as knowledge, self-efficacy, intention, or attitudes were the outcomes.

Results: A total of 11 intervention studies were included. We found that educational intervention based on both gain and loss frames could improve better communication effects, promote healthy behaviors and beliefs with chronic disease patients. Moreover, education messages based on the loss frame might produce the same or even better effects than those based on the gain frame. Thus, behavioral attitude appears to be a promising mediating variable of the influence of frame on behavior and intention.

Conclusions: Integrating message framing, particularly loss framing, into health education might be a promising strategy to motivate chronic disease patients to improve their health behaviors and beliefs. More extensive and well-designed trials are needed to support the conclusions and discuss the moderators and mediators of

framing.

PROSPERO registration number: CRD42021250931.

Key words: message framing; chronic diseases; nursing; health behavior; health beliefs; systematic review

Strengths and limitations of this study

► This systematic review is focusing on the impact of educational interventions based on gain and loss frames on the health behaviors and beliefs of patients with chronic diseases.

► This systematic review is first to identity that education messages based on the loss frame might produce the same or even better effects than those based on the gain frame of patients with chronic diseases.

► In limited number of randomised clinical trials were included, limited the quality of the evidences.

INTRODUCTION

Chronic diseases have become the leading cause of morbidity and mortality worldwide, accounting for 41 million deaths, more than 70% of all deaths, and 80% of total disabilities, indicating that this trend will continue to increase. [1 2] More than 300 million people in China were diagnosed with chronic diseases since 2018. [3] The rising burden of various diseases has increased the medical expenses among people: just only for diabetes, the medical costs had been reached $110 billion in China in 2017, ranking second in the world. [4] Hence, the treatment and care of chronic diseases pose a significant impact on individuals, their families, and societies, as well as a huge demand to healthcare systems. [5 6]

Providing health-related information and support to patients can encourage them

to promote change and maintain their health behavior, improve their psychological and physiological outcomes, [7] which effectively prevent and reduce complications associated with chronic diseases, risk of death, and disease burden. [8] At the same time, it is more cost-effective than improving the social environment and healthcare system. [9 10]

Nurses play a critical role in educating patients to improve their health. Nurses are just as reliable as doctors when it comes to health information, and patients prefer to get it from nurses because they are more accessible than doctors. [7 11 12] The number of people getting long-term conditions in need of nursing care is increasing rapidly. The number of health care professionals, especially registered nurses, is far from meeting the current and future demand. [13 14] Thus, we need to explore a more effective way to deliver messages to patients to maximize the effectiveness of health management education.

The effectiveness of educational messages in promoting behavior change may depend on the message presented rather than by the content itself. Message framing is a message tailoring method that can influence an individual's behavioral decision by adjusting the presentation of a message without changing the content, thereby promoting a particular behavior. [15] The most common method is to develop a message based on a gain (positive) or loss (negative) frame. The benefits of adopting the target behavior are typically emphasized in gain-framing messages whereas the costs of not adopting the target behavior are stressed in loss-framing information. [15] The previous study found that positive frames were better for disease prevention and negative frames were better for disease detection; however, only small effect sizes were observed. [16 17]

Reviewing the past literature, a large number of studies on health-related behaviors such as smoking, [18] drinking, [19] dental hygiene, [20] breast screenings, [21] Papanicolaou tests, [22] and vaccinations [23] have emerged in message framing research. These papers appear mainly in the psychological literature, with only a few appearing

in the nursing literature. [24] It is worth noting that many studies are involved in the general population, such as high school or college students, [25] [26] rather than representative samples of people suffering from various diseases or high-risk groups, such as diabetes and cardiovascular diseases. At the same time, the impact of message framing on chronic disease education is inconsistent. For example, a gain-framed foot care message was more effective in changing foot care behavior in the American diabetes patients. [27] In contrast, the Korean diabetes patients showed loss-framed foot care message was more effective in activating attitudes and intentions to conduct foot care. [28]

Nurses have significant opportunities to use message framing to provide health information. The primary purpose of this study was to review the impact of message framing educational interventions on the health behaviors and beliefs of chronic disease patients to introduce an innovative view in delivering health-related information.

METHODS

Search strategy

This systematic review was carried out based on the PRISMA guidelines [29] and recommendations of the Cochrane Collaboration. [30] There was no need for ethical approval because the literature analyzed in this study was from previously published studies. The PROSPERO registration number is CRD42021250931.

We searched for studies published in PubMed, Web of Science, PsycINFO, and CINAHL from their inception to March 2021. Terms related to message framing and chronic diseases used in this article were retrieved, including message framing, information framing, gain-framed, loss-framed, gain fram*, loss fram*, positive fram*, negative fram*, framing effect*, noncommunicable diseases, comorbidity, multimorbidity, chronic disease, chronic illness, chronic condition, long term condition, long term illness, cardiovascular disease, hypertension, stroke, diabetes

mellitus, metabolic syndrome, neoplasms, and chronic obstructive pulmonary disease. The reference lists of included and relevant publications were manually screened for additional articles.

Study selection

The inclusion criteria included adult chronic diseases patients (≥18 years old), intervention methods or contents involved in the application of message framing, and intervention studies (randomized controlled trials or quasi-experimental studies) published as peer-reviewed full-text articles in the English language. These studies had to measure health behavior or beliefs such as knowledge, self-efficacy, intention, or attitude. Exclusion criteria included articles from patients with severe mental disorders or cognitive impairment.

The retrieval results were imported into Endnote X 20 for literature management. Following the removal of duplicates, two independent researchers first screened the title and abstract based on the pre-established inclusion and exclusion criteria. If they found any disagreement, it was resolved by a third independent researcher.

Data extraction and analysis

Data extraction and entry were performed using a pre-designed data extraction form, including first author, year of publication, country, study aims, sample size, gender, and age, key contents of intervention, outcome measures, and findings. Two independent researchers completed data extraction, and if there was any disagreement or uncertainty, it was arbitrated and resolved by a third independent researcher.

Although our initial goal was to complete a systematic review and meta-analysis, quantitative analysis could not carry out due to the large heterogeneity of the literature.

Quality assessment

Two independent researchers completed the quality assessment of the included

articles using Review Manager 5.3 software (Nordic Cochrane Center, Copenhagen, Denmark). If they found any uncertainty or difference in opinion, it was resolved by a third independent researcher. The Cochrane Collaboration's tool is used for quality assessment; [31] for quasi-experimental studies, the item of random sequence generation of selection bias was automatically identified as high risk. [32 33]

Patient and public involvement

Neither patients nor the public were involved in this research.

RESULT

Literature search

After removing duplicate literature and screening the titles and abstracts, a total of 2253 pieces of literature were systematically retrieved, with 42 pieces of literature were read the full text. A total of 11 studies were included, [27,34–43] ten randomized controlled trials (RCT), and one quasi-experimental study [35] based on previously established inclusion and exclusion criteria. Figure 1 illustrates the literature screening process.

Characteristics of the included studies

The included studies were published between 2004 and 2020; only three are from Asian countries, including China, Korea, and the Philippines, with the remaining eight from the United States, United Kingdom, and Canada. The number of participants ranged from 49 to 1,108, for a total of 2,216, with an average age of 40 to 71, and a male proportion of 43.7%.

Diabetes, cardiovascular disease, and cancer are the most common chronic diseases addressed in the included literature. Seven studies were set up in two groups, with one received educational intervention based on gain frame, and the other group received educational intervention based on loss frame. Only four studies set up three groups: a gain-framed group, a loss frame group, and a standard control group for

providing usual care, with no message framing. [35 39 40 43] The content of message intervention primarily focused on healthy behaviors such as physical activity, medical adherence, and self-management for chronic disease patients. The gain framing condition highlighted the positive outcomes of completing or adhering to the healthy behavior, while the loss framing condition emphasized the undesirable consequences of failing to comply or adhere to the healthy behavior, which corresponded to the positive framing outcomes. Messages were delivered via video, pamphlet, and online message. Nine studies only once conducted intervention, and two studies sent the pamphlet to patients to take home for further reading. [38 43] Table 1 presents specific information about the included studies.

Quality assessment of the included studies

Out of ten RCTs, only two studies described the methods of randomization. [34 39] In the quasi-experimental study, non-randomized sampling was used; participants were just assigned to different groups in separate days for a single time, identified as high risk. [35] Only one RCT showed allocation concealment among the 11 studies. [34] Only two studies showed a low risk of performance bias. None of the 11 articles indicated whether the blind method was applied to the outcome assessment. All studies showed low risk in attrition bias, and almost no participants were lost in the eight studies. Meanwhile, three studies showed no demographic biases for those who dropped out of the study. [27 38 41] All studies were unclear for bias from reporting or other sources Figures 2 and 3 summarize the quality assessment of the included studies.

Main effects of framing

Several studies have reported effects on numerous outcomes. Six studies assessed outcomes immediately after the intervention, [34–36 39 40 42] and five studies measured actual behavior from four weeks to 12 months of follow-up. [27 37 38 41 43] Five studies assessed intentions, [34 36 38 39 40] three measured attitudes at the same time, [34 38 40] and three studies measured knowledge and self-efficacy. [35 41 42] However, the outcomes

measured in the eleven studies were too diverse to analyze quantitatively. Table 2 shows a summary of findings from the studies included in this review.

Several studies reported significant main or interactive effects of framing. Among the included studies, we found that in chronic disease patients, loss framing messages have the same or even greater impact on the behaviors and cognitive variables such as the intention, attitude, and self-efficacy of patients to adopt or maintain health behaviors than gain framing messages. Five studies showed a main framing effect on behavior, with two studies reported a loss-framed advantage over gain-farmed alternatives. [37 41] In contrast, two studies found that a gain-framed was slightly superior to a loss-framed message, [27 43] and one study reported that both gain and loss-framed messages resulted in more behavior than at baseline, with no differences between framing conditions. [38]

Five studies showed a main framing effect on intention. When compared to control, both gain- and loss-framed messages lead to higher intentions. [40] One study reported a loss-framed advantage over gain-farmed alternatives. [39] Two additional studies reported that loss frames were not differentially persuasive than gain frames. [34 40] One study showed when messages focused on long-term health risk, loss-framed messages were more persuasive. In contrast, gain-framed messages were more persuasive for short-term health risk. [36] And one study found that loss-framed was superior to gain-framed for improving attitude, [34] while another found that both conditions lead to higher attitude without a difference between them. [40] However, one study found that neither gain nor loss-framing elicited higher intention or attitude. [38]

One study found that loss-framed messages contributed more knowledge gain than gain-framed. [42] Another study demonstrated that both loss-framed and gain-framed messages contributed to knowledge gain with no difference between the two. [35] One study reported that loss-framed messages increased self-efficacy more than gain-framed. [41] However, another study found that although both frames improved self-efficacy, the average increase of the following intervention in a

gain-framed group was slightly higher than in the loss-framed group. [35] Furthermore, one study found that the loss-framed group increased perceived efficacy of health behavior more than the gain-framed group. [39]

Notably, none of the studies discussed the effect of different message framing on physiological measures such as blood glucose levels or cardiopulmonary function.

Moderator and mediator variables of framing effects

Several studies focused on moderators and mediators of framing effects. In particular, Park et al. reported that message framing had a significant indirect impact on intentions for diabetes self-care behavior, mediated through attitudes and perceived control. However, no significant interaction effects between health literacy and message framing were found. [34] Grady et al. found that attitude and framing are also important predictors of behavior. [27] Nevertheless, no mediating effects between HBM constructs and messages were observed in McCall's study. [43]

Zhao et al. investigated the interaction between frames and individual time perspective considering future consequences (CFC), and they found a significant interaction between the two. Their results showed that, among high-CFC patients, both gain- and loss-framed messages heightened intention and attitude regarding the no-message control. The message exposure did not affect the two outcomes, low- and medium-CFC participants. [40]

DISCUSSION

Patients with chronic diseases need to maintain long-term health behaviors to avoid complications and improve their quality of life. It is necessary to explore the most effective method of conveying health educational information to patients in order to minimize the workload of nurses and improve patients' health behaviors. Message framing provides a new perspective for achieving this goal by presenting information in different frames without changing the content. However, there has not been sufficient research on integrating message framing into educational details. Hence, we

summarized the research on the influence of educational interventions based on message framing on the cognition and behavior of health behavior patients with long-term illnesses. In this research, we found that most studies showed that educational message intervention based on the gain and loss frame could effectively improve health behaviors and cognitive variables such as knowledge, intention, attitude, self-efficacy of patients with chronic diseases. Previous studies have suggested that gain framing is more effective for preventive behavior, but it was not concluded in this study. We suggest here that loss framing may be as effective as or even more effective than gain framing in influencing health behavior and cognitive variables in patients with chronic diseases.

The persuasion of gain and loss framing appeal seems to be more complicated than previously thought. Compared with the general population, chronic disease patients usually have a longer duration of disease, more severe illness, and may have lower health awareness. The loss framing might be more efficacious if people do not intend to take action in the foreseeable future and are unaware of the issues related to their behavior. [44] Besides, individuals weigh the benefits of engaging in healthy behaviors (such as reducing symptoms and improving mood) against the potential costs (such as the time and effort spent learning a new skill). [42] Individuals suffering from chronic diseases, who typically have a long history of illness, may have had a learning history and outcome expectation (e.g., perceived importance) that may have resulted in an avoidance tendency toward health behavior. Individuals with a dominant avoidance tendency typically respond more strongly to threat cues, [45] making them more receptive to loss-framing encouragement. [46] However, no relevant variables were assessed in this study; we only proposed a research hypothesis that requires further investigation.

Fewer studies have explored the potential mechanism of message frames, which is of great significance for designing and applying message intervention. These studies found that attitudes and intentions may act as mediating factors of framing

effect on behavior, consistent with the theory of planned behavior. [27 34 47] A negative frame may allow patients without behavior change awareness to develop attitudes and behavioral intentions, thereby promoting behavior. The interaction between message frame and individual time perspective also suggests that individual factors must be considered. [40] Matching frames with individual factors can have a greater framing effect and help to promote the occurrence or maintenance of healthy behaviors. This is consistent with the view raised by Latimer et al. that the effectiveness of the message frame may be dependent on the individual's thinking and feeling about behavior, rather than just the function or nature of the behavior itself. Failing the influence of individual differences on message framing effects may suppress the true framing effect and underestimate the utility of gain and loss-framed appeals. [48]

Limitations

This review offers critical insights into the impact of message-framed education on health behaviors of chronic disease patients; however, several limitations have to be considered. Although we retrieved a considerable amount of literature from the database, only 11 articles met the inclusion criteria used in the present study. In the analysis, the diversity of outcome measurements did not permit a quantitative analysis, limiting the reliability of the conclusions. Only five studies measured changes in actual behavior whereas only six studies just measured changes in cognitive variables immediately after the intervention. Of course, we are aware that there is still some distance between the initiation of behavioral intention to the occurrence and maintenance of actual behavior. At the same time, no physiological indicators such as blood glucose or cardiovascular functions were measured in the included studies. Hence, future research needs to determine the effects of message framing on actual behavior and physiological indicators through long-term observation or objective measurement. Few studies have been explored the underlying mechanisms of the influence of message framing on behavioral or cognitive variables. However, in general, the included studies have relatively high bias risk and low

methodological quality, limiting the reliability of the results. Besides, among the 11 articles included here, only three are from Asian countries; thus, further research is needed to explore if there are regional or cultural limitations on the feasibility and suitability of educational interventions based on the gain and loss-frame for health behaviors of chronic disease patients. Therefore, with these limitations of the present review, interpretation of the results should be made with caution.

Implications for nursing

One of the primary goals of this research is to provide suggestions for nurses and other healthcare professionals, extend the message framing effect to chronic disease education interventions and improve patients' health, well-being, and quality of life. This study suggests that loss frame prevention messages may be more effective than a gain frame in promoting health behaviors and beliefs in patients with chronic diseases. The present findings add to the growing evidence that the way health education messages are delivered has an impact on results that are more than the content of messages. Proper design and delivery of messages can improve the persuasiveness of education, effectiveness, and efficiency of nursing, enabling chronic disease patients to adopt and maintain health promotion behaviors. Furthermore, by empowering patients to be active decision-makers rather than passive nursing recipients, patients' role in managing health-related issues can be strengthened.

CONCLUSION

Message framing is an effective strategy for health communication. Besides, integration of loss framing into health education may be a promising strategy for motivating patients with chronic disease to improve health behaviors and related cognitive variables. The best framework for improving the actual health behavior of chronic disease patients, as well as its potential moderators and mediators, need to be studied further and strengthened in order to guide health education.

Author contributions

RG and FL performed the conception and design of the study, drafting the article or revising it critically for important intellectual content. RG, HG, FL and YL performed the acquisition of data, or analysis and interpretation of data. MS, LX and TY performed the quality assessment. All authors read and final approval of the version to be submitted.

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Table 1 Characteristics of studies included in this systematic review.

Authors Year Country	Design	Population	Group	Sample Size (M/F) Age (years)	Key component of intervention			
					Content	Format	Frame	Dose
Park [34] 2020 Korea	RCT	Diabetes	Gain-frame	26 (10/16) 65.65±10.61	Content pertaining to diabetic complications in diabetes.	Video	Gain framing presented positive outcomes resulting from adherence to a diabetes care regimen, showing a patient success story about proper diabetes self-care.	1
			Loss-frame	26 (6/20) 64.92±12.21			Loss framing presented undesirable consequences resulting from failure to comply with a diabetes care regimen, showing a story about a patient with diabetic complications caused by inadequate diabetes self-care.	
Paragas [35] 2019 Philippines	Quasi-experimental study	Diabetes	Gain-frame	55 (25/30) 58.95±10.25	Videos including the definition of diabetes and health teachings about blood glucose monitoring; proper diet and exercise; oral hypoglycemic agents; and recognition, treatment, and prevention of hypoglycemia and hyperglycemia.	Video	Gain-framed video comprised the 10 positive outcomes of adherence to diabetes self-care in the last scenes of the videos, e.g. one statement was "If you maintain good control of your blood glucose, the acid in your blood will be normal, and being comatose will be prevented," with a scene showing a healthy person.	1
			Loss-frame	55 (25/30) 58.60±10.23			Loss-framed video contained the 10 negative outcomes of non-adherence in the last scenes of the videos, e. g. one version was "If you do not maintain good control of your blood glucose, the acid in your blood will be elevated that could lead to being comatose," with a	

							scene showing a comatose patient.	
			No-frame	55 (24/31) 58.96±9.74		Lecture	Standard approach of providing health teachings about diabetes self-care, with no message framing.	
Keyworth [36] 2018 UK	RCT	Psoriasis	Gain-frame	217 (75/126) 41.23±14.31	Information about the effects of health behavior change on either psoriasis symptoms or CVD risk.	Sheet	Gain-framed message addressed the positive outcomes for adherence to the health behaviors, e. g. "Research shows that risk factors for cardiovascular disease include smoking, having a poor diet, having insufficient physical activity, and drinking excessive amounts of alcohol. By making changes to your lifestyle, you [lower] your risk of cardiovascular disease."	1
			Loss-frame				Loss-framed message addressed the negative outcomes for not adherence to the health behaviors, e. g. "Research shows that risk factors for cardiovascular disease include smoking, having a poor diet, having insufficient physical activity, and drinking excessive amounts of alcohol. By [not] making changes to your lifestyle, you [increase] your risk of cardiovascular disease."	
Li [37] 2017 China	RCT	Diabetes	Gain-frame	211 (101/110) 71.41±6.80	The pamphlet included a brief description of PA participation in Hong Kong, the recommended PA level.	Pamphlet	Gain-framed pamphlet contained the benefits of PA participation, including physical (11 items: e.g., improve muscle strength), psychological (8 items: e.g., improve mood), and social (4 items: expand social network) domains.	1
			Loss-				Loss-framed pamphlet contained the absence of benefits of PA participation. The contents of the benefits were identical between the	

			frame				gain- and loss-framed messages, with differences only in the framing of the messages.	
Hirschey [38] 2016 USA	RCT	CRC	Gain-frame	78 (36/42) 64.3 (29.9–98.4)	Tips on how to become more physically active with examples of activities of MIPA; description of other diseases for which CRC cancer survivors are at increased risk and the protective influence of PA on these co-morbid conditions; description inverse relationship between PA and risk of cancer-specific mortality and all-cause mortality; a summary of benefits of being or disadvantages of not being physically active.	Pamphlet	Gain-framed version addresses the benefits of being physically active.	Pamphlet could be taken to home to read.
			Loss-frame	70 (35/35) 65.4 (43.2–88.5)			Loss-framed version addresses the disadvantages of not being physically active.	
Bassett [39] 2013 Canada	RCT	SCI	Gain-frame	94 (57/37) 45±12	Six messages contained information about benefits (showed in gain framed messages) or risks (showed in loss framed messages);	Online messages	Gain-framed messages outlined the benefits of engaging in regular LTPA (i.e. Adding LTPA to your day can help you manage your pain gain framed)	1
			Loss-				Loss-framed messages outlined the risks of not engaging in regular	

			frame		quotations from SCI experts and patients; summary statements about research evidence regarding LTPA.		LTPA. (i.e., By not adding LTPA to your day you miss an opportunity to manage your pain)	
			No-frame		Usual care		The control group did not receive any additional information.	
Zhao [40] 2012 USA	RCT	Chronic diseases	Gain-frame	1108 (411/697) 40-85	Messages addressing perceived need and perceived concerns about medications, messages content was held the same across the two frames.	Online plain text message	Gain-framed messages outlined the benefits of adherence to medication taking (i.e. You may wonder whether you really need your prescription medication. But taking your medicine as directed is very important even if you don't feel sick. It's the first step toward long-term health. Talk to your doctor about your medicine and changes you can make to your lifestyle to help manage your condition.)	1
			Loss-frame				Loss-framed messages outlined the negative outcomes of not adherence to medication taking. (i.e., You may wonder whether you really need your prescription medication. But not taking your medicine is very dangerous to your health, even when you don't have symptoms. Your condition can get worse. If you don't talk to your doctor about your medicine or other lifestyle questions, you can miss out on information that can help your condition.)	
			No-frame		Usual care	NR	The control group did not receive any additional information.	

Trupp [41] 2011 USA	RCT	CVD with OSA	Gain-frame	26 (19/7) 29-74	A brief, about 50 seconds educational video about CPAP was provided.	Video	Gain-framed video positively focused on the benefits associated with CPAP use.	1
			Loss-frame	29 (17/12) 38-77			Loss-framed video negatively emphasized the negative consequences that may occur if CPAP was not worn as directed.	
Janke [42] 2011 USA	RCT	Chronic pain	Gain-frame	62 (61/1) 50	Messages stressed the importance of the patient playing an active role in their pain care and techniques could use to help manage pain. Pain management topics were the same across all pamphlets and included effective communication with providers about pain, relaxation, pleasant activities, activity pacing and promoting healthy lifestyle behaviors.	Pamphlet	Gain-framed messages emphasized the gains patients would make if they engage in these behaviors.	1
			Loss-frame				Loss-framed messages focused on the losses they would realize if they did not do these things.	
Grady [27]	RCT	Diabetes	Gain-	155	The video contained verbal and graphical content,	Video	Gain-framed version offered the positive outcome that can accrue by appropriate foot care, e.g. “Good foot care can help you avoid the	1

2011 USA			frame	(64 /91) 61.2±11.4	approximately 10 minutes in length and addressed topics about foot care such as cleaning procedures, toenail care, footwear use, and foot and footwear inspection procedures.		serious complications of nerve and blood vessel damage, and keep your feet healthy" (with a picture of healthy feet).	
			Loss-frame				Loss-framed version offered the negative outcome that can accrue if the desired behavior is not followed, e.g. "Poor foot care can lead to the serious complications of nerve and blood vessel damage, and unhealthy feet" (with a picture of a foot with an infected sore).	
McCall [43] 2004 Canada	RCT	Post CABG surgery patients	Gain-frame	16 (15/1)	Statements regarding the effects of exercise in relation to CAD.	Sheet	Gain-framed condition listed 10 gain-framed statements regarding the benefits of exercise in relation to the progression of CAD. (i.e., Regular exercise will help you maintain a healthy body weight.)	Sheet could be taken to home to read.
			Loss-frame	13 (12/1)			Loss-framed condition with the same 10 statements phrased in a loss-framed manner. (i.e., By not exercising regularly, you decrease your chances of keeping a healthy body weight.)	
			No-frame	20 (19/1)	Usual care	NR	The control group did not receive any additional information.	

Abbreviations: CABG: Coronary artery bypass graft; CAD: Coronary artery diseases; CRC: Colorectal cancer; CVD: Cardiovascular disease; LTPA: Leisure time physical activity; MIPA: Moderate intensity physical activity; NR: Not report; OSA: Obstructive sleep apnea; PA: Physical activity; RCT: Randomized controlled trial; SCI: Spinal cord injury; T2D: Type 2 diabetes.

Table 2 Summary of findings of studies included in this systematic review.

Authors Year	Outcome measures and collection time	Main findings	Mediators/Moderators
Park [34] 2020	Attitudes, perceived control and intentions for diabetes self-care behavior. All measured at post-intervention.	Attitudes: Loss-framed group improved more; Perceived control: Loss-framed group improved more; Intentions: Both conditions produced significant increases, but no group difference.	Significant indirect effect of message framing on intentions for diabetes self-care behavior mediated through attitudes and perceived control. No significant interaction effects were observed between health literacy level and message framing.
Paragas [35] 2019	Knowledge, self-efficacy. All measured at pre- and post-intervention.	Knowledge: Both loss-framed and gain framed group improved more, but no difference between the two; Self-efficacy: Both loss- and gain- framed group improved, and gain framed group improved more.	NR
Keyworth [36] 2018	Intention. Measured at post-intervention.	Intention: messages focused on short-term health risk, gain-framed messages were more persuasive than loss-framed messages; messages about long-term health risk a loss-framed message more persuasive than a gain-framed message	A significant frame by focus interaction was found for behavioral intention to reduce alcohol intake.
Li [37] 2017	PA. Measured at pre-intervention and 2-week follow up: PA.	PA: Loss-framed group improved more.	NR

Hirschey [38] 2016	PA, attitudes, subjective norms, perceived behavioral control, intention. PA, intention were measured at pre- and post-intervention, 1-and 12-months follow up; Attitudes, subjective norms and perceived behavioral control measured at pre-intervention and 1-month follow up.	PA: Both conditions produced significant increases in PA, with no differences between framing conditions; TPB constructs: Neither the gain- nor loss-framed brochures produced significant changes from baseline to the 1- and 12-months follow-up.	NR
Bassett [39] 2013	Response efficacy, intention. All measured at pre- and post-intervention.	LTPA response efficacy: Loss-framed condition increased more than gain-framed and control conditions, no difference between gain-framed and control conditions; Intention: Loss-framed condition increased more than gain-framed and control conditions, no difference between gain-framed and control conditions.	NR
Zhao [40] 2012	Intention, attitude. All measured at post-intervention.	Intention: Gain- and loss-framed messages improved more than control, no difference between gain- and loss-framed conditions; Attitude: Gain- and loss-framed messages improved more than control, no difference between gain- and loss-framed conditions.	Significant interaction between frames and CFC, among high-CFC patients, both gain- and loss-framed messages heightened intention ad attitude with respect to the no-message control, and the gain frame showed a consistent superior to the loss frame. Message exposure had not effect on the two outcomes for low-and medium-CFC participants.
Trupp [41]	Adherence to CPAP, self-efficacy.	CPAP use: Loss-framed group improved more; Self-efficacy: Both conditions improved, Loss-framed group	NR

2011	CPAP use was measured at post-intervention; Self-efficacy was measured at pre- and post-intervention.	improved more than gain-framed group.	
Janke [42] 2011	Knowledge, pain self-efficacy, pain readiness to change, pain self-management behavioral skills (communicating with providers, relaxation, activity pacing, pleasant activities and healthy lifestyle). Pain self-efficacy, pain readiness to change were measured at pre-intervention; Knowledge, pain self-management behavioral skills were measured at post-intervention.	Knowledge: Loss-framed group improved more; Confidence to practice relaxation: Loss-framed group improved more.	Pain self-efficacy, pain readiness to change and message frame independently influenced motivation to engage in relaxation. There were no observed interactions between message frame and either self-efficacy or readiness to change.
Grady [27] 2011	Knowledge, attitude, foot care behaviors. Knowledge and attitude were measured at pre- and post-intervention, 3- and 6-month follow-ups; Foot care behaviors were measured at pre-intervention, 3- and 6-month follow-ups.	Foot care behaviors: Gain-framed group improved more.	Attitude and framing are significant predictors of 6-months behavior, gain framing positively related to long-term behavior; knowledge affects attitudes, in turn, attitudes affect behavior.
McCall [43] 2004	Adherence to exercise, health belief cognitions (perceived susceptibility, benefits and barriers). Adherence to exercise was measured at 3-months follow-ups; Health belief cognitions were measured at post-intervention.	Adherence to exercise: Gain-framed condition attended more exercise sessions than control; loss-framed group attend more exercise, but no difference with control; Perceived susceptibility: Gain- and loss-framed conditions perceived more susceptibility than control;	HBM constructs did not mediate the effects of the educational messages.

		Perceived barriers: Loss-framed condition perceived grater barriers than gain-framed and control conditions; Perceived benefits: No difference among the three conditions.	

Abbreviations: CFC: Consideration of future consequences; CPAP: Continuous positive airway pressure; HBM: Health belief model; LTPA: Leisure time physical activity; NR: Not report; PA: Physical activity; TPB: Theory of planned behavior.

Figure legend

Figure 1 Flowchart of the literature search

Figure 2 Risk of bias assessment

Figure 3 Risk of bias summary

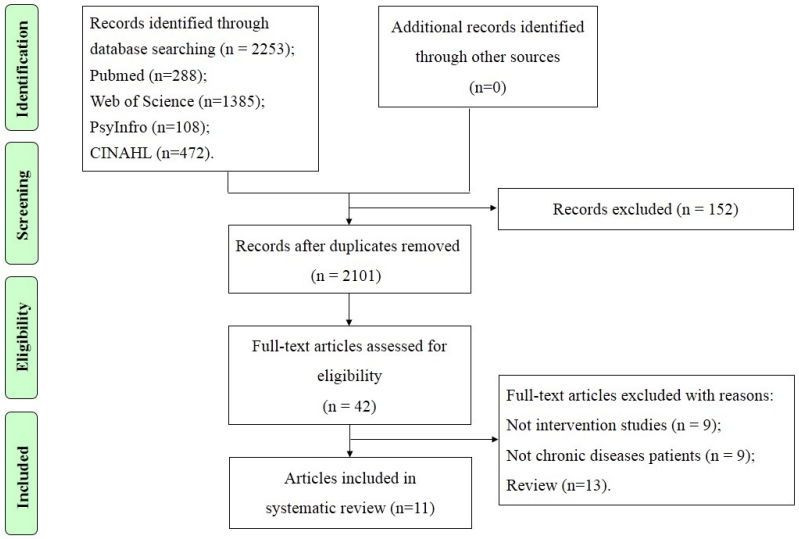

Figure 1 Flowchart of the literature search

338x190mm (96 x 96 DPI)

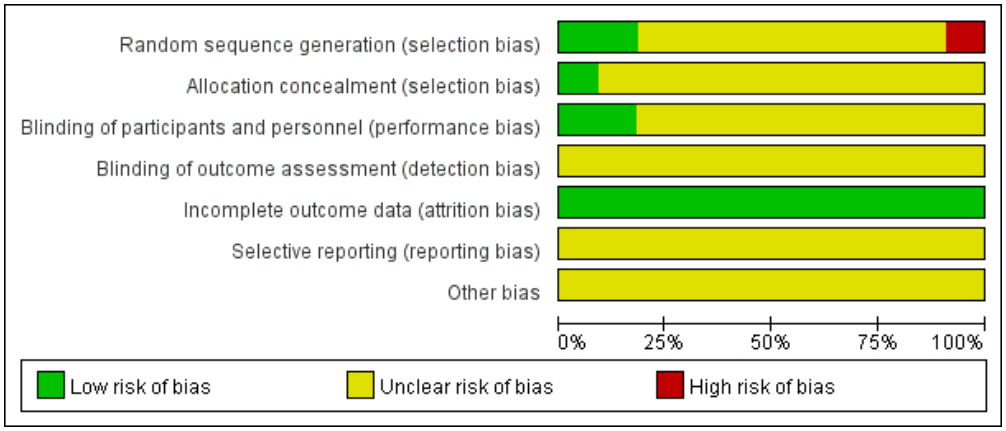

Figure 2 Risk of bias assessment

213x90mm (72 x 72 DPI)

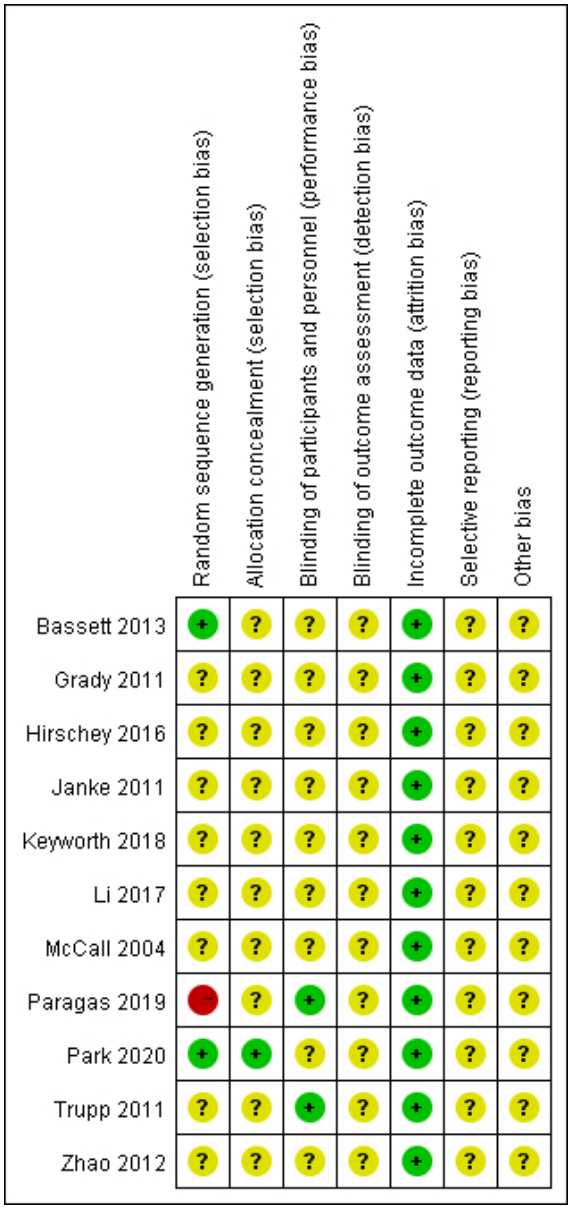

Figure 3 Risk of bias summary

111x236mm (72 x 72 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1,2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	none
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	none

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	none
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	none
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	6,7
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	7,8,9
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	none
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	none
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9,10,11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11,12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	13
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	13

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The effects of health behaviors and beliefs based on message framing among patients with chronic diseases: A systematic review

Short running title: Message Framing for Health Behaviors and Beliefs

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The effects of health behaviors and beliefs based on message framing among patients with chronic diseases: A systematic review

Abstract

Objective: The effectiveness of integrating message framing into educational interventions to promote the health behavior of patients with chronic diseases is still being debated in nursing research. The objective of this study is to assess the impact of educational interventions based on gain and loss frames on the health behaviors and beliefs of patients with chronic diseases and identifies the frame that achieves better outcomes.

Design: Systematic review was based on PRISMA guidelines for comprehensively searching, appraising, and synthesizing research evidence.

Data sources: Data were extracted from PubMed, Web of Science, PsycINFO, and CINAHL databases from their inception until March 26, 2021.

Eligibility criteria: Intervention studies with adult patients and chronic disease published in English, and intervention contents involved in the implementation of message framing, were considered. The outcomes were health behaviors or beliefs, such as knowledge, self-efficacy, intention, or attitudes.

Data extraction and synthesis: Data extraction and entry were performed using a pre-designed data extraction form and assessed independently by two reviewers using the Cochrane Collaboration Risk of Bias I.

Results: A total of 11 intervention studies were included. We found that educational intervention based on both gain and loss frames could enhance the positive effects of communication, promote healthy behaviors and beliefs in patients with chronic disease. Many of the studies we included here showed the advantage of loss framing messages, due to the limited number of articles included and without quantitative analysis, this result should be interpreted cautiously.

Conclusions: Integrating message framing into health education might be a promising strategy to motivate patients with chronic disease to improve their health behaviors and beliefs. More extensive and well-designed trials are needed to support the conclusions and discuss the effective framing, moderators and mediators of framing.

PROSPERO registration number: CRD42021250931.

Key words: message framing; chronic diseases; nursing; health behavior; health beliefs; systematic review

Strengths and limitations of this study

► This systematic review has extracted evidence from interventional studies, which had a guiding significance of practice.

► A limited number of randomised clinical trials were included, limiting the quality of the evidence.

► Heterogeneity of different patient samples and health messages and the diversity of outcome measurements did not permit quantitative analysis.

INTRODUCTION

Chronic diseases have become the leading cause of morbidity and mortality worldwide, accounting for 41 million deaths, more than 70% of all deaths, and 80% of total disabilities. [1 2] An aging population, lifestyle factors influencing diseases such as high-fat diets and low levels of physical activity indicate that this trend will continue to increase. [3] More than 300 million people in China have been diagnosed with chronic diseases since 2018. [4] The rising burden of various diseases has increased medical expenses; for example, diabetes, a common chronic disease, according to the International Diabetes Federation, diabetes-related direct medical expenditures amounted to approximately $25 billion in China in 2017. [5] Hence, the treatment and care of chronic diseases pose a significant impact on individuals, their families, and societies, as well as a huge demand to healthcare systems. [6 7]

Providing health-related information and support to patients can encourage them to promote change and maintain their health behavior, improve their psychological and physiological outcomes, [8] which effectively prevent and reduce complications associated with chronic diseases, risk of death, and disease burden. [9] Nurses play a critical role in educating patients about how to improve their health. When it comes to health information, nurses are just as reliable as doctors, and patients prefer to get it from nurses because they are more accessible than doctors. [8 10 11] The number of people developing long-term conditions that in need of nursing care is increasing rapidly.[12] The number of health care professionals, especially registered nurses, is far from meeting the current and future demands. [12 13] Thus, we need to explore a more effective way to deliver messages to patients to maximize the effectiveness of health management education.

The effectiveness of educational messages in promoting behavior change may depend on how the message is presented rather than the meaning of the content itself. Message framing is a message tailoring method that can influence an individual's behavioral decision by adjusting the presentation of a message without changing the

meaning of the content, thereby promoting a particular behavior. [14] The most common method is to develop a message based on the gain (positive) or loss (negative) frame. The benefits of adopting the target behavior are typically emphasized in gain-framing messages, whereas the costs of not adopting the target behavior are stressed in loss-framing information. [14] In O'Keefe and Jensen's reviews, they found that positive frames were slighter better for disease prevention. However, when they classified disease prevention behaviors, only a slight advantage of positive framing was showed in dental hygiene behavior, while there was no difference between the two frames for other disease prevention behaviors such as diet/nutrition behaviors, or exercise behaviors.[15 16.]

Reviewing the past literature, several studies on health-related behaviors such as smoking, [17] physical activity, [18] dental hygiene, [19] have emerged in message framing research. Notably, many studies are examined in messaging framing effect on health-related behaviors in the general population rather than representative samples of people suffering from various diesases or high risk groups, such as diabetes and cardiovascular diseases. [20-22] At the same time, the effects of message framing on chronic disease education are inconsistent. For example, Grady et al. found that a gain-framed foot care message was more effective in changing foot care behavior in patients with diabetes. [23] In contrast, Lee and Gu's study showed that loss-framed foot care message was more effective in activating attitudes and intentions to conduct foot care in patients with diabetes. [24]

There are many opportunities in nursing to provide patient health information in various settings, ranging from the distribution of written materials to teaching chronic disease self-management skills. [12] Meanwhile, patients feel more open and free to communicate with nurses. [11] Thus, nurses have significant opportunities to use message framing to provide health information. The primary purpose of this study was to review the impact of message framing educational interventions on the health behaviors and beliefs of patients with chronic disease, and to inform the design of

future health information interventions.

METHODS

Search strategy

This systematic review was carried out based on the PRISMA guidelines [25] and recommendations of the Cochrane Collaboration. [26] There was no need for ethical approval because the literature analyzed in this study was from previously published studies. The PROSPERO registration number is CRD42021250931.

We searched for studies published in PubMed, Web of Science, PsycINFO, and CINAHL from their inception to March 26, 2021. Terms related to message framing and chronic diseases used in this article were retrieved, including message framing, information framing, gain-framed, loss-framed, gain fram*, loss fram*, positive fram*, negative fram*, framing effect*, noncommunicable diseases, comorbidity, multimorbidity, chronic disease, chronic illness, chronic condition, long term condition, long term illness. The search strategies of each database are available in the in the Supplementary file 1. The reference lists of included and relevant publications were manually screened for additional articles.

Study selection

The inclusion criteria included adult patients aged 18 years or older with chronic diseases (persist and require care over time, such as cardiovascular conditions, diabetes, and cancer), [27] [28] intervention contents involved in the application of message framing, and intervention studies (randomized controlled trials or quasi-experimental studies) published as peer-reviewed full-text articles in the English language. Messages could be delivered in paper or electronic form, and there were no restrictions on who had delivered the intervention. These studies measured health behavior or beliefs such as knowledge, self-efficacy, intention, or attitude. Exclusion criteria included articles from patients with severe mental disorders or cognitive impairment.

The retrieval results were imported into Endnote X 20 for literature management. Following the removal of duplicates, two independent researchers (RG, YL) screened the title, abstract and full text based on the pre-established inclusion and exclusion criteria. If they found any disagreement, it was resolved by a third independent researcher (HG).

Data extraction and analysis

Data extraction and entry were performed using a pre-designed data extraction form, including first author, year of publication, country, sample size, gender, age, key contents of intervention, outcome measures, and findings. Two independent researchers completed data extraction (RG, LX), and if there was any disagreement or uncertainty, it was arbitrated and resolved by a third independent researcher (FL).

Although our initial goal was to complete a systematic review and meta-analysis, quantitative analysis could not carry out due to the large statistical and clinical heterogeneity of the literature.

Quality assessment

Two independent researchers (RG, MS) completed the quality assessment of the included articles using Cochrane Collaboration Risk of Bias I. [29] If they found any uncertainty or difference in opinion, it was resolved by a third independent researcher (TY). For quasi-experimental studies without randomization, the item of random sequence generation of selection bias was automatically identified as high risk. [30 31]

Patient and public involvement

Neither patients nor the public were involved in this research.

RESULT

Literature search

After removing duplicate literature and screening the titles and abstracts, 2253 pieces

of literature were systematically retrieved, with 42 articles were read the full text. A total of eleven studies were included, [23 32–41] ten randomized controlled trials (RCT), and one quasi-experimental study [33] based on previously established inclusion and exclusion criteria. Figure 1 illustrates the literature screening process.

Characteristics of the included studies

The included studies were published between 2004 and 2020 and came from Korea, Philippines, the United Kingdom, China, the United States and Canada. The number of participants ranged from 49 to 1,108, for a total of 2,216, with a mean age ranging from 40 to 71 and a male proportion of 43.7%.

Diabetes, cardiovascular disease, and cancer are the most common chronic diseases addressed in the included literature. [23 32 33 35 36 41] Seven studies were set up in two groups, with one receiving educational intervention based on gain frame, and the other group receiving educational intervention based on loss frame. [23 32 34-36 39 40] Only four studies were set up in three groups: a gain-framed group, a loss frame group, and a standard control group for providing usual care, with no message framing. [33 37 38 41] The gain framing condition highlighted the positive outcomes of completing or adhering to the healthy behavior, whereas the loss framing condition emphasized the undesirable consequences of failing to comply or adhere to the healthy behavior, which corresponded to the positive framing outcomes. Messages were delivered via video, pamphlet, and online message. Nine studies only once conducted intervention, [23 32-35 37-40] and two studies sent the pamphlet to patients to take home for further reading. [36 41] Supplementary file 2 presents specific information about the included studies.

Quality assessment of the included studies

Regarding selection bias, two RCT described adequate random sequence generation [32 37] and other eight RCT reported randomization but did not report a specific method. [23 34-36 38-41] One quasi-experimental study, non-randomized sampling was used;

participants were just assigned to different groups in separate days for a single time, identified as high risk. [33] Only one studies reported adequate allocation concealment, [32] and the other ten were rated as having an unclear risk of bias due to insufficient information.[23 33-41] Only two studies showed a low risk of performance bias. [33 39] The risk of detection bias was rated as unclear risk as none of the eleven articles indicated whether the blind method was applied to the outcome assessment.[23 32-41] Regarding attrition bias, eleven studies were rated as low risk bias. [23 32-41] The report and other sources bias of the eleven studies were rated as having an unclear risk of bias due to insufficient information. [23 32-41] Figures 2 and 3 summarize the quality assessment of the included studies.

Main effects of framing

Several studies have reported effects on numerous outcomes. Six studies assessed outcomes immediately after the intervention, [32–34 37 38 40] and five studies measured actual behavior from four weeks to 12 months of follow-up. [23 35 36 39 41] The content of message intervention primarily focused on healthy behaviors such as physical activity, medical adherence, and self-management for patients with chronic disease. However, the outcomes measured in the eleven studies were too diverse to analyze quantitatively. Supplementary file 3 presents a summary of findings from the studies included in this review.

Several studies reported significant main or interactive effects of framing. Among the included studies, five studies mainly explored the influence of educational intervention based on message framing on self-management behavior and related cognitive variables of patients with chronic disease. [23 32-34 40] Three of the five studies showed the advantage of loss framing messages. [32 33 40] Two studies found that loss-framed message was superior to gain-framed for improving the scores of intention, attitude, and knowledge of self-management behavior in patients with diabetes. However, the increase in intention and knowledge scores did not meet the criteria for statistical difference. [32 33] One study found that loss-framed messages

contributed more knowledge gain than gain-framed patients with chronic pain. [40] On the other hand, one study found that a gain-framed was slightly superior to a loss-framed message in sustaining long-term foot care behavior change. [23] Anthor study of patients with psoriasis found that when messages focused on long-term health risk, loss-framed messages were more persuasive to improving in reducing alcohol intake intention, while messages focused on short-term health risk, gain-framed messages were more persuasive than loss-framed messages. [34]

Four studies mainly explored the influence of educational intervention based on message framing on physical activity and related cognitive variables in patients with chronic disease. [35-37 41] Three of the four studies showed the advantage of loss framing messages. [35-37] One study found that loss-framed messages contributed more physical activity gain than gain-framed in patients with diabetes. [35] Furthermore, one study found that in patients with spinal cord injury, the loss-framed group increased their physical activity intention than the gain-framed group and the usual care group, while there was no significant difference between the physical activity intention in the gain-frame group and the usual care group. [37] One study reported that both gain and loss-framed messages resulted in more physical activity than at baseline, and increased more in the loss-framed group, but the difference between the two groups did not reach statistical significance; neither gain nor loss-framing elicited higher physical activity intention or attitude. [36] In contrast, one study found that a gain-framed was slightly superior to a loss-framed message in improving exercise adherence among patients with cardiovascular disease. [41]

Two studies primarily explored the influence of educational intervention based on message framing on adherence to medicine and treatment therapy and related cognitive variables in patients with chronic disease. [38 39] One study reported that loss-framed messages increased adherence to treatment therapy and self-efficacy more than gain-framed in patients with cardiovascular disease. [39] Another study found that when compared to the usual care group, both gain- and loss-framed messages lead to higher medicine adherence intention and attitude, but without a difference

between the two conditions. [38]

Moderator and mediator variables of framing effects

Several studies focused on moderators and mediators of framing effects. In particular, Park et al. reported that message framing had a significant indirect impact on intentions for diabetes self-care behavior, mediated through attitudes and perceived control, but no significant differences between message framing groups. [32] Grady et al. performed regression analyses after the intervention. They found that changes in knowledge predicted changes in attitudes and that both framing and attitudes were predictors of long-term diabetes self-managemnt behavior. [23] Nevertheless, McCall's study observed no mediating effects between health belief model constructs and messages. [41]

Zhao et al. investigated the interaction between frames and individual time perspective considering future consequences (CFC). They found a significant interaction between the two, which showed that among high-CFC patients, both gain- and loss-framed messages heightened medicine adherence intention and attitude toward no-message control. The message exposure did not affect the two outcomes in low- and medium-CFC participants.[38]

DISCUSSION

Patients with chronic diseases need to maintain long-term health behaviors to avoid complications and improve their quality of life. It is necessary to explore the most effective method of conveying health educational information to patients to minimize the nurses' workload and improve patients' health behaviors. Message framing, as an effective message tailoring strategy, provides a new perspective for achieving this goal by increasing the persuasiveness in promotion of healthy behaviors. Hence, we summarized the research on the influence of educational interventions based on message framing on health behavior and related cognitive variables in patients with long-term illnesses. This research found that most studies showed educational

message intervention based on the gain and loss frame that could effectively improve health behaviors and cognitive variables such as health behavior knowledge, intention, attitude, self-efficacy of patients with chronic diseases. Previous studies have suggested that gain framing is more effective for preventive behavior, but not concluded in this study. Many of the studies we included in this review showed the advantage of loss framing messages, but due to the limited number of included articles and lack of quantitative analysis, this result should be interpreted with caution.

The persuasion of gain and loss framing appeal seems to be more complicated than previously thought. Many patients with chronic disease may have low health awareness and health literacy. [42 43] The loss framing might be more efficacious if people do not intend to take action in the foreseeable future and are unaware of the issues related to their behavior. [44] Besides, individuals weigh the benefits of engaging in healthy behaviors (such as reducing symptoms and improving mood) against the potential costs (such as the time and effort spent learning a new skill). [40] Individuals suffering from chronic diseases, who typically have a long history of illness, may have had a learning history and outcome expectation (e.g., perceived importance) that may have resulted in an avoidance tendency toward health behavior. [45] Individuals with a dominant avoidance tendency typically respond more strongly to threat cues, [46] making them more receptive to loss-framing encouragement. [47] However, no relevant variables were assessed in this study; we only proposed a research hypothesis that requires further investigation.

Fewer studies have explored the potential mechanism of message frames, which is of great significance for designing and applying message intervention. These studies found that attitudes and intentions may act as mediating factors of framing effect on behavior, consistent with the theory of planned behavior. [23 32 48] A negative frame may allow patients without behavior change awareness to develop attitudes and behavioral intentions, thereby promoting behavior. The interaction between message frame and individual time perspective also suggests that individual factors must be

considered. [38] Matching frames with individual factors may have a greater framing effect and help to promote the occurrence or maintenance of healthy behaviors. This is consistent with the view raised by Latimer et al. that the effectiveness of the message frame may be dependent on the individual's thinking and feeling about behavior, rather than just the function or nature of the behavior itself.[49 50] Failing the influence of individual differences on message framing effects may suppress the true framing effect and underestimate the utility of gain and loss-framed appeals. [49]

Limitations

This review offers critical insights into the impact of message-framed education on health behaviors of chronic disease patients; however, several limitations have to be considered. Although we retrieved a considerable amount of literature from the database, only 11 articles met the inclusion criteria used in the present study. In the analysis, heterogeneity of different patient samples and health messages, and the diversity of outcome measurements did not permit a quantitative analysis, limiting the reliability of conclusions. Furthermore, this review only included research reported in English, which may exclude some studies; language constraints are also associated with potential bias in this systematic reviews. Only five studies measured actual behavior changes, and only six studies just measured changes in cognitive variables immediately after the intervention. Of course, we know that there is still some distance between the initiation of behavioral intention to the occurrence and the maintenance of actual behavior. Hence, future research needs to determine the effects of message framing on actual behavior through long-term observation or objective measurement. Few studies have been explored the underlying mechanisms of the influence of message framing on behavioral or cognitive variables. Future studies also need to explore the different effects of message framing according to the advocated behavior and consider participants' existing beliefs and perceptions about the behavior. [50 51] However, in general, the included studies have relatively high bias risk and low methodological quality, limiting the reliability of the results. Therefore, with

these limitations of the present review, interpretation of the results should be made with caution.

Implications for nursing

One of the primary goals of this research is to provide suggestions for nurses and other healthcare professionals, extend the message framing effect to chronic disease education interventions and improve patients' health, well-being, and quality of life. The present findings add to the growing evidence that the way health education messages are delivered and impacts more than the meaning of the content of messages. Proper design and delivery of messages can improve the persuasiveness of education, effectiveness, and efficiency, enabling patients with chronic disease to adopt and maintain health promotion behaviors. Furthermore, by empowering patients to be active decision-makers rather than passive nursing recipients, patients' role in managing health-related issues can be strengthened.

CONCLUSION

Message framing can be an effective tool for encouraging health promotion information to promote health behaviors and beliefs in patients with chronic diseases. Besides, integration of message framing, especially loss framing into health education might be a promising strategy for motivating patients with chronic disease to improve health behaviors and related cognitive variables. However, no firm recommendation could be made of this study. The best framework for improving the actual health behavior of patients with chronic disease, as well as its potential moderators and mediators, need to be studied further and strengthened in to guide health education.

Author contributions

RG and FL performed the conception and design of the study, drafting the article or revising it critically for important intellectual content. RG, HG, FL, YL and LX performed the acquisition of data, or analysis and interpretation of data. RG, MS and TY performed the quality assessment. All authors read and final approval of the version to be submitted.

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Competing interests We declare no competing interests.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No additional data are available.

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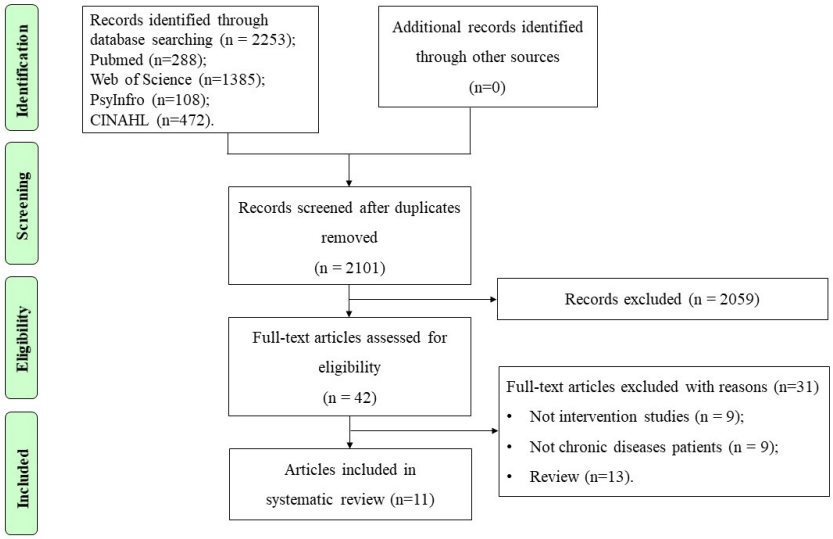
Figure legend

Figure 1 Flowchart of the literature search

Figure 2 Risk of bias assessment

Figure 3 Risk of bias summary



7 Figure 1 Flowchart of the literature search

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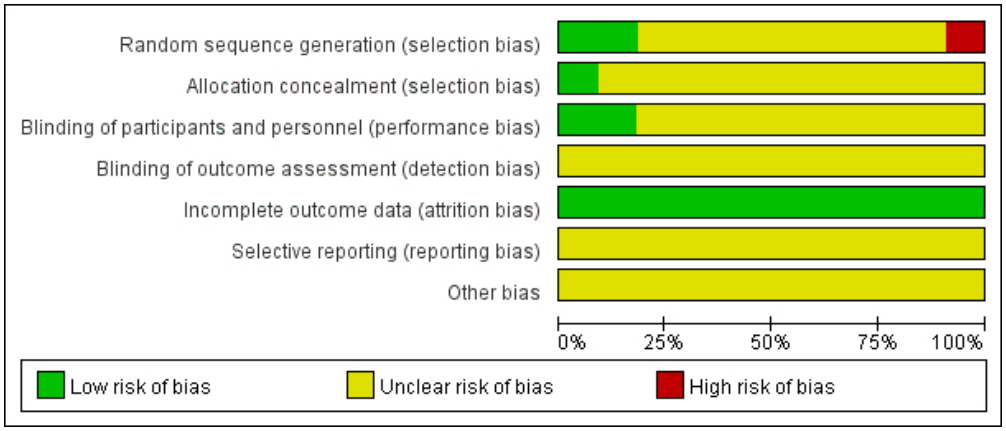

Figure 2 Risk of bias assessment

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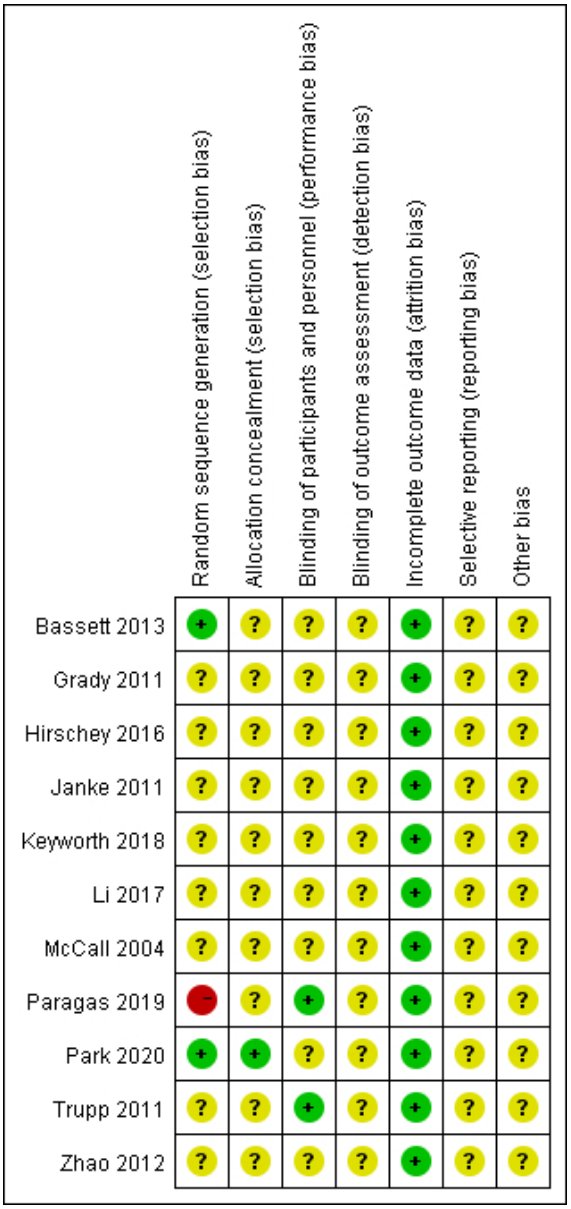

Figure 3 Risk of bias summary

111x236mm (72 x 72 DPI)

Supplementary file 1: Search strategy

This Supplementary file provides the search strategy details, performed March 26, 2021.

1. Pubmed	
#1	Search: ((((((((((((message framing[Title/Abstract]) OR (message fram*[Title/Abstract])) OR (information framing[Title/Abstract])) OR (information fram*[Title/Abstract])) OR (gain-framed[Title/Abstract])) OR (loss-framed[Title/Abstract])) OR (gain fram*[Title/Abstract])) OR (loss fram*[Title/Abstract])) OR (positive frame[Title/Abstract])) OR (positive fram*[Title/Abstract])) OR (negative frame[Title/Abstract])) OR (negative fram*[Title/Abstract])) OR (goal fram*[Title/Abstract])) OR (framing effect*[Title/Abstract])
#2	Search: ((((((((((((((((((((Heart disease[MeSH]) OR (Cardiovascular disease[MeSH])) OR (Heart Failure[MeSH])) OR (Hypertension[MeSH])) OR (Stroke[MeSH])) OR (Diabetes Mellitus[MeSH])) OR (Metabolic syndrome[MeSH])) OR (Neoplasms[MeSH])) OR (Pulmonary Disease, Chronic Obstructive[MeSH])) OR (Lung Diseases[MeSH])) OR (Alzheimer disease[MeSH])) OR (Dementia[MeSH])) OR (Asthma[MeSH])) OR (Hepatitis[MeSH])) OR (Fatty Liver[MeSH])) OR (Kidney diseases[MeSH])) OR (Pain[MeSH])) OR (Psoriasis[MeSH])) OR (Fibromyalgia[MeSH])) OR (Multiple Sclerosis[MeSH])) OR (Arthritis[MeSH])) OR (Osteoporosis[MeSH])) OR (((((Noncommunicable Diseases[MeSH]) OR (Comorbidity[MeSH])) OR (Multimorbidity[MeSH])) OR (Chronic disease[MeSH])) OR (Chronic illness[MeSH]))
#3	Search: ((((((((((((((((((((((((((((((((non communicable[Title/Abstract]) OR (noncommunicable[Title/Abstract])) OR (NCD[Title/Abstract])) OR (comorbidity[Title/Abstract])) OR (multimorbidity[Title/Abstract])) OR (chronic disease[Title/Abstract])) OR (chronic condition[Title/Abstract])) OR (chronic illness[Title/Abstract])) OR (long term condition[Title/Abstract])) OR (long term ill[Title/Abstract])) OR (cardi*[Title/Abstract])) OR (heart disease[Title/Abstract])) OR (cardiovascular disease[Title/Abstract])) OR (Heart Failure[Title/Abstract])) OR (high blood pressure[Title/Abstract])) OR (hypertension[Title/Abstract])) OR (Stroke[Title/Abstract])) OR (diabet*[Title/Abstract])) OR (Diabetes[Title/Abstract])) OR (metabolic syndrome[Title/Abstract])) OR (cancer[Title/Abstract])) OR (neoplasm[Title/Abstract])) OR (chronic obstructive pulmonary disease[Title/Abstract])) OR (chronic respir*[Title/Abstract])) OR (Lung Diseases[Title/Abstract])) OR (respiratory disease*[Title/Abstract])) OR (Alzheimer disease[Title/Abstract])) OR (dementia[Title/Abstract])) OR (psoriasis[Title/Abstract])) OR (Asthma[Title/Abstract])) OR (Hepatitis[Title/Abstract])) OR (Fatty Liver[Title/Abstract])) OR (Kidney disease*[Title/Abstract])) OR (Pain[Title/Abstract])) OR (Fibromyalgia[Title/Abstract])) OR (multiple sclerosis[Title/Abstract])) OR (Arthritis[Title/Abstract])) OR (Osteoporosis[Title/Abstract])
#4	#2 OR #3
#5	#1 AND #4 Filters: English

	Items found: 288
2. Web of Science	
#1	message framing (TS) or message fram* (TS) or information framing (TS) or information fram* (TS) or gain-framed (TS) or loss-framed (TS) or gain fram* (TS) or loss fram* (TS) or positive frame (TS) or positive fram* (TS) or negative frame (TS) or negative fram* (TS) or goal fram* (TS) or framing effect* (TS)
#2	non communicable (TS) or noncommunicable (TS) or NCD (TS) or comorbidity (TS) or multimorbidity (TS) or chronic disease (TS) or chronic condition (TS) or chronic illness (TS) or long term condition (TS) or long term ill (TS) or cardi* (TS) or heart disease (TS) or cardiovascular disease (TS) or Heart Failure (TS) or high blood pressure (TS) or hypertension (TS) or Stroke (TS) or diabet* (TS) or Diabetes (TS) or metabolic syndrome (TS) or cancer (TS) or neoplasm (TS) or chronic obstructive pulmonary disease (TS) or chronic respir* (TS) or Lung Diseases (TS) or respiratory disease* (TS) or Alzheimer disease (TS) or dementia (TS) or psoriasis (TS) or Asthma (TS) or Hepatitis (TS) or Fatty Liver (TS) or Kidney disease* (TS) or Pain (TS) or Fibromyalgia (TS) or multiple sclerosis (TS) or Arthritis (TS) or Osteoporosis (TS)
#3	#1 AND #2 Filters: English; Not conference abstract/review Items found: 1385
3. CINAHL	
S1	TI message framing OR TI negative fram* OR TI negative frame OR TI information framing OR TI message fram* OR TI information fram* OR TI loss-framed OR TI gain fram* OR TI gain-framed
S2	TI loss fram* OR TI positive frame OR TI positive fram* OR TI goal fram* OR TI framing effect*
S3	AB message framing OR AB message fram* OR AB information framing OR AB gain-framed OR AB information fram* OR AB loss-framed OR AB gain fram* OR AB loss fram*
S4	AB positive frame OR AB positive fram* OR AB negative fram* OR AB negative frame OR AB goal fram* OR AB framing effect*
S5	S1 OR S2 OR S3 OR S4
S6	TI non communicable OR TI noncommunicable OR TI NCD OR TI comorbidity OR TI multimorbidity OR TI chronic illness OR TI long term ill OR TI chronic disease OR TI long term condition OR TI chronic condition OR TI cardi* OR TI heart disease
S7	AB non communicable OR AB NCD OR AB noncommunicable OR AB comorbidity OR AB multimorbidity OR AB chronic illness OR AB chronic disease OR AB chronic condition OR AB long term condition OR AB long term ill OR AB cardi* OR AB heart disease
S8	TI cardiovascular disease OR TI high blood pressure OR TI hypertension OR TI Heart Failure OR TI Stroke OR TI diabet* OR TI Diabetes OR TI metabolic syndrome OR TI chronic obstructive pulmonary disease OR TI chronic respir* OR TI cancer OR TI neoplasm
S9	AB cardiovascular disease OR AB Heart Failure OR AB high blood pressure OR AB hypertension OR AB Stroke OR AB diabet* OR AB Diabetes OR AB metabolic

	syndrome OR AB cancer OR AB neoplasm OR AB chronic obstructive pulmonary disease OR AB chronic respir*
S10	TI Lung Diseases OR TI respiratory disease* OR TI Alzheimer disease OR TI dementia OR TI psoriasis OR TI Asthma OR TI Hepatitis OR TI Fatty Liver OR TI Kidney disease* OR TI Pain OR TI Fibromyalgia OR TI multiple sclerosis
S11	AB Lung Diseases OR AB respiratory disease* OR AB Asthma OR AB Kidney disease* OR AB Alzheimer disease OR AB dementia OR AB psoriasis OR AB Hepatitis OR AB Fatty Liver OR AB Pain OR AB Fibromyalgia OR AB multiple sclerosis
S12	TI Arthritis OR TI Osteoporosis OR AB Arthritis OR AB Osteoporosis
S13	S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12
S14	S5 AND S13 Filter: English, Human, Adult Items found: 472
4. PsycINFO	
S1	TI message framing OR TI message fram* OR TI information framing OR TI information fram* OR TI loss-framed OR TI gain-framed OR TI gain fram* OR TI loss fram* OR TI positive frame OR TI positive fram* OR TI negative frame OR TI negative fram*
S2	AB message framing OR AB message fram* OR AB information framing OR AB information fram* OR AB loss-framed OR AB gain-framed OR AB gain fram* OR AB loss fram* OR AB positive frame OR AB positive fram* OR AB negative frame OR AB negative fram*
S3	AB goal fram* OR AB framing effect* OR TI goal fram* OR TI framing effect*
S4	S1 OR S2 OR S3
S5	TI non communicable OR TI noncommunicable OR TI NCD OR TI comorbidity OR TI multimorbidity OR TI chronic disease OR TI long term condition OR TI chronic condition OR TI chronic illness OR TI long term ill OR TI cardi* OR TI heart disease
S6	AB non communicable OR AB noncommunicable OR AB NCD OR AB comorbidity OR AB multimorbidity OR AB chronic disease OR AB long term condition OR AB chronic condition OR AB chronic illness OR AB long term ill OR AB cardi* OR AB heart disease
S7	AB cardiovascular disease OR AB Heart Failure OR AB high blood pressure OR AB hypertension OR AB Stroke OR AB diabet* OR AB Diabetes OR AB metabolic syndrome OR AB cancer OR AB neoplasm OR AB chronic obstructive pulmonary disease OR AB chronic respir*
S8	TI cardiovascular disease OR TI Heart Failure OR TI high blood pressure OR TI hypertension OR TI Stroke OR TI diabet* OR TI Diabetes OR TI metabolic syndrome OR TI cancer OR TI neoplasm OR TI chronic obstructive pulmonary disease OR TI chronic respir*
S9	TI Lung Diseases OR TI respiratory disease* OR TI Alzheimer disease OR TI dementia OR TI psoriasis OR TI Asthma OR TI Hepatitis OR TI Fatty Liver OR TI Kidney disease* OR TI Pain OR TI Fibromyalgia OR TI multiple sclerosis
S10	AB Lung Diseases OR AB respiratory disease* OR AB Alzheimer disease OR AB dementia OR AB psoriasis OR AB Asthma OR AB Hepatitis OR AB Fatty Liver OR AB

	Kidney disease* OR AB Pain OR AB Fibromyalgia OR AB multiple sclerosis
S11	AB Arthritis OR AB Osteoporosis OR TI Arthritis OR TI Osteoporosis
S12	S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11
S13	S4 AND S12 Filter: English, Human, Adult Items found: 108

Supplementary file 2: Characteristics of studies included in this systematic review.

Authors Year Design	Population	Group	Sample Size (M/F) Age (years)	Key component of intervention		
				Content	Frame	Format/ Dose
Park [32] 2020 RCT	Diabetes	Gain-frame	26 (10/16) 65.65±10.61	Content pertaining to diabetic complications in diabetes.	Gain framing presented positive outcomes resulting from adherence to a diabetes care regimen, showing a patient success story about proper diabetes self-care.	Video 1
		Loss-frame	26 (6/20) 64.92±12.21		Loss framing presented undesirable consequences resulting from failure to comply with a diabetes care regimen, showing a story about a patient with diabetic complications caused by inadequate diabetes self-care.	
Paragas [33] 2019 Quasi-experimental study	Diabetes	Gain-frame	55 (25/30) 58.95±10.25	Definition of diabetes, teachings about blood glucose monitoring; proper diet and exercise; oral hypoglycemic agents; recognition, treatment, and prevention of hypoglycemia and hyperglycemia.	Gain-framed video comprised 10 positive outcomes of adherence to diabetes self-care in the last scenes of videos, e.g. one statement was "If you maintain good control of your blood glucose, the acid in your blood will be normal, and being comatose will be prevented," with a scene showing a healthy person.	Video/ Lecture 1
		Loss-frame	55 (25/30) 58.60±10.23		Loss-framed video contained 10 negative outcomes of non-adherence in the last scenes of videos, e. g. one version was "If you do not maintain good control of your blood glucose, the acid in your blood will be elevated that could lead to being comatose," with a scene showing a comatose patient.	
		No-frame	55 (24/31) 58.96±9.74		Standard approach of providing health teachings about diabetes self-care, with no message framing.	
Keyworth [34] 2018 RCT	Psoriasis	Gain-frame	217(75/126) 41.23±14.31	Information about the effects of health behavior change on either psoriasis symptoms or CVD risk.	Gain-framed message addressed the positive outcomes for adherence to the health behaviors, e. g. "Research shows that risk factors for cardiovascular disease include smoking, having a poor diet, having insufficient physical activity, and drinking excessive amounts of alcohol. By making changes to your lifestyle, you [lower] your risk of cardiovascular disease."	Sheet 1
		Loss-frame			Loss-framed message addressed the negative outcomes for not adherence to the health behaviors, e. g. "Research shows that risk factors for cardiovascular disease include smoking, having a poor diet, having insufficient physical activity, and drinking excessive amounts of alcohol. By [not] making changes to your lifestyle, you [increase] your risk of cardiovascular disease."	
Li [35]	Diabetes	Gain-	211	The pamphlet included a brief	Gain-framed pamphlet contained the benefits of PA participation, including physical (11 items: e.g., improve	Pamphlet

2017 RCT		frame	(101/110) 71.41±6.80	description of PA participation in Hong Kong, the recommended PA level.	muscle strength), psychological (8 items: e.g., improve mood), and social (4 items: expand social network) domains.	1
		Loss-frame			Loss-framed pamphlet contained the absence of benefits of PA participation. The contents of the benefits were identical between the gain- and loss-framed messages, with differences only in the framing of the messages.	
Hirschey [36] 2016 RCT	CRC	Gain-frame	78 (36/42) 64.3 (29.9–98.4)	Tips on how to become more physically active with examples of activities of MIPA; protective influence of PA on CRC co-morbid conditions; inverse relationship between PA and risk of cancer-specific mortality and all-cause mortality.	Gain-framed version addresses the benefits of being physically active.	Pamphlet / taken home to read
		Loss-frame	70 (35/35) 65.4 (43.2–88.5)		Loss-framed version addresses the disadvantages of not being physically active.	
Bassett [37] 2013 RCT	SCI	Gain-frame	94 (57/37) 45±12	Benefits or risks quotations from SCI experts and research evidence.	Gain-framed messages outlined the benefits of engaging in regular LTPA (i.e. Adding LTPA to your day can help you manage your pain gain framed)	Online message 1
		Loss-frame			Loss-framed messages outlined the risks of not engaging in regular LTPA. (i.e., By not adding LTPA to your day you miss an opportunity to manage your pain)	
		No-frame		Usual care	The control group did not receive any additional information.	
Zhao [38] 2012 RCT	Chronic diseases	Gain-frame	1108 (411/697) 40-85	Messages addressing perceived need and perceived concerns about medications, messages content was held the same across the two frames.	Gain-framed messages outlined the benefits of adherence to medication taking (i.e. You may wonder whether you really need your prescription medication. But taking your medicine as directed is very important even if you don't feel sick. It's the first step toward long-term health. Talk to your doctor about your medicine and changes you can make to your lifestyle to help manage your condition.)	Online message 1
		Loss-frame			Loss-framed messages outlined the negative outcomes of not adherence to medication taking. (i.e., You may wonder whether you really need your prescription medication. But not taking your medicine is very dangerous to your health, even when you don't have symptoms. Your condition can get worse. If you don't talk to your doctor about your medicine or other lifestyle questions, you can miss out on information that can help your condition.)	

		No-frame		Usual care	The control group did not receive any additional information.	
Trupp [39] 2011 RCT	CVD with OSA	Gain-frame	26 (19/7) 29-74	A brief, about 50 seconds educational video about CPAP was provided.	Gain-framed video positively focused on the benefits associated with CPAP use.	Video 1
		Loss-frame	29 (17/12) 38-77		Loss-framed video negatively emphasized the negative consequences that may occur if CPAP was not worn as directed.	
Janke [40] 2011 RCT	Chronic pain	Gain-frame	62 (61/1) 50	Messages stressed the importance of the patient playing an active role in their pain care and techniques could use to help manage pain.	Gain-framed messages emphasized the gains patients would make if they engage in these behaviors.	Pamphlet 1
		Loss-frame			Loss-framed messages focused on the losses they would realize if they did not do these things.	
Grady [23] 2011 RCT	Diabetes	Gain-frame	155 (64 /91) 61.2±11.4	The video addressed topics about foot care such as cleaning procedures, toenail care, footwear use, and foot and footwear inspection procedures.	Gain-framed version offered the positive outcome that can accrue by appropriate foot care, e.g. "Good foot care can help you avoid the serious complications of nerve and blood vessel damage, and keep your feet healthy" (with a picture of healthy feet).	Video 1
		Loss-frame			Loss-framed version offered the negative outcome that can accrue if the desired behavior is not followed, e.g. "Poor foot care can lead to the serious complications of nerve and blood vessel damage, and unhealthy feet" (with a picture of a foot with an infected sore).	
McCall [41] 2004 RCT	CVD	Gain-frame	16 (15/1)	Statements regarding the effects of exercise in relation to CAD.	Gain-framed condition listed 10 gain-framed statements regarding the benefits of exercise in relation to the progression of CAD. (i.e., Regular exercise will help you maintain a healthy body weight.)	Sheet /taken home to read
		Loss-frame	13 (12/1)		Loss-framed condition with the same 10 statements phrased in a loss-framed manner. (i.e., By not exercising regularly, you decrease your chances of keeping a healthy body weight.)	
		No-frame	20 (19/1)	Usual care	The control group did not receive any additional information.	

Abbreviations: CAD: Coronary artery diseases; CRC: Colorectal cancer; CVD: Cardiovascular disease; LTPA: Leisure time physical activity; MIPA: Moderate intensity physical activity; NR: Not report; OSA: Obstructive sleep apnea; PA: Physical activity; RCT: Randomized controlled trial; SCI: Spinal cord injury; T2D: Type 2 diabetes.

Supplementary file 3: Summary of findings of studies included in this systematic review.

Authors Year	Outcome measures and collection time	Main findings	Mediators/Moderators
Park [32] 2020	Attitudes, perceived control and intentions for diabetes self-care behavior. All measured at post-intervention.	Attitudes: Loss-framed group improved more; Perceived control: Loss-framed group improved more; Intentions: Both conditions produced significant increases, but no group difference.	Significant indirect effect of message framing on intentions for diabetes self-care behavior mediated through attitudes and perceived control. No significant interaction effects were observed between health literacy level and message framing.
Paragas [33] 2019	Diabetes self-management knowledge and self-efficacy. All measured at pre- and post-intervention.	Knowledge: Both loss-framed and gain framed group improved more, but no difference between the two; Self-efficacy: Both loss- and gain- framed group improved, and gain framed group improved more.	NR
Keyworth [34] 2018	Self-care behavior intention. Measured at post-intervention.	Intention: Messages focused on short-term health risk, gain-framed messages more persuasive than loss-framed messages; messages about long-term health risk, loss-framed message more persuasive than gain-framed message	A significant frame by focus interaction was found for behavioral intention to reduce alcohol intake.
Li [35] 2017	PA. Measured at pre-intervention and 2-week follow up: PA.	PA: Loss-framed group improved more.	NR
Hirschey [36] 2016	PA, attitudes, subjective norms, perceived behavioral control, intention. PA and intention were measured at pre- and post-intervention, 1-and 12-months follow up; Attitudes, subjective norms and perceived behavioral control measured at pre-intervention and 1-month follow up.	PA: Both conditions produced significant increases in PA, with no differences between framing conditions; TPB constructs: Neither the gain- nor loss-framed brochures produced significant changes from baseline to the 1- and 12-months follow-up.	NR
Bassett [37] 2013	PA response efficacy and intention. All measured at pre- and post-intervention.	LTPA response efficacy: Loss-framed condition increased more than gain-framed and control conditions, no difference	NR

		between gain-framed and control conditions; Intention: Loss-framed condition increased more than gain-framed and control conditions, no difference between gain-framed and control conditions.	
Zhao [38] 2012	Medicine adherence intention and attitude. All measured at post-intervention.	Intention: Gain- and loss-framed messages improved more than control, no difference between gain- and loss-framed conditions; Attitude: Gain- and loss-framed messages improved more than control, no difference between gain- and loss-framed conditions.	Significant interaction between frames and CFC, among high-CFC patients, both gain- and loss-framed messages heightened intention ad attitude with respect to the no-message control, gain frame showed a consistent superior to the loss frame. Message exposure had not effect on the two outcomes for low-and medium-CFC participants.
Trupp [39] 2011	Adherence to CPAP, self-efficacy. CPAP use was measured at post-intervention; Self-efficacy was measured at pre- and post-intervention.	CPAP use: Loss-framed group improved more; Self-efficacy: Both conditions improved, Loss-framed group improved more than gain-framed group.	NR
Janke [40] 2011	Knowledge, pain self-efficacy, pain readiness to change, pain self-management behavioral skills. Pain self-efficacy, pain readiness to change were measured at pre-intervention; Knowledge, pain self-management behavioral skills were measured at post-intervention.	Knowledge: Loss-framed group improved more; Confidence to practice relaxation: Loss-framed group improved more.	Pain self-efficacy, pain readiness to change and message frame independently influenced motivation to engage in relaxation. There were no observed interactions between message frame and either self-efficacy or readiness to change.
Grady [23] 2011	Knowledge, attitude, foot care behaviors. Knowledge and attitude were measured at pre- and post-intervention, 3- and 6-month follow-ups; Foot care behaviors were measured at pre-intervention, 3- and 6-month follow-ups.	Foot care behaviors: Gain-framed group improved more.	Attitude and framing are significant predictors of 6-months behavior, gain framing positively related to long-term behavior; knowledge affects attitudes, in turn, attitudes affect behavior.

McCall [41] 2004	Adherence to exercise, health belief cognitions (perceived susceptibility, benefits and barriers). Adherence to exercise was measured at 3-months follow-ups; Health belief cognitions were measured at post-intervention.	Adherence to exercise: Gain-framed condition attended more exercise sessions than control; loss-framed group attend more exercise, but no difference with control; Perceived susceptibility: Gain- and loss-framed conditions perceived more susceptibility than control; Perceived barriers: Loss-framed condition perceived grater barriers than gain-framed and control conditions; Perceived benefits: No difference among the three conditions.	HBM constructs did not mediate the effects of the educational messages.

Abbreviations: CFC: Consideration of future consequences; CPAP: Continuous positive airway pressure; HBM: Health belief model; LTPA: Leisure time physical activity; NR: Not report; PA: Physical activity; TPB: Theory of planned behavior.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1,2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5,6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	none
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	none

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	none
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	none
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6,7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7,8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8,9,10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	none
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	none
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9,10,11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	13
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	14

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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The effects of health behaviors and beliefs based on message framing among patients with chronic diseases: a systematic review

Short running title: Message Framing for Health Behaviors and Beliefs

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Abstract

Objective: The effectiveness of integrating message framing into educational interventions to promote the health behavior of patients with chronic diseases is still being debated in nursing research. The objective of this study was to assess the impact of educational interventions based on gain and loss frames on the health behaviors and beliefs of patients with chronic diseases and to identify the frame that achieves better outcomes.

Design: Systematic review was based on PRISMA guidelines for comprehensively searching, appraising, and synthesizing research evidence.

Data sources: We searched the PubMed, Web of Science, PsycINFO, and CINAHL databases for reports published from database inception until March 26, 2021.

Eligibility criteria: Intervention studies, published in English, with adult patients with chronic disease conditions, and with intervention contents involved in the implementation of message framing, were considered. The outcomes were health behaviors or beliefs, such as knowledge, self-efficacy, intention, or attitudes.

Data extraction and synthesis: Data extraction and entry were performed using a pre-designed data extraction form and assessed independently by two reviewers using the Cochrane Collaboration Risk of Bias I.

Results: A total of 11 intervention studies were included. We found that educational intervention based on both gain and loss frames could enhance the positive effects of

communication, promote healthy behaviors and beliefs in patients with chronic disease. Many of the studies we included here showed the advantage of loss framing messages, due to the limited number of articles included and without quantitative analysis, this result should be interpreted cautiously.

Conclusions: Integrating message framing into health education might be a promising strategy to motivate patients with chronic disease to improve their health behaviors and beliefs. More extensive and well-designed trials are needed to support the conclusions and discuss the effective framing, moderators and mediators of framing.

PROSPERO registration number: CRD42021250931.

Key words: message framing; chronic diseases; nursing; health behavior; health beliefs; systematic review

Strengths and limitations of this study

► This systematic review has extracted evidence from interventional studies, which provided a theoretical and evidence base for practice.

► A limited number of randomised clinical trials were included, limiting the quality of the evidence.

► Heterogeneity of different patient samples and health messages and the diversity of outcome measurements did not permit quantitative analysis.

INTRODUCTION

Chronic diseases have become the leading cause of morbidity and mortality worldwide, accounting for 41 million deaths, more than 70% of all deaths, and 80% of total disabilities. [1 2] An aging population, lifestyle factors influencing diseases such as high-fat diets and low levels of physical activity indicate that this trend will continue to increase. [3] More than 300 million people in China have been diagnosed with chronic diseases since 2018. [4] The rising burden of various diseases has increased medical expenses; for example, diabetes, a common chronic disease, according to the International Diabetes Federation, diabetes-related direct medical expenditures amounted to approximately $25 billion in China in 2017. [5] Hence, the treatment and care of chronic diseases pose a significant impact on individuals, their families, and societies, as well as a huge demand to healthcare systems. [6 7]

Providing health-related information and support to patients can encourage them to promote change and maintain their health behavior, improve their psychological and physiological outcomes, [8] which effectively prevent and reduce complications associated with chronic diseases, risk of death, and disease burden. [9] Nurses play a critical role in educating patients about how to improve their health. When it comes to health information, nurses are just as reliable as doctors, and patients prefer to get it from nurses because they are more accessible than doctors. [8 10 11] The number of people developing long-term conditions that in need of nursing care is increasing rapidly.[12] The number of health care professionals, especially registered nurses, is far from meeting the current and future demands. [12 13] Thus, we need to explore a more effective way to deliver messages to patients to maximize the effectiveness of health management education.

The effectiveness of educational messages in promoting behavior change may depend on how the message is presented rather than the meaning of the content itself. Message framing is a message tailoring method that can influence an individual's behavioral decision by adjusting the presentation of a message without changing the meaning of the content, thereby promoting a particular behavior. [14] The most common method is to develop a message based on the gain (positive) or loss (negative) frame. The benefits of adopting the target behavior are typically emphasized in gain-framing messages, whereas the costs of not adopting the target behavior are stressed in loss-framing information. [14] In O'Keefe and Jensen's reviews, they found that positive frames were slighter better for disease prevention. However, when they classified disease prevention behaviors, only a slight advantage of positive framing was showed in dental hygiene behavior, while there was no difference between the two frames for other disease prevention behaviors such as diet/nutrition behaviors, or exercise behaviors.[15 16.]

Reviewing the past literature, several studies on health-related behaviors such as smoking, [17] physical activity, [18] dental hygiene, [19] have emerged in message framing research. Notably, many studies are examined in messaging framing effect on health-related behaviors in the general population rather than representative samples of people suffering from various diseases or high risk groups, such as diabetes and cardiovascular diseases. [20-22] At the same time, the effects of message framing on chronic disease education are inconsistent. For example, Grady et al. found that a gain-framed foot care message was more effective in changing foot care behavior in patients with diabetes. [23] In contrast, Lee and Gu's study showed that loss-framed foot care message was more effective in activating attitudes and intentions to conduct foot care in patients with diabetes. [24]

There are many opportunities in nursing to provide patient health information in various settings, ranging from the distribution of written materials to teaching chronic disease self-management skills. [12] Meanwhile, patients feel more open and free to

communicate with nurses. [11] Thus, nurses have significant opportunities to use message framing to provide health information. The primary purpose of this study was to review the impact of message framing educational interventions on the health behaviors and beliefs of patients with chronic disease, and to inform the design of future health information interventions.

METHODS

Search strategy

This systematic review was carried out based on the PRISMA guidelines [25] and recommendations of the Cochrane Collaboration. [26] There was no need for ethical approval because the literature analyzed in this study was from previously published studies. The PROSPERO registration number is CRD42021250931.

We searched for studies published in PubMed, Web of Science, PsycINFO, and CINAHL from their inception to March 26, 2021. Terms related to message framing and chronic diseases used in this article were retrieved, including message framing, information framing, gain-framed, loss-framed, gain fram*, loss fram*, positive fram*, negative fram*, framing effect*, noncommunicable diseases, comorbidity, multimorbidity, chronic disease, chronic illness, chronic condition, long term condition, long term illness. The search strategies of each database are available in the in the Supplementary file 1. The reference lists of included and relevant publications were manually screened for additional articles.

Study selection

The inclusion criteria included adult patients aged 18 years or older with chronic diseases (persist and require care over time, such as cardiovascular conditions, diabetes, and cancer), [27] [28] intervention contents involved in the application of message framing, including involving a comparison of a message framing intervention with either a control intervention or other message frames, and intervention studies (randomized controlled trials or quasi-experimental studies)

published as peer-reviewed full-text articles in the English language. Messages could be delivered in paper or electronic form, and there were no restrictions on who had delivered the intervention. These studies measured health behavior or beliefs such as knowledge, self-efficacy, intention, or attitude. Exclusion criteria included articles from patients with severe mental disorders or cognitive impairment.

The retrieval results were imported into Endnote X 20 for literature management. Following the removal of duplicates, two independent researchers (RG, YL) screened the title, abstract and full text based on the pre-established inclusion and exclusion criteria. If they found any disagreement, it was resolved by a third independent researcher (HG).

Data extraction and analysis

Data extraction and entry were performed using a pre-designed data extraction form, including first author, year of publication, country, sample size, gender, age, key contents of intervention, outcome measures, and findings. Two independent researchers completed data extraction (RG, LX), and if there was any disagreement or uncertainty, it was arbitrated and resolved by a third independent researcher (FL).

Although our initial goal was to complete a systematic review and meta-analysis, quantitative analysis could not carry out due to the large statistical and clinical heterogeneity of the literature.

Quality assessment

Two independent researchers (RG, MS) completed the quality assessment of the included articles using Cochrane Collaboration Risk of Bias I. [29] If they found any uncertainty or difference in opinion, it was resolved by a third independent researcher (TY). For quasi-experimental studies without randomization, the item of random sequence generation of selection bias was automatically identified as high risk. [30 31]

Patient and public involvement

Neither patients nor the public were involved in this research.

RESULT

Literature search

After removing duplicate literature and screening the titles and abstracts, 2253 articles were systematically retrieved, with 42 articles were read the full text. A total of eleven studies were included, [23] [32–41] ten randomized controlled trials (RCT), and one quasi-experimental study [33] based on previously established inclusion and exclusion criteria. Figure 1 illustrates the PRISMA flowchart of literature screening process.[25]

Characteristics of the included studies

The included studies were published between 2004 and 2020 and came from Korea, Philippines, the United Kingdom, China, the United States and Canada. The number of participants ranged from 49 to 1,108, for a total of 2,216, with a mean age ranging from 40 to 71 and a male proportion of 43.7%.

Diabetes, cardiovascular disease, and cancer are the most common chronic diseases addressed in the included literature. [23 32 33 35 36 41] Seven studies were set up in two groups, with one receiving educational intervention based on gain frame, and the other group receiving educational intervention based on loss frame. [23 32 34-36 39 40] Only four studies were set up in three groups: a gain-framed group, a loss frame group, and a standard control group for providing usual care, with no message framing. [33 37 38 41] The gain framing condition highlighted the positive outcomes of completing or adhering to the healthy behavior, whereas the loss framing condition emphasized the undesirable consequences of failing to comply or adhere to the healthy behavior, which corresponded to the positive framing outcomes. Messages were delivered via video, pamphlet, and online message. Nine studies only once conducted intervention, [23 32-35 37-40] and two studies sent the pamphlet to patients to take home for further reading. [36 41] Supplementary file 2 presents specific information about the included studies.

Quality assessment of the included studies

Regarding selection bias, two RCT described adequate random sequence generation [32] [37] and other eight RCT reported randomization but did not report a specific method. [23] [34-36] [38-41] One quasi-experimental study, non-randomized sampling was used; participants were just assigned to different groups in separate days for a single time, identified as high risk. [33] Only one studies reported adequate allocation concealment, [32] and the other ten were rated as having an unclear risk of bias due to insufficient information.[23] [33-41] Only two studies showed a low risk of performance bias. [33] [39] The risk of detection bias was rated as unclear risk as none of the eleven articles indicated whether the blind method was applied to the outcome assessment.[23] [32-41] Regarding attrition bias, eleven studies were rated as low risk bias. [23] [32-41] The report and other sources bias of the eleven studies were rated as having an unclear risk of bias due to insufficient information. [23] [32-41] Figures 2 and 3 summarize the quality assessment of the included studies.

Main effects of framing

Several studies have reported effects on numerous outcomes. Six studies assessed outcomes immediately after the intervention, [32–34] [37] [38] [40] and five studies measured actual behavior from four weeks to 12 months of follow-up. [23] [35] [36] [39] [41] The content of message intervention primarily focused on healthy behaviors such as physical activity, medical adherence, and self-management for patients with chronic disease. However, the outcomes measured in the eleven studies were too diverse to analyze quantitatively. Supplementary file 3 presents a summary of findings from the studies included in this review.

Several studies reported significant main or interactive effects of framing. Among the included studies, five studies mainly explored the influence of educational intervention based on message framing on self-management behavior and related cognitive variables of patients with chronic disease. [23] [32-34] [40] Three of the five studies

showed the advantage of loss framing messages. [32 33 40] Two studies found that loss-framed message was superior to gain-framed for improving the scores of intention, attitude, and knowledge of self-management behavior in patients with diabetes. However, the increase in intention and knowledge scores did not meet the criteria for statistical difference. [32 33] One study found that loss-framed messages contributed more knowledge gain than gain-framed patients with chronic pain. [40] On the other hand, one study found that a gain-framed was slightly superior to a loss-framed message in sustaining long-term foot care behavior change. [23] Another study of patients with psoriasis found that when messages focused on long-term health risk, loss-framed messages were more persuasive to improving in reducing alcohol intake intention, while messages focused on short-term health risk, gain-framed messages were more persuasive than loss-framed messages. [34]

Four studies mainly explored the influence of educational intervention based on message framing on physical activity and related cognitive variables in patients with chronic disease. [35-37 41] Three of the four studies showed the advantage of loss framing messages. [35-37] One study found that loss-framed messages contributed more physical activity gain than gain-framed in patients with diabetes. [35] Furthermore, one study found that in patients with spinal cord injury, the loss-framed group increased their physical activity intention than the gain-framed group and the usual care group, while there was no significant difference between the physical activity intention in the gain-frame group and the usual care group. [37] One study reported that both gain and loss-framed messages resulted in more physical activity than at baseline, and increased more in the loss-framed group, but the difference between the two groups did not reach statistical significance; neither gain nor loss-framing elicited higher physical activity intention or attitude. [36] In contrast, one study found that a gain-framed was slightly superior to a loss-framed message in improving exercise adherence among patients with cardiovascular disease. [41]

Two studies primarily explored the influence of educational intervention based on message framing on adherence to medicine and treatment therapy and related

cognitive variables in patients with chronic disease. [38 39] One study reported that loss-framed messages increased adherence to treatment therapy and self-efficacy more than gain-framed in patients with cardiovascular disease. [39] Another study found that when compared to the usual care group, both gain- and loss-framed messages lead to higher medicine adherence intention and attitude, but without a difference between the two conditions. [38]

Moderator and mediator variables of framing effects

Several studies focused on moderators and mediators of framing effects. In particular, Park et al. reported that message framing had a significant indirect impact on intentions for diabetes self-care behavior, mediated through attitudes and perceived control, but no significant differences between message framing groups. [32] Grady et al. performed regression analyses after the intervention. They found that changes in knowledge predicted changes in attitudes and that both framing and attitudes were predictors of long-term diabetes self-managemnt behavior. [23] Nevertheless, McCall's study observed no mediating effects between health belief model constructs and messages. [41]

Zhao et al. investigated the interaction between frames and individual time perspective considering future consequences (CFC). They found a significant interaction between the two, which showed that among high-CFC patients, both gain- and loss-framed messages heightened medicine adherence intention and attitude toward no-message control. The message exposure did not affect the two outcomes in low- and medium-CFC participants.[38]

DISCUSSION

Patients with chronic diseases need to maintain long-term health behaviors to avoid complications and improve their quality of life. It is necessary to explore the most effective method of conveying health educational information to patients to minimize the nurses' workload and improve patients' health behaviors. Message framing, as an

effective message tailoring strategy, provides a new perspective for achieving this goal by increasing the persuasiveness in promotion of healthy behaviors. Hence, we summarized the research on the influence of educational interventions based on message framing on health behavior and related cognitive variables in patients with long-term illnesses. This research found that most studies showed educational message intervention based on the gain and loss frame that could effectively improve health behaviors and cognitive variables such as health behavior knowledge, intention, attitude, self-efficacy of patients with chronic diseases. Previous studies have suggested that gain framing is more effective for preventive behavior, but not concluded in this study. Many of the studies we included in this review showed the advantage of loss framing messages, but due to the limited number of included articles and lack of quantitative analysis, this result should be interpreted with caution.

The persuasion of gain and loss framing appeal seems to be more complicated than previously thought. Many patients with chronic disease may have low health awareness and health literacy. [42] [43] The loss framing might be more efficacious if people do not intend to take action in the foreseeable future and are unaware of the issues related to their behavior. [44] Besides, individuals weigh the benefits of engaging in healthy behaviors (such as reducing symptoms and improving mood) against the potential costs (such as the time and effort spent learning a new skill). [40] Individuals suffering from chronic diseases, who typically have a long history of illness, may have had a learning history and outcome expectation (e.g., perceived importance) that may have resulted in an avoidance tendency toward health behavior. [45] Individuals with a dominant avoidance tendency typically respond more strongly to threat cues, [46] making them more receptive to loss-framing encouragement. [47] However, no relevant variables were assessed in this study; we only proposed a research hypothesis that requires further investigation.

Fewer studies have explored the potential mechanism of message frames, which is of great significance for designing and applying message intervention. These

studies found that attitudes and intentions may act as mediating factors of framing effect on behavior, consistent with the theory of planned behavior. [23 32 48] A negative frame may allow patients without behavior change awareness to develop attitudes and behavioral intentions, thereby promoting behavior. The interaction between message frame and individual time perspective also suggests that individual factors must be considered. [38] Matching frames with individual factors may have a greater framing effect and help to promote the occurrence or maintenance of healthy behaviors. This is consistent with the view raised by Latimer et al. that the effectiveness of the message frame may be dependent on the individual's thinking and feeling about behavior, rather than just the function or nature of the behavior itself.[49 50] Failing the influence of individual differences on message framing effects may suppress the true framing effect and underestimate the utility of gain and loss-framed appeals. [49]

Limitations

This review offers critical insights into the impact of message-framed education on health behaviors of chronic disease patients; however, several limitations have to be considered. Although we retrieved a considerable amount of literature from the database, only 11 articles met the inclusion criteria used in the present study. In the analysis, heterogeneity of different patient samples and health messages, and the diversity of outcome measurements did not permit a quantitative analysis, limiting the reliability of conclusions. Furthermore, this review only included research reported in English, which may exclude some studies; language constraints are also associated with potential bias in this systematic reviews. Only five studies measured actual behavior changes, and only six studies just measured changes in cognitive variables immediately after the intervention. Of course, we know that there is still some distance between the initiation of behavioral intention to the occurrence and the maintenance of actual behavior. Hence, future research needs to determine the effects of message framing on actual behavior through long-term observation or objective measurement. Few studies have been explored the underlying mechanisms of the

influence of message framing on behavioral or cognitive variables. Future studies also need to explore the different effects of message framing according to the advocated behavior and consider participants' existing beliefs and perceptions about the behavior. [50 51] However, in general, the included studies have relatively high bias risk and low methodological quality, limiting the reliability of the results. Therefore, with these limitations of the present review, interpretation of the results should be made with caution.

Implications for nursing

One of the primary goals of this research is to provide suggestions for nurses and other healthcare professionals, extend the message framing effect to chronic disease education interventions and improve patients' health, well-being, and quality of life. The present findings add to the growing evidence that the way health education messages are delivered and impacts more than the meaning of the content of messages. Proper design and delivery of messages can improve the persuasiveness of education, effectiveness, and efficiency, enabling patients with chronic disease to adopt and maintain health promotion behaviors. Furthermore, by empowering patients to be active decision-makers rather than passive nursing recipients, patients' role in managing health-related issues can be strengthened.

CONCLUSION

Message framing can be an effective tool for encouraging health promotion information to promote health behaviors and beliefs in patients with chronic diseases. Besides, integration of message framing, especially loss framing into health education might be a promising strategy for motivating patients with chronic disease to improve health behaviors and related cognitive variables. However, no firm recommendation could be made of this study. The best framework for improving the actual health behavior of patients with chronic disease, as well as its potential moderators and mediators, need to be studied further and strengthened in to guide health education.

Contributors

RG and FL performed the conception and design of the study, drafting the article or revising it critically for important intellectual content. RG, HG, FL, YL and LX performed the acquisition of data, or analysis and interpretation of data. RG, MS and TY performed the quality assessment. All authors read and final approval of the version to be submitted.

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Competing interests We declare no competing interests.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No additional data are available.

Ethical Approval Statement Not applicable

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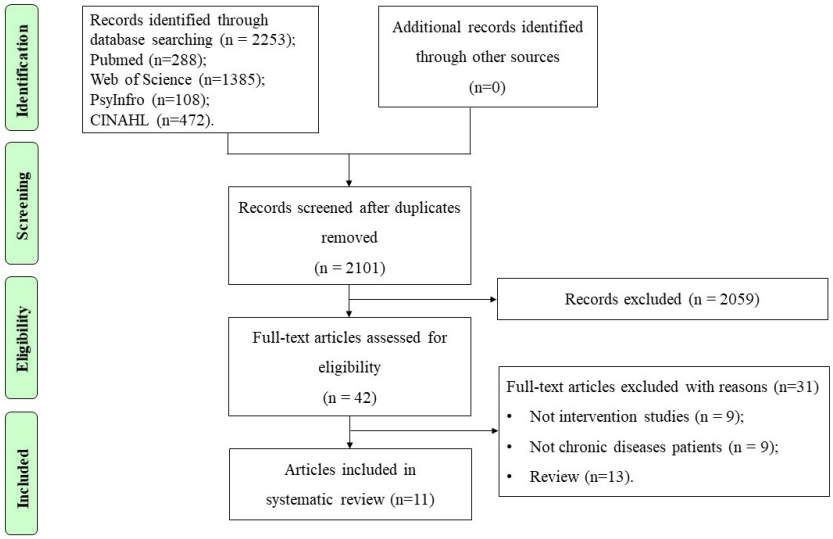
Figure legends

Figure 1: PRISMA flowchart[25]

Figure 2: Risk of bias assessment

Figure 3: Risk of bias summary



7 Figure 1 Flowchart of the literature search

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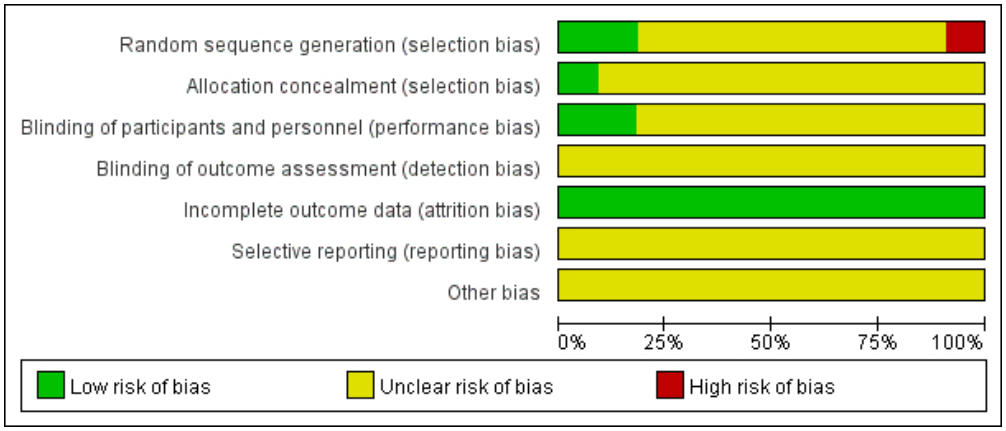

Figure 2 Risk of bias assessment

213x90mm (72 x 72 DPI)

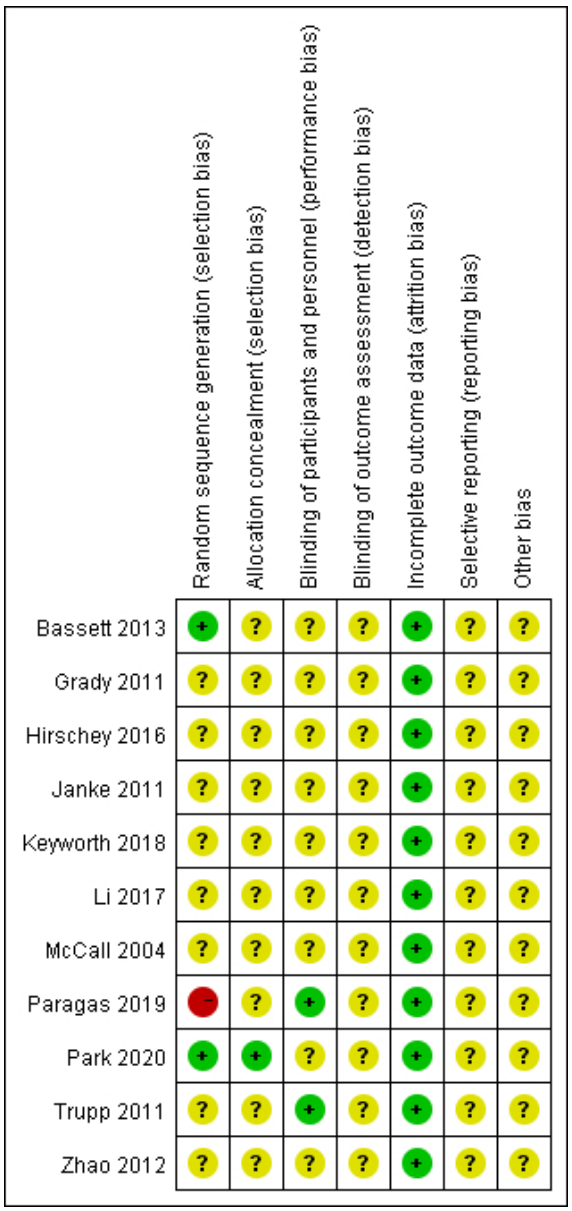

Figure 3 Risk of bias summary

111x236mm (72 x 72 DPI)

Supplementary file 1: Search strategy

This Supplementary file provides the search strategy details, performed March 26, 2021.

1. Pubmed	
#1	Search: ((((((((((((message framing[Title/Abstract]) OR (message fram*[Title/Abstract])) OR (information framing[Title/Abstract])) OR (information fram*[Title/Abstract])) OR (gain-framed[Title/Abstract])) OR (loss-framed[Title/Abstract])) OR (gain fram*[Title/Abstract])) OR (loss fram*[Title/Abstract])) OR (positive frame[Title/Abstract])) OR (positive fram*[Title/Abstract])) OR (negative frame[Title/Abstract])) OR (negative fram*[Title/Abstract])) OR (goal fram*[Title/Abstract])) OR (framing effect*[Title/Abstract])
#2	Search: ((((((((((((((((((((Heart disease[MeSH]) OR (Cardiovascular disease[MeSH])) OR (Heart Failure[MeSH])) OR (Hypertension[MeSH])) OR (Stroke[MeSH])) OR (Diabetes Mellitus[MeSH])) OR (Metabolic syndrome[MeSH])) OR (Neoplasms[MeSH])) OR (Pulmonary Disease, Chronic Obstructive[MeSH])) OR (Lung Diseases[MeSH])) OR (Alzheimer disease[MeSH])) OR (Dementia[MeSH])) OR (Asthma[MeSH])) OR (Hepatitis[MeSH])) OR (Fatty Liver[MeSH])) OR (Kidney diseases[MeSH])) OR (Pain[MeSH])) OR (Psoriasis[MeSH])) OR (Fibromyalgia[MeSH])) OR (Multiple Sclerosis[MeSH])) OR (Arthritis[MeSH])) OR (Osteoporosis[MeSH])) OR (((((Noncommunicable Diseases[MeSH]) OR (Comorbidity[MeSH])) OR (Multimorbidity[MeSH])) OR (Chronic disease[MeSH])) OR (Chronic illness[MeSH]))
#3	Search: ((((((((((((((((((((((((((((((((non communicable[Title/Abstract]) OR (noncommunicable[Title/Abstract])) OR (NCD[Title/Abstract])) OR (comorbidity[Title/Abstract])) OR (multimorbidity[Title/Abstract])) OR (chronic disease[Title/Abstract])) OR (chronic condition[Title/Abstract])) OR (chronic illness[Title/Abstract])) OR (long term condition[Title/Abstract])) OR (long term ill[Title/Abstract])) OR (cardi*[Title/Abstract])) OR (heart disease[Title/Abstract])) OR (cardiovascular disease[Title/Abstract])) OR (Heart Failure[Title/Abstract])) OR (high blood pressure[Title/Abstract])) OR (hypertension[Title/Abstract])) OR (Stroke[Title/Abstract])) OR (diabet*[Title/Abstract])) OR (Diabetes[Title/Abstract])) OR (metabolic syndrome[Title/Abstract])) OR (cancer[Title/Abstract])) OR (neoplasm[Title/Abstract])) OR (chronic obstructive pulmonary disease[Title/Abstract])) OR (chronic respir*[Title/Abstract])) OR (Lung Diseases[Title/Abstract])) OR (respiratory disease*[Title/Abstract])) OR (Alzheimer disease[Title/Abstract])) OR (dementia[Title/Abstract])) OR (psoriasis[Title/Abstract])) OR (Asthma[Title/Abstract])) OR (Hepatitis[Title/Abstract])) OR (Fatty Liver[Title/Abstract])) OR (Kidney disease*[Title/Abstract])) OR (Pain[Title/Abstract])) OR (Fibromyalgia[Title/Abstract])) OR (multiple sclerosis[Title/Abstract])) OR (Arthritis[Title/Abstract])) OR (Osteoporosis[Title/Abstract])
#4	#2 OR #3
#5	#1 AND #4 Filters: English

	Items found: 288
2. Web of Science	
#1	message framing (TS) or message fram* (TS) or information framing (TS) or information fram* (TS) or gain-framed (TS) or loss-framed (TS) or gain fram* (TS) or loss fram* (TS) or positive frame (TS) or positive fram* (TS) or negative frame (TS) or negative fram* (TS) or goal fram* (TS) or framing effect* (TS)
#2	non communicable (TS) or noncommunicable (TS) or NCD (TS) or comorbidity (TS) or multimorbidity (TS) or chronic disease (TS) or chronic condition (TS) or chronic illness (TS) or long term condition (TS) or long term ill (TS) or cardi* (TS) or heart disease (TS) or cardiovascular disease (TS) or Heart Failure (TS) or high blood pressure (TS) or hypertension (TS) or Stroke (TS) or diabet* (TS) or Diabetes (TS) or metabolic syndrome (TS) or cancer (TS) or neoplasm (TS) or chronic obstructive pulmonary disease (TS) or chronic respir* (TS) or Lung Diseases (TS) or respiratory disease* (TS) or Alzheimer disease (TS) or dementia (TS) or psoriasis (TS) or Asthma (TS) or Hepatitis (TS) or Fatty Liver (TS) or Kidney disease* (TS) or Pain (TS) or Fibromyalgia (TS) or multiple sclerosis (TS) or Arthritis (TS) or Osteoporosis (TS)
#3	#1 AND #2 Filters: English; Not conference abstract/review Items found: 1385
3. CINAHL	
S1	TI message framing OR TI negative fram* OR TI negative frame OR TI information framing OR TI message fram* OR TI information fram* OR TI loss-framed OR TI gain fram* OR TI gain-framed
S2	TI loss fram* OR TI positive frame OR TI positive fram* OR TI goal fram* OR TI framing effect*
S3	AB message framing OR AB message fram* OR AB information framing OR AB gain-framed OR AB information fram* OR AB loss-framed OR AB gain fram* OR AB loss fram*
S4	AB positive frame OR AB positive fram* OR AB negative fram* OR AB negative frame OR AB goal fram* OR AB framing effect*
S5	S1 OR S2 OR S3 OR S4
S6	TI non communicable OR TI noncommunicable OR TI NCD OR TI comorbidity OR TI multimorbidity OR TI chronic illness OR TI long term ill OR TI chronic disease OR TI long term condition OR TI chronic condition OR TI cardi* OR TI heart disease
S7	AB non communicable OR AB NCD OR AB noncommunicable OR AB comorbidity OR AB multimorbidity OR AB chronic illness OR AB chronic disease OR AB chronic condition OR AB long term condition OR AB long term ill OR AB cardi* OR AB heart disease
S8	TI cardiovascular disease OR TI high blood pressure OR TI hypertension OR TI Heart Failure OR TI Stroke OR TI diabet* OR TI Diabetes OR TI metabolic syndrome OR TI chronic obstructive pulmonary disease OR TI chronic respir* OR TI cancer OR TI neoplasm
S9	AB cardiovascular disease OR AB Heart Failure OR AB high blood pressure OR AB hypertension OR AB Stroke OR AB diabet* OR AB Diabetes OR AB metabolic

	syndrome OR AB cancer OR AB neoplasm OR AB chronic obstructive pulmonary disease OR AB chronic respir*
S10	TI Lung Diseases OR TI respiratory disease* OR TI Alzheimer disease OR TI dementia OR TI psoriasis OR TI Asthma OR TI Hepatitis OR TI Fatty Liver OR TI Kidney disease* OR TI Pain OR TI Fibromyalgia OR TI multiple sclerosis
S11	AB Lung Diseases OR AB respiratory disease* OR AB Asthma OR AB Kidney disease* OR AB Alzheimer disease OR AB dementia OR AB psoriasis OR AB Hepatitis OR AB Fatty Liver OR AB Pain OR AB Fibromyalgia OR AB multiple sclerosis
S12	TI Arthritis OR TI Osteoporosis OR AB Arthritis OR AB Osteoporosis
S13	S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12
S14	S5 AND S13 Filter: English, Human, Adult Items found: 472
4. PsycINFO	
S1	TI message framing OR TI message fram* OR TI information framing OR TI information fram* OR TI loss-framed OR TI gain-framed OR TI gain fram* OR TI loss fram* OR TI positive frame OR TI positive fram* OR TI negative frame OR TI negative fram*
S2	AB message framing OR AB message fram* OR AB information framing OR AB information fram* OR AB loss-framed OR AB gain-framed OR AB gain fram* OR AB loss fram* OR AB positive frame OR AB positive fram* OR AB negative frame OR AB negative fram*
S3	AB goal fram* OR AB framing effect* OR TI goal fram* OR TI framing effect*
S4	S1 OR S2 OR S3
S5	TI non communicable OR TI noncommunicable OR TI NCD OR TI comorbidity OR TI multimorbidity OR TI chronic disease OR TI long term condition OR TI chronic condition OR TI chronic illness OR TI long term ill OR TI cardi* OR TI heart disease
S6	AB non communicable OR AB noncommunicable OR AB NCD OR AB comorbidity OR AB multimorbidity OR AB chronic disease OR AB long term condition OR AB chronic condition OR AB chronic illness OR AB long term ill OR AB cardi* OR AB heart disease
S7	AB cardiovascular disease OR AB Heart Failure OR AB high blood pressure OR AB hypertension OR AB Stroke OR AB diabet* OR AB Diabetes OR AB metabolic syndrome OR AB cancer OR AB neoplasm OR AB chronic obstructive pulmonary disease OR AB chronic respir*
S8	TI cardiovascular disease OR TI Heart Failure OR TI high blood pressure OR TI hypertension OR TI Stroke OR TI diabet* OR TI Diabetes OR TI metabolic syndrome OR TI cancer OR TI neoplasm OR TI chronic obstructive pulmonary disease OR TI chronic respir*
S9	TI Lung Diseases OR TI respiratory disease* OR TI Alzheimer disease OR TI dementia OR TI psoriasis OR TI Asthma OR TI Hepatitis OR TI Fatty Liver OR TI Kidney disease* OR TI Pain OR TI Fibromyalgia OR TI multiple sclerosis
S10	AB Lung Diseases OR AB respiratory disease* OR AB Alzheimer disease OR AB dementia OR AB psoriasis OR AB Asthma OR AB Hepatitis OR AB Fatty Liver OR AB

	Kidney disease* OR AB Pain OR AB Fibromyalgia OR AB multiple sclerosis
S11	AB Arthritis OR AB Osteoporosis OR TI Arthritis OR TI Osteoporosis
S12	S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11
S13	S4 AND S12 Filter: English, Human, Adult Items found: 108

Supplementary file 2: Characteristics of studies included in this systematic review.

Authors Year Design	Population	Group	Sample Size (M/F) Age (years)	Key component of intervention		
				Content	Frame	Format/ Dose
Park [32] 2020 RCT	Diabetes	Gain-frame	26 (10/16) 65.65±10.61	Content pertaining to diabetic complications in diabetes.	Gain framing presented positive outcomes resulting from adherence to a diabetes care regimen, showing a patient success story about proper diabetes self-care.	Video 1
		Loss-frame	26 (6/20) 64.92±12.21		Loss framing presented undesirable consequences resulting from failure to comply with a diabetes care regimen, showing a story about a patient with diabetic complications caused by inadequate diabetes self-care.	
Paragas [33] 2019 Quasi-experimental study	Diabetes	Gain-frame	55 (25/30) 58.95±10.25	Definition of diabetes, teachings about blood glucose monitoring; proper diet and exercise; oral hypoglycemic agents; recognition, treatment, and prevention of hypoglycemia and hyperglycemia.	Gain-framed video comprised 10 positive outcomes of adherence to diabetes self-care in the last scenes of videos, e.g. one statement was "If you maintain good control of your blood glucose, the acid in your blood will be normal, and being comatose will be prevented," with a scene showing a healthy person.	Video/ Lecture 1
		Loss-frame	55 (25/30) 58.60±10.23		Loss-framed video contained 10 negative outcomes of non-adherence in the last scenes of videos, e. g. one version was "If you do not maintain good control of your blood glucose, the acid in your blood will be elevated that could lead to being comatose," with a scene showing a comatose patient.	
		No-frame	55 (24/31) 58.96±9.74		Standard approach of providing health teachings about diabetes self-care, with no message framing.	
Keyworth [34] 2018 RCT	Psoriasis	Gain-frame	217(75/126) 41.23±14.31	Information about the effects of health behavior change on either psoriasis symptoms or CVD risk.	Gain-framed message addressed the positive outcomes for adherence to the health behaviors, e. g. "Research shows that risk factors for cardiovascular disease include smoking, having a poor diet, having insufficient physical activity, and drinking excessive amounts of alcohol. By making changes to your lifestyle, you [lower] your risk of cardiovascular disease."	Sheet 1
		Loss-frame			Loss-framed message addressed the negative outcomes for not adherence to the health behaviors, e. g. "Research shows that risk factors for cardiovascular disease include smoking, having a poor diet, having insufficient physical activity, and drinking excessive amounts of alcohol. By [not] making changes to your lifestyle, you [increase] your risk of cardiovascular disease."	
Li [35]	Diabetes	Gain-	211	The pamphlet included a brief	Gain-framed pamphlet contained the benefits of PA participation, including physical (11 items: e.g., improve	Pamphlet

2017 RCT		frame	(101/110) 71.41±6.80	description of PA participation in Hong Kong, the recommended PA level.	muscle strength), psychological (8 items: e.g., improve mood), and social (4 items: expand social network) domains.	1
		Loss-frame			Loss-framed pamphlet contained the absence of benefits of PA participation. The contents of the benefits were identical between the gain- and loss-framed messages, with differences only in the framing of the messages.	
Hirschey [36] 2016 RCT	CRC	Gain-frame	78 (36/42) 64.3 (29.9–98.4)	Tips on how to become more physically active with examples of activities of MIPA; protective influence of PA on CRC co-morbid conditions; inverse relationship between PA and risk of cancer-specific mortality and all-cause mortality.	Gain-framed version addresses the benefits of being physically active.	Pamphlet / taken home to read
		Loss-frame	70 (35/35) 65.4 (43.2–88.5)		Loss-framed version addresses the disadvantages of not being physically active.	
Bassett [37] 2013 RCT	SCI	Gain-frame	94 (57/37) 45±12	Benefits or risks quotations from SCI experts and patients and research evidence.	Gain-framed messages outlined the benefits of engaging in regular LTPA (i.e. Adding LTPA to your day can help you manage your pain gain framed)	Online message 1
		Loss-frame			Loss-framed messages outlined the risks of not engaging in regular LTPA. (i.e., By not adding LTPA to your day you miss an opportunity to manage your pain)	
		No-frame		Usual care	The control group did not receive any additional information.	
Zhao [38] 2012 RCT	Chronic diseases	Gain-frame	1108 (411/697) 40-85	Messages addressing perceived need and perceived concerns about medications, messages content was held the same across the two frames.	Gain-framed messages outlined the benefits of adherence to medication taking (i.e. You may wonder whether you really need your prescription medication. But taking your medicine as directed is very important even if you don't feel sick. It's the first step toward long-term health. Talk to your doctor about your medicine and changes you can make to your lifestyle to help manage your condition.)	Online message 1
		Loss-frame			Loss-framed messages outlined the negative outcomes of not adherence to medication taking. (i.e., You may wonder whether you really need your prescription medication. But not taking your medicine is very dangerous to your health, even when you don't have symptoms. Your condition can get worse. If you don't talk to your doctor about your medicine or other lifestyle questions, you can miss out on information that can help your condition.)	

		No-frame		Usual care	The control group did not receive any additional information.	
Trupp [39] 2011 RCT	CVD with OSA	Gain-frame	26 (19/7) 29-74	A brief, about 50 seconds educational video about CPAP was provided.	Gain-framed video positively focused on the benefits associated with CPAP use.	Video 1
		Loss-frame	29 (17/12) 38-77		Loss-framed video negatively emphasized the negative consequences that may occur if CPAP was not worn as directed.	
Janke [40] 2011 RCT	Chronic pain	Gain-frame	62 (61/1) 50	Messages stressed the importance of the patient playing an active role in their pain care and techniques could use to help manage pain.	Gain-framed messages emphasized the gains patients would make if they engage in these behaviors.	Pamphlet 1
		Loss-frame			Loss-framed messages focused on the losses they would realize if they did not do these things.	
Grady [23] 2011 RCT	Diabetes	Gain-frame	155 (64 /91) 61.2±11.4	The video addressed topics about foot care such as cleaning procedures, toenail care, footwear use, and foot and footwear inspection procedures.	Gain-framed version offered the positive outcome that can accrue by appropriate foot care, e.g. "Good foot care can help you avoid the serious complications of nerve and blood vessel damage, and keep your feet healthy" (with a picture of healthy feet).	Video 1
		Loss-frame			Loss-framed version offered the negative outcome that can accrue if the desired behavior is not followed, e.g. "Poor foot care can lead to the serious complications of nerve and blood vessel damage, and unhealthy feet" (with a picture of a foot with an infected sore).	
McCall [41] 2004 RCT	CVD	Gain-frame	16 (15/1)	Statements regarding the effects of exercise in relation to CAD.	Gain-framed condition listed 10 gain-framed statements regarding the benefits of exercise in relation to the progression of CAD. (i.e., Regular exercise will help you maintain a healthy body weight.)	Sheet /taken home to read
		Loss-frame	13 (12/1)		Loss-framed condition with the same 10 statements phrased in a loss-framed manner. (i.e., By not exercising regularly, you decrease your chances of keeping a healthy body weight.)	
		No-frame	20 (19/1)	Usual care	The control group did not receive any additional information.	

Abbreviations: CAD: Coronary artery diseases; CRC: Colorectal cancer; CVD: Cardiovascular disease; LTPA: Leisure time physical activity; MIPA: Moderate intensity physical activity; NR: Not report; OSA: Obstructive sleep apnea; PA: Physical activity; RCT: Randomized controlled trial; SCI: Spinal cord injury; T2D: Type 2 diabetes.

Supplementary file 3: Summary of findings of studies included in this systematic review.

Authors Year	Outcome measures and collection time	Main findings	Mediators/Moderators
Park [32] 2020	Attitudes, perceived control and intentions for diabetes self-care behavior. All measured at post-intervention.	Attitudes: Loss-framed group improved more; Perceived control: Loss-framed group improved more; Intentions: Both conditions produced significant increases, but no group difference.	Significant indirect effect of message framing on intentions for diabetes self-care behavior mediated through attitudes and perceived control. No significant interaction effects were observed between health literacy level and message framing.
Paragas [33] 2019	Diabetes self-management knowledge and self-efficacy. All measured at pre- and post-intervention.	Knowledge: Both loss-framed and gain framed group improved more, but no difference between the two; Self-efficacy: Both loss- and gain- framed group improved, and gain framed group improved more.	NR
Keyworth [34] 2018	Self-care behavior intention. Measured at post-intervention.	Intention: Messages focused on short-term health risk, gain-framed messages more persuasive than loss-framed messages; messages about long-term health risk, loss-framed message more persuasive than gain-framed message	A significant frame by focus interaction was found for behavioral intention to reduce alcohol intake.
Li [35] 2017	PA. Measured at pre-intervention and 2-week follow up: PA.	PA: Loss-framed group improved more.	NR
Hirschey [36] 2016	PA, attitudes, subjective norms, perceived behavioral control, intention. PA and intention were measured at pre- and post-intervention, 1-and 12-months follow up; Attitudes, subjective norms and perceived behavioral control measured at pre-intervention and 1-month follow up.	PA: Both conditions produced significant increases in PA, with no differences between framing conditions; TPB constructs: Neither the gain- nor loss-framed brochures produced significant changes from baseline to the 1- and 12-months follow-up.	NR
Bassett [37] 2013	PA response efficacy and intention. All measured at pre- and post-intervention.	LTPA response efficacy: Loss-framed condition increased more than gain-framed and control conditions, no difference	NR

		between gain-framed and control conditions; Intention: Loss-framed condition increased more than gain-framed and control conditions, no difference between gain-framed and control conditions.	
Zhao [38] 2012	Medicine adherence intention and attitude. All measured at post-intervention.	Intention: Gain- and loss-framed messages improved more than control, no difference between gain- and loss-framed conditions; Attitude: Gain- and loss-framed messages improved more than control, no difference between gain- and loss-framed conditions.	Significant interaction between frames and CFC, among high-CFC patients, both gain- and loss-framed messages heightened intention ad attitude with respect to the no-message control, gain frame showed a consistent superior to the loss frame. Message exposure had not effect on the two outcomes for low-and medium-CFC participants.
Trupp [39] 2011	Adherence to CPAP, self-efficacy. CPAP use was measured at post-intervention; Self-efficacy was measured at pre- and post-intervention.	CPAP use: Loss-framed group improved more; Self-efficacy: Both conditions improved, Loss-framed group improved more than gain-framed group.	NR
Janke [40] 2011	Knowledge, pain self-efficacy, pain readiness to change, pain self-management behavioral skills. Pain self-efficacy, pain readiness to change were measured at pre-intervention; Knowledge, pain self-management behavioral skills were measured at post-intervention.	Knowledge: Loss-framed group improved more; Confidence to practice relaxation: Loss-framed group improved more.	Pain self-efficacy, pain readiness to change and message frame independently influenced motivation to engage in relaxation. There were no observed interactions between message frame and either self-efficacy or readiness to change.
Grady [23] 2011	Knowledge, attitude, foot care behaviors. Knowledge and attitude were measured at pre- and post-intervention, 3- and 6-month follow-ups; Foot care behaviors were measured at pre-intervention, 3- and 6-month follow-ups.	Foot care behaviors: Gain-framed group improved more.	Attitude and framing are significant predictors of 6-months behavior, gain framing positively related to long-term behavior; knowledge affects attitudes, in turn, attitudes affect behavior.

McCall [41] 2004	Adherence to exercise, health belief cognitions (perceived susceptibility, benefits and barriers). Adherence to exercise was measured at 3-months follow-ups; Health belief cognitions were measured at post-intervention.	Adherence to exercise: Gain-framed condition attended more exercise sessions than control; loss-framed group attend more exercise, but no difference with control; Perceived susceptibility: Gain- and loss-framed conditions perceived more susceptibility than control; Perceived barriers: Loss-framed condition perceived grater barriers than gain-framed and control conditions; Perceived benefits: No difference among the three conditions.	HBM constructs did not mediate the effects of the educational messages.

Abbreviations: CFC: Consideration of future consequences; CPAP: Continuous positive airway pressure; HBM: Health belief model; LTPA: Leisure time physical activity; NR: Not report; PA: Physical activity; TPB: Theory of planned behavior.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1,2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5,6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	none
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	none

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	none
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	none
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6,7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7,8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8,9,10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	none
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	none
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9,10,11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	13
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	14

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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