

RESEARCH ARTICLE

Using protection motivation theory to support patient adherence in healthcare settings: A scoping review

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Abstract

Background

Protection motivation theory (PMT) shows promise as a basis for motivating healthy behaviours in healthcare settings. There has been no systematic overview of how PMT has been translated into clinical practice and which translation strategies effectively improve outcomes.

Objectives

This scoping review aimed to systematically map and synthesise existing literature on PMT-based interventions targeting health behaviours in healthcare contexts.

Methods

Medline, PsycINFO, and EMBASE were searched for studies applying PMT within healthcare contexts. Eligible populations had a clinical condition. To be eligible, studies had to report a healthcare-delivered PMT intervention with adherence outcomes directly benefiting participants. Two reviewers extracted data on study features, intervention characteristics including behaviour change techniques employed, PMT constructs addressed, results, and research recommendations. Findings were summarised narratively and tabulated.

Results

Thirteen studies published between 1998 and 2023 met the eligibility criteria, including 12 randomised trials. Studies addressed acute and chronic conditions across primary, secondary, and non-clinical settings. Half significantly improved behaviour outcomes in intervention groups. All targeted coping-self-efficacy and perceived

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threat-severity PMT constructs to some degree. Combinations of behaviour change techniques did not clearly differentiate successful outcomes. Studies recommended longer follow-up, clarifying effective PMT component combinations, and drawing on multiple behaviour theories.

Discussion

Despite heterogeneity in how PMT interventions were operationalised, they show potential benefits for motivating adherence to healthy behaviours. To enable optimisation and dissemination, consistent nonadherence detection and reporting methods are critical. Further research should include translation of PMT to other healthcare settings, refining methodology and implementing well-powered effectiveness trials in routine care.

Introduction

Patient non-adherence to healthy behaviours and treatment plans is a widespread issue that constitutes both a humanistic and economic burden [1,2]. Studies show adherence rates can be as low as 30% in unsupervised home exercise programs and vary significantly across conditions [3]. This lack of adherence leads to worse health outcomes, increased risk of condition progression, greater healthcare use, and millions in avoidable costs [1,4,5]. Addressing this challenge requires us to understand the different reasons underlying non-adherence, including individual, socioeconomic, healthcare system, and treatment-related factors [5]. This, in turn, implies a need for theories, models and frameworks that can inform the development of interventions to improve adherence.

One such theory that has shown promise for improving adherence behaviours is Protection Motivation Theory (PMT) [6–8]. Meta-analyses have extensively validated PMT across various health contexts, demonstrating moderate to strong relationships between PMT variables and health behaviours ($d^+ = 0.52$), with particularly strong effects for self-efficacy ($d^+ = 0.88$) and notably higher effect sizes ($d^+ = 0.98$) for medical treatment adherence specifically [8]. PMT considers how individuals react when encountering a health threat, with two key processes: threat appraisal and coping appraisal [7]. Threat appraisal refers to an individual's perception of their vulnerability to, and severity of, the health threat, as well as any intrinsic or extrinsic rewards associated with maladaptive behaviours. Coping appraisal refers to an individual's perception of their ability to carry out the recommended protective behaviour change (self-efficacy), the effectiveness of the behaviour to reduce the threat (response efficacy), and the response cost required to perform the behaviour. These two appraisal pathways contribute to an individual's protection motivation (i.e., intention) to perform the health behaviour (Fig 1). By targeting specific PMT constructs within an intervention, healthcare professionals and those designing interventions can aim to increase perceptions of threat and coping ability, motivating positive health behaviour changes.

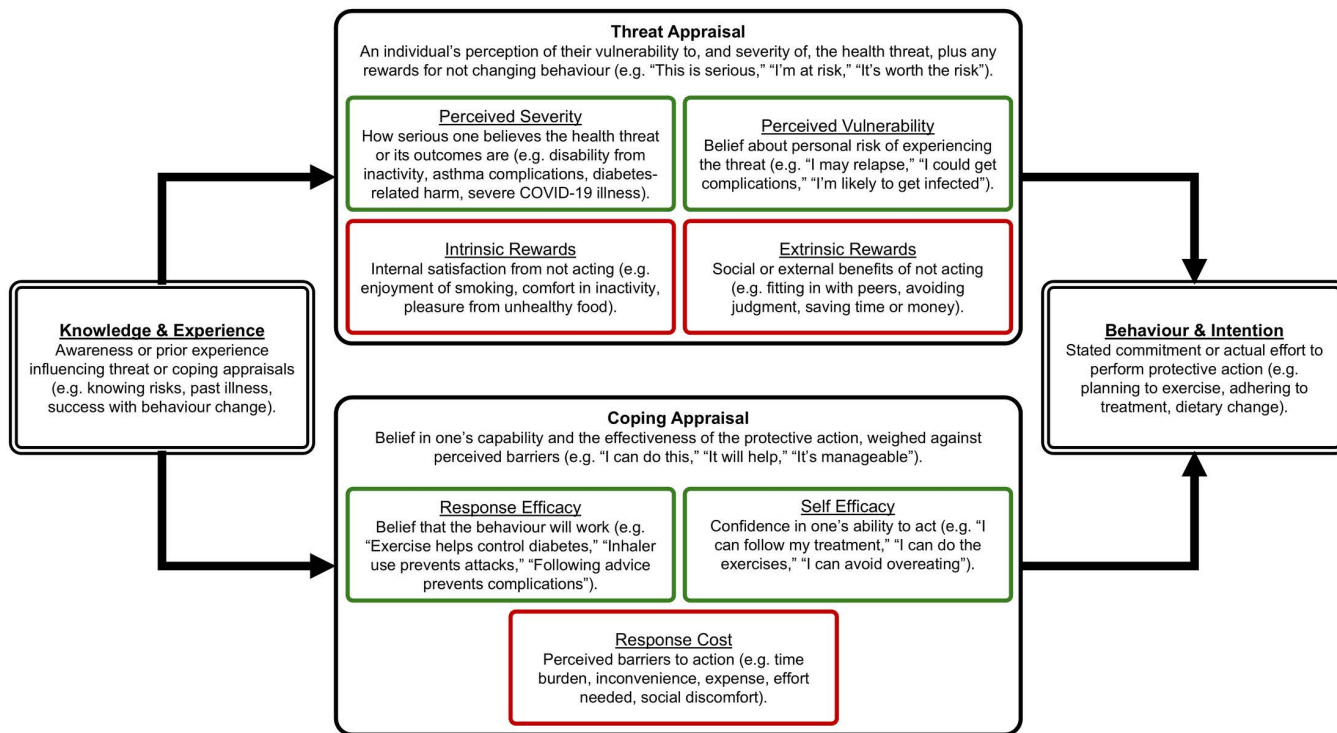


Fig 1. Key constructs in Protection Motivation Theory.

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Guidelines on intervention design highlight the importance of reviewing existing evidence and theory throughout the development process [9]. Adaptation of existing interventions underpinned by robust theory represents an efficient approach, provided the mechanisms behind successful outcomes are retained [10]. While PMT's theoretical validity is well-established, uncertainty remains around how to effectively translate it into clinical practice. Reviewing existing PMT-based interventions can clarify which techniques effectively target relevant constructs to improve adherence, facilitating adaptation of successful interventions across healthcare domains.

A scoping review is an ideal vehicle to synthesise the existing literature on PMT interventions in healthcare. Scoping reviews can be used to map concepts and research activity across a broad area to clarify methods and identify gaps to shape future studies [11]. Our aim is not to assess effectiveness as in a systematic review, but to systematically characterise how PMT is being applied to improve adherence in physical healthcare contexts, providing practical guidance for front-line health professionals seeking to implement PMT-based interventions in routine care. Reviewing existing interventions based on PMT theory will reveal research gaps and concepts needing clarification to inform policy and the development of new optimised interventions tailored for wider implementation.

Methods

Protocol

We developed a protocol for the scoping review using the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA-P) [12] which was fixed on 26th September 2023 and made available online [13].

Eligibility criteria

The eligibility criteria for the scoping review were developed based on the Population Concept Context framework [11]. Eligible studies had clinical populations, including those at risk of condition progression. Studies of healthy populations were ineligible, including those who are currently healthy but at high risk of developing a condition (e.g., smokers, people with obesity). Studies in healthy pregnant people were ineligible. To be eligible in terms of concept, studies had to be of healthcare delivered interventions or adjunctive interventions based on PMT aiming to improve patient adherence. Protocol papers for studies of such interventions were included. Preventative interventions (e.g., for vaccine hesitancy, smoking cessation, breast screening behaviour) were ineligible. To be eligible, the context had to be such that the adherence outcome would directly affect the research participants. Studies in which the outcome of the intervention would not directly benefit the research participant (e.g., promoting adherence of condom use in HIV positive patients) were excluded.

Information sources and search

On 18th September 2023 we searched MEDLINE, EMBASE (via Ovid) and PsycINFO using the search strategy detailed in Table 1. We limited the language to English but applied no date restrictions. In order to capture the grey literature, we conducted a search in Google Scholar. We screened the first 200 relevant references, as recommended in the literature [14].

Selection of sources of evidence

We uploaded the search results to Rayyan [15] and removed duplicates. Two reviewers (JS and DJ) independently screened the titles and abstracts of all records against the eligibility criteria. The full texts of those records which appeared to be eligible were then assessed. Any disagreements on study selection were resolved by discussion with additional reviewers.

Data charting process

Data charting forms were developed and piloted in Google Sheets. Two reviewers (JS and DJ) charted data from each eligible article. Any disagreements were resolved by discussion with additional reviewers.

Data items

We charted data on the study characteristics (study design, setting, type of condition and type of outcomes collected) and the intervention characteristics. The data items relating to the intervention characteristics were informed by the Template for Intervention Description and Replication (TIDieR) checklist [16]. These were: the clinical outcomes ('why'); who provided the intervention; what procedures were employed (these were categorised using the cluster headings from the Behaviour Change Technique Taxonomy [17]); how the intervention was delivered; the number of times the intervention was delivered; tailoring and modification. We also charted data on which PMT constructs the interventions targeted, the results of the studies, and research recommendations.

Table 1. Search strategy.

	Search terms
1.	Protection motivation theory.mp.
2.	Exp Rehabilitation/
3.	Exp Surgery/
4.	2 OR 3
5.	1 AND 4

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Synthesis of results

We produced narrative and tabular summaries for study characteristics, intervention characteristics, PMT constructs targeted, results of the studies, and research recommendations.

Results

Selection of sources of evidence

After the removal of duplicates, 972 records were identified (Fig 2). Based on the title and abstract, 952 records were excluded and the full texts of the remaining 20 reports were assessed for eligibility. Seven of these were excluded. The remaining 13 studies were included in the review. No additional eligible studies were identified by screening the first 200 results from the Google Scholar search.

Study characteristics

Studies included in the review were conducted in a range of countries: USA (n=4 [18–21]); Iran (n=3 [22–24]); China (n=3 [25–27]); Canada (n=1 [28]), New Zealand (n=1 [29]), and the UK (n=1 [30]). The types of studies were randomised controlled trials (RCTs) (n=12 [18–27,29,30]) and a quasi-experimental study (n=1 [28]). Studies took place in a range of settings: clinical primary care settings (n=6 [19–23,29]); clinical secondary care settings (n=4 [18,25,27,30]); and non-clinical settings (n=3 [24,26,28]). The types of conditions being studied were chronic (n=9 [18,19,21–23,25–27,30]) and acute (n=4 [20,24,28,29]). The outcomes measured in the studies related to: beliefs, cognitions and knowledge

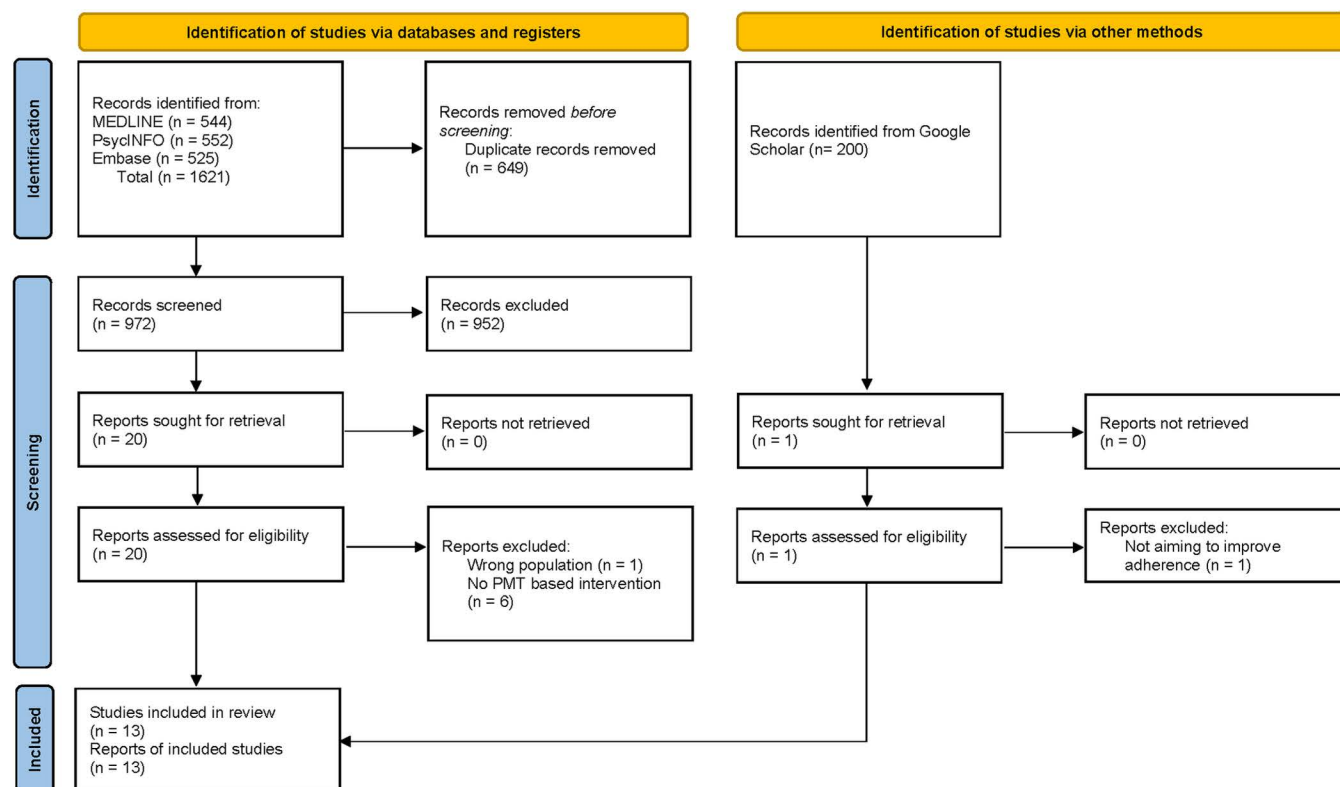


Fig 2. Flow diagram of selection of sources of evidence for inclusion in the review.

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(n = 12 [18–22,24–30]); behaviour (n = 10 [18,20–26,28,29]); and physical health (n = 10 [18,20–23,25–29]). Table 2 presents the study characteristics.

Characteristics of the interventions

The clinical aims of the interventions were to: improve self-management (n = 7 [18,20,21,25,27,29,30]); increase healthy behaviours (n = 4 [22–24,26]); and identify behaviour determinants (n = 2 [19,28]).

The materials used in the interventions were: digital educational materials (n = 3 [21,24,29]); paper-based educational materials (n = 6 [18–21,25,27]); educational materials (type unspecified) (n = 2 [22,23]); digital applications (n = 2 [26,30]); protocols, checklists, or lists to support intervention delivery (n = 3 [18,20,30]); and individualised risk information letters (n = 1 [28]).

We categorised the procedures used in each intervention according to the cluster headings listed in the Behaviour Change Technique Taxonomy [17]. These included: Natural consequences (n = 9 [18,19,22–27,29]); Feedback and monitoring (n = 5 [25–28,30]); Shaping knowledge (n = 5 [20–23,29]); Goals and planning (n = 3 [23,26,27]); Self-belief (n = 2

Table 2. Study characteristics.

Author, year and country of origin	Design	Setting	Condition type	Outcomes		
				Beliefs/cognitions /knowledge	Behaviour	Physical health
Asimakopoulou, 2015 (UK)	RCT	Clinical, Secondary care	Chronic	PMT constructs; emotional reactions	None	None
Boeka, 2009 (USA)	RCT	Clinical, Secondary care	Chronic	PMT constructs; adherence intention	Adherence	Weight
Boeka, 2010 (USA)	RCT	Clinical, primary care	Chronic	PMT constructs; adherence intention	None	None
Dashti, 2020 (Iran)	RCT	Clinical, primary care	Chronic	PMT constructs	Dietary intake; physical activity	Weight; haemoglobin A1C
Guan, 2023 (China)	RCT	Clinical, Secondary care	Chronic	PMT Constructs	Chronic disease self-management	Pulmonary function
Haugtvedt, 1998 (USA)	RCT	Clinical, primary care	Acute	PMT constructs; adherence intention	Medication adherence	Illness symptoms
Lin, 2019 (China)	RCT (protocol)	Non-clinical	Chronic	PMT constructs; adherence intention	Adherence	Tuberculosis treatment outcomes; nicotine dependence
Morowatisharifabad, 2021 (Iran)	RCT	Clinical, primary care	Chronic	None	Physical activity	V02 max; haemoglobin A1C
R Bassett, 2011 (Canada)	Quasi-experimental study	Non-clinical	Acute	PMT constructs	Physical activity	BMI; waist circumference; c-reactive protein; triglycerides; glucose; insulin
S Bassett, 2011 (New Zealand)	RCT	Clinical, primary care	Acute	PMT constructs; adherence intention	Rehabilitation adherence	Ankle function
Schaffer, 2004 (USA)	RCT	Clinical, primary care	Chronic	PMT constructs; knowledge	Medication adherence	Asthma control; quality of life
Vasli, 2023 (Iran)	RCT	Non-clinical	Acute	Knowledge; PMT constructs	Health behaviours	None
Yao, 2020 (China)	RCT	Clinical, Secondary care	Chronic	Self-rated depression; psychological resilience	None	Blood glucose control; quality of life

RCT: randomised controlled trial

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[19,23]); Associations (n = 1 [26]); Comparison of behaviour (n = 1 [29]); Regulation (n = 1 [21]); Repetition and substitution (n = 1 [26]) and Social support (n = 1 [25]). Characteristics of the interventions are summarised in Table 3.

The interventions were provided by: researchers (n = 8 [18,19,21,23,24,26,28,30]); allied health professionals (n = 2 [20,29]); multidisciplinary teams (n = 1 [25]), and nurses (n = 1 [27]). One study did not report who provided the intervention (n = 1 [22]).

Interventions were delivered in various ways: face-to-face only (n = 6 [18,19,22,23,27,30]); material led (n = 3 [21,28,29]); via digital applications (n = 2 [24,26]), and face-to-face and by telephone (n = 2 [20,25]). Interventions were

Table 3. Characteristics of the interventions: brief name, why (clinical aim), what (materials), and what (procedures).

Study	Brief name	Why (clinical aim)	What (materials)	What (procedures)
Asimakopoulou 2015	Individualised periodontal disease risk consultation to alter psychological variables related to adherence with periodontal instructions.	Improve self-management	Protocol/checklist/script to support intervention delivery; digital application	Feedback and monitoring
Boeka 2009	PMT based informational intervention for people undergoing bariatric surgery to promote adherence to post-surgery eating behaviour guidelines	Improve self-management	Paper-based educational materials; protocol/checklist/script to support intervention delivery	Natural consequences
Boeka 2010	PMT based psychosocial intervention for patients undergoing bariatric surgery.	Investigate behaviour determinants	Paper-based educational materials	Natural consequences; self-belief
Dashti 2020	PMT based training programme for improving nutritional behaviour and physical activity in military patients with type 2 diabetes mellitus.	Promote healthy behaviours	Educational materials (unspecified)	Shaping knowledge; natural consequences
Guan 2023	PMT based nursing intervention for patients with respiratory diseases.	Promote healthy behaviours	Paper-based educational materials	Natural consequences; feedback and monitoring; social support
Haugtvedt 1998	PMT based brochure on taking antibiotics correctly, along with verbal reinforcement from a pharmacist, to promote adherence to an antibiotic regimen.	Improve self-management	Paper-based educational materials; protocol/checklist/script to support intervention delivery	Shaping knowledge
Lin 2019	Smartphone application “QinTb” for smoking cessation in tuberculosis patients.	Promote healthy behaviours	Digital application	Natural consequences; goals and planning; feedback and monitoring; repetition and substitution; associations
Morowatisharifabad 2021	Educational intervention based on PMT and Implementation Intention to promote physical activity in patients with type 2 diabetes mellitus.	Promote healthy behaviours	Educational materials (unspecified)	Natural consequences; goals and planning; self-belief; shaping knowledge
R Bassett 2011	Individualised, PMT based informational intervention to promote physical activity among people with spinal cord injury.	Investigate behaviour determinants	Individualised risk information letters	Feedback and monitoring
S Bassett 2011	PMT based informational video to promote adherence to physiotherapy.	Improve self-management	Digital educational materials	Shaping knowledge; natural consequences; comparison of behaviour
Schaffer 2004	A PMT based informational intervention to promote asthma medication adherence.	Improve self-management	Digital educational materials; paper-based educational materials	Shaping knowledge; regulation
Vasli 2023	PMT based empowerment intervention to promote health behaviours in women with HPV.	Promote healthy behaviours	Digital educational materials	Natural consequences
Yao 2020	PMT based informational intervention for patients with type 2 diabetes mellitus.	Improve self-management	Paper-based educational materials	Feedback and monitoring; natural consequences; goals and planning

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delivered: individually (n=6 [20,24–26,28,30]); in both groups and individually (n=4 [18,19,27,29]) and in groups (n=1 [23]). Two studies did not report whether the intervention was delivered individually or in groups (n=2 [21,22]).

Interventions were delivered in: a single session (n=6 [19–21,28–30]); more than five sessions (n=4 [23,25–27]) and fewer than five sessions (n=3 [18,22,24]). These characteristics of the intervention are summarised in Table 4.

As detailed in Table 5, six of the interventions in the studies were tailored to individual participants (n=6 [22,23,25–27,29]) and seven were not (n=7 [18–21,24,28,30]).

Most studies did not report any modifications to the intervention (n=12 [18–28,30]). One study increased the emphasis on self-efficacy within the intervention after seeing no significant difference between the intervention group and the control group [29].

Few studies reported on approaches to maintain intervention fidelity – i.e., how well (planned) (n=3 [18,20,25]). The approaches that were reported are summarised in Table 5. None of the studies reported on the actual intervention fidelity – i.e., how well (actual).

Targeting of PMT constructs

The studies targeted different constructs within PMT (Table 6). Interventions targeted the following threat appraisal constructs: perceived vulnerability (n=10 [18,19,21,23–26,28–30]); perceived severity (n=10 [18,19,22–27,29,30]); and intrinsic and extrinsic rewards (n=4 [20,23–25]). One study did not report targeting any threat appraisal constructs (n=1 [20]). In terms of coping appraisal, interventions targeted: self-efficacy (n=10 [18–21,23–27,30]); response efficacy (n=8 [18,20–22,24,25,27,29]); response cost (n=4 [23–26]). One study did not report targeting any coping appraisal constructs (n=1 [28]).

Follow up

The length of follow up ranged from immediately post intervention (n=2, [27,30]) to 12 months post intervention (n=1, [26]). Table 7 presents the length of follow up used in each of the studies.

Table 4. Characteristics of the interventions: who provided, how, and number of sessions.

Study	Who provided	How		Number of sessions
		Mode of delivery	Group or individual delivery	
Asimakopoulou 2015	Researchers	Face-to-face	Individual	1
Boeka 2009	Researchers	Face-to-face	Individual and group	<5
Boeka 2010	Researchers	Face-to-face	Individual and group	1
Dashti 2020	Unspecified	Face-to-face	Not reported	<5
Guan 2023	Multidisciplinary team	Face-to-face; telephone	Individual	>5
Haugtvedt 1998	Pharmacists	Face-to-face; telephone	Individual	1
Lin 2019	Researchers	Virtual	Individual	>5
Morowatisharifabad 2021	Researchers	Face-to-face	Group	>5
R Bassett 2011	Researchers	Material led	Individual	1
S Bassett 2011	Physiotherapists	Material led	Individual and group	1
Schaffer 2004	Researchers	Material led	Not reported	1
Vasli 2023	Researchers	Virtual	Individual	<5
Yao 2020	Nurses	Face-to-face	Individual and group	>5

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Table 5. Characteristics of the interventions: tailoring, modification, how well (planned) and how well (actual).

Study	Tailoring	Modification	How well	
			Planned	Actual
Asimakopoulou 2015	No	None reported	Not reported	Not reported
Boeka 2009	No	None reported	Investigator used a checklist of discussion points to maintain continuity across the group discussions	Not reported
Boeka 2010	No	None reported	Not reported	Not reported
Dashti 2020	Yes	None reported	Not reported	Not reported
Guan 2023	Yes	None reported	The intervention team were trained in PMT before delivering the intervention	Not reported
Haugtvedt 1998	No	None reported	Pharmacists followed a written protocol for verbal reinforcement	Not reported
Lin 2019	Yes	None reported	Not reported	Not applicable – study protocol
Morowatishari-fabad 2021	Yes	None reported	Not reported	Not reported
R Bassett 2011	No	None reported	Not reported	Not reported
S Bassett 2011	Yes	Increased emphasis on self-efficacy within the intervention.	Not reported	Not reported
Schaffer 2004	No	None reported	Not reported	Not reported
Vasli 2023	No	None reported	Not reported	Not reported
Yao 2020	Yes	None reported	Not reported	Not reported

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Results of the interventions

Seven studies found a significant difference in behaviour change between the intervention and control group [18,21,22,24,25,27,30]. Five studies found no significant difference in behaviour change between the intervention and control group [19,20,23,28,29]. One of the included articles was a protocol for a study so did not present any results [26].

Studies that found a significant difference in behaviour change between the intervention and control group more often targeted the response efficacy construct (7/7 [18,21,22,24,25,27,30]) than those which did not find significant differences (2/5 [20,29]).

Research recommendations

Studies provided a range of recommendations for further research. These were: using longer follow up periods (n=6 [18,23,25,27,28,30]); investigating the impact of specific PMT constructs (n=3 [19,20,28]); incorporating other behaviour change theories alongside PMT (n=2 [21,29]); investigating the impact of delivering the intervention over a longer period of time (n=2 [27,30]); exploring the optimal mode of intervention delivery (n=1 [29]) and using more individualised interventions (n=1 [28]). These are summarised in Table 8.

Discussion

This scoping review of PMT-based healthcare interventions included 13 studies published between 1998 and 2023 in six different countries. The majority were randomised controlled trials conducted across primary care, secondary care, and non-clinical settings for both acute and chronic conditions. Intervention aims included promoting healthy behaviours, improving self-management, and identifying behaviour determinants. Half of studies reported significant between-group differences in behaviour change, while the remainder found no significant differences. The core PMT constructs

Table 6. Threat appraisal and coping appraisal constructs targeted in each intervention.

Study	Threat appraisal			Coping appraisal		
	Perceived severity	Perceived vulnerability	Intrinsic and extrinsic rewards	Response efficacy	Self-efficacy	Response cost
Asimakopoulou 2015	✓	✓		✓	✓	
Boeka 2009	✓	✓		✓	✓	
Boeka 2010	✓	✓			✓	
Dashti 2020	✓			✓		
Guan 2023	✓	✓	✓	✓	✓	✓
Haugtvedt 1998			✓	✓	✓	
Lin 2019	✓	✓			✓	
Morowatisharifabad 2021	✓	✓	✓		✓	✓
R Bassett 2011		✓				
S Bassett 2011	✓	✓		✓		
Schaffer 2004	✓	✓		✓	✓	
Vasli 2023	✓	✓	✓	✓	✓	✓
Yao 2020	✓			✓	✓	

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Table 7. Length of follow up used in each of the studies.

Study	Length of follow up
Asimakopoulou 2015	Immediately post intervention
Boeka 2009	3 months
Boeka 2010	1 week
Dashti 2020	3 months
Guan 2023	4 weeks
Haugtvedt 1998	10 days
Lin 2019	12 months
Morowatisharifabad 2021	3 months
R Bassett 2011	2 weeks
S Bassett 2011	Not reported
Schaffer 2004	6 months
Vasli 2023	3 months
Yao 2020	Immediately post intervention

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of perceived severity, perceived vulnerability, response efficacy and self-efficacy were targeted in most interventions, whereas response costs and intrinsic and extrinsic rewards were targeted in few interventions. Few studies reported on intervention fidelity. We could not identify any consistent intervention feature clearly associated with superior outcomes. While showing potential promise in select settings, this review revealed substantial heterogeneity in how PMT has been implemented and substantial remaining uncertainties around what drives efficacy to motivate patient adherence.

Strengths of this scoping review include the use of robust methodology aligned with published guidance. The involvement of two independent reviewers improved reliability in study selection and data extraction. The TIDieR framework enabled consistent reporting on key features [16]. The broad, cross-disciplinary scope facilitates identification of research gaps and potential new applications.

However, as a scoping review, there was no formal quality assessment or risk of bias evaluation as in a systematic review [11]. This is especially important in interpreting the results, given the small size of the individual studies, which is

Table 8. Research gaps identified from included studies.

Theme	Research Gap	Importance	References
Longer follow-up periods	Are behaviour changes following the intervention maintained?	Examining the long-term effects is important for health-care planning and for understanding the effectiveness of the intervention.	[18,23,25,27,28,30]
Specific constructs of PMT	Does emphasis on specific combinations of PMT constructs impact the success of an intervention?	To refine the design of interventions to produce optimal behaviour change.	[19,20,28]
Other behaviour change theories	What is the effect of incorporating other behaviour change theories with PMT?	A multi-theoretical approach may create more effective interventions for patient adherence.	[21,29]
Mode of intervention delivery	What other modes of presenting the intervention may improve behaviour change?	To increase effectiveness and improve efficiency of interventions.	[29]
Individualising interventions	Does tailoring of an intervention to each individual produce greater or faster behaviour change?	To understand how to make the most effective intervention.	[28]
Longer duration of intervention delivery	Does increased duration of intervention delivery affect behaviour change?	To optimise intervention design and delivery.	[27,30]

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often associated with exaggerated treatment effects [31–35]. The included studies exhibited substantial heterogeneity in populations, interventions, outcomes, and PMT operationalisation, precluding definitive conclusions or clinical recommendations on what drives efficacy. Restricting the search to three databases may have excluded potentially relevant literature. Generalisability is limited given that all interventions were trialled in upper-middle- or high-income countries. Finally, the lack of primary studies investigating adaptations of successful PMT interventions represents a broader evidence gap.

The synthesis provides a breakdown of the existing PMT based interventions in a range of clinical areas, allowing healthcare professionals to select components that are relevant to and practicable in their setting. Those developing PMT interventions should follow best practice guidance on design [9,36] and reporting [16,37]. Healthcare professionals should consider assessing perceptions of threat and coping ability using simple PMT screening questions to identify targets for intervention. The most relevant constructs within PMT are likely to differ across health conditions and treatment regimens. Therefore, exploratory research should be undertaken prior to intervention development to identify the constructs most pertinent to the specific clinical context. Multi-component interventions addressing various PMT constructs may have the greatest impact on behavioural intentions and health outcomes. Adaptations maximising perceived personal relevance are likely to be important for success. Cultural factors should be taken into account when designing and adapting interventions to ensure that these are relevant for the target audience.

This scoping review demonstrates that PMT holds promise for motivating health behaviours, but uncertainty remains around optimal implementation. Most studies revealed positive effects in select settings, but none established definitive strategies for ensuring reliable adherence improvements. Future research should investigate effective combinations of constructs, delivery adaptations and individualisation approaches to expand impact and accessibility. Studies should determine necessary intervention intensity and duration, and examine intervention sustainability in well-powered, real-world effectiveness trials. Above all researchers should use standardised reporting methods and pragmatic, theory-driven trials assessing long-term, patient important outcomes across diverse contexts.

Supporting information

S1 File. PRISMA-ScR Checklist.
(PDF)

Author contributions

Conceptualization: Paul Norman, Daniel Hind, Raveen Jayasuriya.

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Writing – original draft: Olivia Hawksworth.

Writing – review & editing: Jemima Solt, Dowon Jang, Paul Norman, Daniel Hind, Raveen Jayasuriya.

References

1. Middleton KR, Anton SD, Perri MG. Long-Term Adherence to Health Behavior Change. *Am J Lifestyle Med.* 2013;7(6):395–404. <https://doi.org/10.1177/1559827613488867> PMID: 27547170
2. Martin LR, Williams SL, Haskard KB, Dimatteo MR. The challenge of patient adherence. *Ther Clin Risk Manag.* 2005;1(3):189–99. PMID: 18360559
3. Ley C, Putz P. Efficacy of interventions and techniques on adherence to physiotherapy in adults: an overview of systematic reviews and panoramic meta-analysis. *Syst Rev.* 2024;13(1):137. <https://doi.org/10.1186/s13643-024-02538-9> PMID: 38773659
4. Barnett NL. Medication adherence: where are we now? A UK perspective. *European J Hospital Pharm.* 2014;21: 181–4. <https://doi.org/10.1136/epharm-2013-000373>
5. Lee EKP, Poon P, Yip BHK, Bo Y, Zhu M, Yu C, et al. Global Burden, Regional Differences, Trends, and Health Consequences of Medication Non-adherence for Hypertension During 2010 to 2020: A Meta-Analysis Involving 27 Million Patients. *J Am Heart Association.* 2022;11: e026582. <https://doi.org/10.1161/JAHA.122.026582>
6. Griffin B, Conner M, Norman P. Applying an extended protection motivation theory to predict Covid-19 vaccination intentions and uptake in 50-64 year olds in the UK. *Soc Sci Med.* 2022;298:114819. <https://doi.org/10.1016/j.socscimed.2022.114819> PMID: 35245755
7. Rogers RW. A Protection Motivation Theory of Fear Appeals and Attitude Change1. *J Psychol.* 1975;91(1):93–114. <https://doi.org/10.1080/00223980.1975.9915803> PMID: 28136248
8. FLOYD DL, PRENTICE-DUNN S, ROGERS RW. A Meta-Analysis of Research on Protection Motivation Theory. *J Applied Social Psychol.* 2000;30(2):407–29. <https://doi.org/10.1111/j.1559-1816.2000.tb02323.x>
9. O’Cathain A, Croot L, Duncan E, Rousseau N, Sworn K, Turner KM, et al. Guidance on how to develop complex interventions to improve health and healthcare. *BMJ Open.* 2019;9(8):e029954. <https://doi.org/10.1136/bmjopen-2019-029954> PMID: 31420394
10. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *BMJ.* 2021;374:n2061. <https://doi.org/10.1136/bmj.n2061> PMID: 34593508
11. Khalil H, Tricco AC. Differentiating between mapping reviews and scoping reviews in the evidence synthesis ecosystem. *J Clin Epidemiol.* 2022;149:175–82. <https://doi.org/10.1016/j.jclinepi.2022.05.012> PMID: 35636593
12. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev.* 2015;4(1):1. <https://doi.org/10.1186/2046-4053-4-1> PMID: 25554246
13. Hind D, Jayasuriya R, Hawksworth O, Duffy K, Woodward J. The use of Protection-Motivation Theory to support patient adherence in perioperative care, rehabilitation and other settings: protocol for a scoping review. The University of Sheffield. 2023. https://orda.shef.ac.uk/articles/workflow/The_use_of_Protection-Motivation_Theory_to_support_patient_adherence_in_perioperative_care_rehabilitation_and_other_settings_protocol_for_a_scoping_review_/24162399/2
14. Haddaway NR, Collins AM, Coughlin D, Kirk S. The role of google scholar in evidence reviews and its applicability to grey literature searching. *PLoS One.* 2015;10(9):e0138237. <https://doi.org/10.1371/journal.pone.0138237> PMID: 26379270
15. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. *Syst Rev.* 2016;5(1):210. <https://doi.org/10.1186/s13643-016-0384-4> PMID: 27919275
16. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ.* 2014;348:g1687. <https://doi.org/10.1136/bmj.g1687> PMID: 24609605
17. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med.* 2013;46(1):81–95. <https://doi.org/10.1007/s12160-013-9486-6> PMID: 23512568
18. Boeka A. Effects of a psychosocial intervention on eating behavior compliance in bariatric surgery patients. University of Alabama Libraries. 2009. <https://ir.ua.edu/handle/123456789/597>
19. Boeka AG, Prentice-Dunn S, Lokken KL. Psychosocial predictors of intentions to comply with bariatric surgery guidelines. *Psychol Health Med.* 2010;15(2):188–97. <https://doi.org/10.1080/13548501003615282> PMID: 20391236

20. Haugtvedt CL. Enhancing adherence to antibiotic regimens: A test of protection motivation theory and persuasive communications. The Ohio State University. 1998. <https://www.proquest.com/dissertations-theses/enhancing-adherence-antibiotic-regimens-test/docview/304441978/se-2?accountid=13828>
21. Schaffer SD, Tian L. Promoting adherence: effects of theory-based asthma education. *Clin Nurs Res*. 2004;13(1):69–89. <https://doi.org/10.1177/1054773803259300> PMID: 14768768
22. Dashti S, Dabaghi P, Tofangchiha S. The effectiveness of training program based on protective motivation theory on improving nutritional behaviors and physical activity in military patients with type 2 diabetes mellitus. *J Family Med Prim Care*. 2020;9(7):3328–32. https://doi.org/10.4103/jfmpc.jfmpc_70_20 PMID: 33102291
23. Morowatisharifabad MA, Asadpour M, Zakeri MA, Abdolkarimi M. The Effect of Integrated Intervention Based on Protection Motivation Theory and Implementation Intention to Promote Physical Activity and Physiological Indicators of Patients with Type 2 Diabetes. *Biomed Res Int*. 2021;2021:6637656. <https://doi.org/10.1155/2021/6637656> PMID: 34258275
24. Vasli P, Zahedinia S, Hosseini M, Nasiri M. A Protection Motivation Theory-Based Empowerment Intervention for Promoting Health Behaviors in Women With Human Papillomavirus: An Experimental Study. *Sex Transm Dis*. 2023;50(11):e34–6. <https://doi.org/10.1097/OLQ.0000000000001864> PMID: 37643418
25. Guan J, Zhang Y, You S, Li Y, Zhao H, Bu W, et al. Application of protection motivation theory in epidemic prevention in patients with respiratory diseases under the COVID-19 pandemic: A cross-sectional study. *Clin Respir J*. 2023;17(10):1058–66. <https://doi.org/10.1111/crj.13693> PMID: 37666659
26. Lin H, Lin Y, Zheng Y, Liu Z, Chang C. Design, development and randomised controlled trial of a smartphone application, “QinTB”, for smoking cessation in tuberculosis patients: study protocol. *BMJ Open*. 2019;9(12):e031204. <https://doi.org/10.1136/bmjopen-2019-031204> PMID: 31796480
27. Yao X, Zhang L, Du J, Gao L. Effect of Information-Motivation-Behavioral Model Based on Protection Motivation Theory on the Psychological Resilience and Quality of Life of Patients with Type 2 DM. *Psychiatr Q*. 2021;92(1):49–62. <https://doi.org/10.1007/s11126-020-09783-w> PMID: 32445004
28. Bassett RL, Ginis KAM. Risky business: the effects of an individualized health information intervention on health risk perceptions and leisure time physical activity among people with spinal cord injury. *Disabil Health J*. 2011;4(3):165–76. <https://doi.org/10.1016/j.dhjo.2010.12.001> PMID: 21723523
29. Bassett SF, Prapavessis H. A test of an adherence-enhancing adjunct to physiotherapy steeped in the protection motivation theory. *Physiother Theory Pract*. 2011;27(5):360–72. <https://doi.org/10.3109/09593985.2010.507238> PMID: 20795875
30. Asimakopoulou K, Newton JT, Daly B, Kutzer Y, Ide M. The effects of providing periodontal disease risk information on psychological outcomes - a randomized controlled trial. *J Clin Periodontol*. 2015;42(4):350–5. <https://doi.org/10.1111/jcpe.12377> PMID: 25682859
31. Lane C, McCrabb S, Nathan N, Naylor P-J, Bauman A, Milat A, et al. How effective are physical activity interventions when they are scaled-up: a systematic review. *Int J Behav Nutr Phys Act*. 2021;18(1):16. <https://doi.org/10.1186/s12966-021-01080-4> PMID: 33482837
32. Wang H, Song J, Lin Y, Dai W, Gao Y, Qin L, et al. Trial-level characteristics associate with treatment effect estimates: a systematic review of meta-epidemiological studies. *BMC Med Res Methodol*. 2022;22(1):171. <https://doi.org/10.1186/s12874-022-01650-5> PMID: 35705904
33. Kotani Y, Turi S, Ortalda A, Baiardo Redaelli M, Marchetti C, Landoni G, et al. Positive single-center randomized trials and subsequent multicenter randomized trials in critically ill patients: a systematic review. *Crit Care*. 2023;27(1):465. <https://doi.org/10.1186/s13054-023-04755-5> PMID: 38017475
34. Raymond J, Darsaut TE, Eneling J, Chagnon M. The small trial problem. *Trials*. 2023;24(1):426. <https://doi.org/10.1186/s13063-023-07348-3> PMID: 37349843
35. Beets MW, Weaver RG, Ioannidis JPA, Geraci M, Brazendale K, Decker L, et al. Identification and evaluation of risk of generalizability biases in pilot versus efficacy/effectiveness trials: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act*. 2020;17(1):19. <https://doi.org/10.1186/s12966-020-0918-y> PMID: 32046735
36. O’Cathain A, Croot L, Sworn K, Duncan E, Rousseau N, Turner K, et al. Taxonomy of approaches to developing interventions to improve health: a systematic methods overview. *Pilot Feasibility Stud*. 2019;5:41. <https://doi.org/10.1186/s40814-019-0425-6> PMID: 30923626
37. Duncan E, O’Cathain A, Rousseau N, Croot L, Sworn K, Turner KM, et al. Guidance for reporting intervention development studies in health research (GUIDED): an evidence-based consensus study. *BMJ Open*. 2020;10(4):e033516. <https://doi.org/10.1136/bmjopen-2019-033516> PMID: 32273313