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Psychological predictors of seasonal influenza vaccination uptake among adults with a high-risk physical health condition: a systematic review

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ABSTRACT

***Objective*:** This review tested the use of psychological theories for predicting seasonal influenza vaccination behaviour among adults with a health condition (for which the vaccine is clinically indicated).

Methods: Ovid (1946–August 2018), Embase (1974–August 2018), CINAHL (1958–August 2018) and PSYCInfo (1986–August 2018) databases were searched. Studies drawing upon a psychosocial or psychological theory to explain seasonal influenza vaccination behaviour among adults with a high-risk health condition were eligible for inclusion. Papers were systematically extracted by title, abstract and full text. Quantitative and qualitative studies were included, and all papers were quality assessed.

Results: A total of 4840 papers were identified after removal of duplicates. Twelve papers were retained in the narrative synthesis. Studies were conducted across a range of high-risk condition populations and most (83.3%) were cross-sectional. The Health Belief Model (HBM), the model of Psychological Flexibility, The Health Action Process Approach and House's Framework of Social Support were applied. Ten out of 12 papers (83.3%) drew on the HBM.

Conclusion: There was evidence of an association between HBM perceived benefits, perceived barriers and vaccination behaviour, although there were inconsistencies across studies. This review highlighted the need for further research, particularly prospective studies of high methodological quality.

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KEYWORDS
Seasonal influenza vaccine; high-risk condition; chronic illness; health beliefs

Introduction

Adults with a chronic health condition are at increased risk of developing serious complications from vaccine-preventable diseases such as influenza (Centers for Disease Prevention and Control, 2018). An annual seasonal flu vaccination is therefore recommended for individuals with chronic renal, heart, respiratory, liver and neurological diseases, and for anyone with diabetes, immunosuppression or morbid obesity (BMI >

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40) (Health Protection Scotland, 2016). Improving vaccination uptake in high-risk groups is essential to reduce the burden of influenza. The World Health Organisation (WHO) estimates that the influenza virus causes between 290,000 and 650,000 deaths per year (WHO, 2017).

Due to the changing nature of influenza, the WHO monitors the epidemiology of the virus before advising which strains should be included in the annual seasonal influenza vaccine (Public Health England, 2017; WHO, 2016). With the exception of the 2014/5 season, the vaccine for the northern hemisphere has been well matched to the most prominent viruses in circulation, and it is the most effective protection against influenza (Centers for Disease Prevention and Control, 2019; Public Health England, 2017). The flu vaccination is recommended for individuals in clinical at-risk groups; however, uptake remains suboptimal. Public Health England (2018) reported that for the 2017/8 season, only 48.9% of individuals aged under 65 years with a high-risk condition had received the vaccine. The Netherlands and the UK have the highest vaccination rates in Europe, with other countries reporting less coverage (British Journal of General Practice, 2016). It is therefore important to understand the determinants of vaccination behaviour among chronically ill adults to ensure that effective strategies can be employed to improve uptake.

Vaccination decision-making is a complex process, and a breadth of studies have sought to understand predictors of vaccination acceptance and refusal. Sociodemographic variables such as sex, age, education and ethnicity are commonly studied, but generally yield inconsistent results across research populations (Schmid et al., 2017). It can therefore be beneficial to consider the psychological processes underlying vaccination decision making, with several studies reporting that attitudinal factors are more influential in predicting vaccination behaviour than demographic factors (Keenan et al., 2007; Lyn-Cook et al., 2007; Turner et al., 2015).

Social cognition theories of behaviour and behaviour change can assist in structuring our understanding of psychosocial factors that impact vaccination decision-making. They also provide a useful framework for designing interventions to promote uptake. In the vaccination behaviour field, a range of models have been applied including; the Theory of Planned Behaviour, Health Belief Model and Protection Motivation Theory (Bish et al., 2011; Cheney & John, 2013; Myers & Goodwin, 2011). Myers and Goodwin (2011) reported that an extended Theory of Planned Behaviour predicted 60% of the variance in healthy adult's intentions to receive the pandemic swine flu vaccination. Cheney and John (2013) applied the Health Belief Model to structure findings from qualitative interviews exploring barriers to seasonal flu vaccination among high-risk groups. They reported that individuals receiving the vaccine were more likely to describe influenza as a threat to health, and they perceived cues to action and access barriers as being influential in determining whether they would receive the vaccine. On the other hand, resistant individuals did not view access barriers as an issue, and they did not respond favourably to prompts and cues to action. This study highlighted how responsivity to vaccination promotion interventions may differ between individuals who hold favourable views of the vaccine compared to those with negative opinions.

Psychological models have been applied in systematic reviews to structure findings about the determinants of vaccination behaviour. Kan and Zhang (2018) used a

framework derived from the HBM and Theory of Reasoned Action (TRA) in a review exploring barriers to seasonal flu vaccination uptake among elderly people. The authors reported that threat perception, behavioural beliefs, subjective norms, cues to action, past behaviour and perceived barriers were most influential in determining vaccination uptake among this population. Protection Motivation Theory was similarly applied by Bish et al. (2011) in a systematic review of factors associated with pandemic flu vaccination uptake. The degree to which individuals perceived the flu as a threat and the vaccination as an effective coping strategy was associated with uptake. There was also evidence that those who felt social pressure to receive the vaccine, and who accessed information from official health sources were also more likely to accept the vaccine than those relying on unofficial sources.

The literature demonstrates that a range of psychological models can be applied to understand vaccination behaviour, with good explanatory power. Application of a theory allows evidence to be accumulated and compared across populations. This therefore supports the development of theoretically-informed interventions which can be tested accordingly. Evidence also suggests that interventions derived from theory can lead to larger and more sustainable changes in behaviour (Prestwich et al., 2015). The purpose of this review was therefore to synthesise evidence examining the association between psychological constructs and seasonal influenza vaccination behaviour among adults with a high-risk physical health condition as this remained as a gap in the literature. It specifically included studies that drew upon a psychosocial or psychological theoretical model or framework in explaining seasonal influenza vaccination behaviour with a view to offering recommendations for psychological constructs that could be targeted in vaccination promotion interventions.

Methods

Review protocol

A review protocol was developed and registered on PROSPERO (reference: CRD42018105114). The registration of the review was completed after full-text papers had been identified, but prior to data extraction

Search strategy

Ovid with Medline (1946–August 2018), Embase – via Ebsco (1974–August 2018), CINAHL via Ovid (1958–August 2018) and PSYCInfo via Ebsco (1986–August 2018) databases were searched for relevant studies. Publication dates differed across databases according to their availability. Google, Google Scholar and reference lists of selected full-text articles were also searched for additional relevant studies. Search terms were organised into three categories; high-risk condition, vaccination and behaviour. High-risk conditions were identified from Health Protection Scotland Guidelines (2016), and example search terms were; (chronic respiratory disease, renal transplant*, diabete*). Vaccination searches included; (flu vaccin*, influenza vaccin*, flu inoculation) and behaviour terms included (uptake, accept*, promot*). MeSH terms

were used within each database. A full list of search terms is available in the supplementary materials.

Selection and analysis

Studies were screened by title, abstract and full text independently by the primary reviewer according to inclusion/exclusion criteria (see Table 1). A second reviewer screened 20% of papers identified by abstract and full text to ensure reliability. A minimum 80% agreement rate was agreed a priori, and if this was not met, the second reviewer would review all papers. Studies were selected using the inclusion criteria outlined in Table 1, and all papers selected were assessed for quality using the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018). This tool can be used to assess the quality of empirical papers and is suitable for reviews that include studies of both quantitative and qualitative designs. Quality appraisal was conducted independently by the primary reviewer. No studies were to be excluded on the grounds of poor quality, and quality levels were instead assigned and used to discuss the relative applicability of each of the studies' findings. Data relevant to the review question were extracted and coded independently by the primary researcher using a data collection tool developed on word processing software. This allowed data gathered using a variety of designs for different research purposes to be synthesised for the current review. Information about the sample obtained in each study including sample size, health condition and demographic characteristics was collected. The following data relating to the psychological theory were coded; the name of the model(s) applied, the sections of the paper that referred to the model, whether the whole theory or particular domains were tested and the measurement tool, including whether a validated measure or study-specific questions were used. The following data about vaccination behaviour were coded; subjective or objective design, prospective or retrospective design and the measurement tool. Since scoping exercises had highlighted

Table 1. Inclusion and exclusion criteria for systematic review.

Factor	Inclusion criteria	Exclusion criteria
Behaviour	• Seasonal influenza vaccination uptake behaviours or intentions.	• Studies not related to a behavioural outcome (e.g. those determining medical efficacy of the vaccine). • Studies focussing on vaccination behaviour for other types of influenza (e.g. pandemic, swine).
Psychological factors	• Studies that draw on a relevant psychosocial or psychological model when explaining vaccination behaviour.	• Studies that do not draw on an appropriate psychosocial or psychological theory in their assessment of psychological factors.
Population	• Adults (aged $\geq$16 years) with a physical health condition for which flu vaccination is recommended by Health Protection Scotland (2016). • Studies conducted in samples of older adults with a high-risk condition are eligible for inclusion.	• Studies in paediatric populations ($\leq$ 15 years) or other clinical at-risk groups (e.g. pregnant women, health care workers, healthy elderly adults, residents in long-term facilities). • Studies targeting health-care professionals or organisational-level practices rather than individual perceptions.
Date	Studies published from any date until August 2018.	N/A
Language	Studies published in the English language.	Studies not published in the English language.
Study type	Empirical research studies (qualitative & quantitative).	Editorials, letters, protocol papers and systematic reviews.

heterogeneity across papers in terms of populations, study design and outcomes, a narrative synthesis was undertaken as opposed to meta-analysis. Analysis and synthesis were completed independently by the primary reviewer.

Results

Screening of eligible studies

Figure 1 illustrates the search and selection process for this review. A total of 9289 papers were identified through database searches, and this was reduced to 4840 after removing duplicates. No additional records were identified through searching Google, Google Scholar or the reference lists of included studies. The primary reviewer identified 312 papers that warranted screening of the abstract, 113 papers requiring full-text review and 12 papers for inclusion in the final review. A random sample of 20% of papers was selected using computerised software for screening by a second reviewer. There was 88% agreement between both reviewers at the abstract-level (Cohen's $k = 0.87$), indicating substantial agreement (Landis & Koch, 1977). When disagreements occurred, they were discussed until a conclusion could be reached. In all cases, a conservative approach was adopted and the paper was retained for full-text review. There was one disagreement between reviewers during full-text screening (95.45% agreement, Cohen's $k = 0.88$, indicating almost perfect agreement (Landis & Koch, 1977). This particular paper adopted an unusual design whereby health provider behaviour was measured through patient recall. Since it targeted participant perceptions of the advice they received, rather than directly measuring provider behaviour, it was decided to retain this study in the analysis.

Study and participant characteristics

This review included studies conducted across Europe, Asia, Canada, and the United States of America (see Table 2). Observational studies were most common, with ten out of 12 studies (83.3%) adopting a cross-sectional observational design. One qualitative study (8.3%) and one controlled trial (8.3%) were also identified. Most studies collected data on the sociodemographic characteristics of their sample, disease-related outcomes and psychological factors. A total of 4568 participants were represented in this review, with 4549 individuals participating in quantitative studies and 19 in qualitative research. The average age of participants across the studies was 61 years, and 49.81% of the participants were male. Three studies (25%) were conducted with diabetes patients, two papers (16.7%) focussed on asthmatic patients, two (16.7%) on participants with chronic heart disease (CHD) and one (8.3%) with patients with chronic respiratory disease (CRD). Two studies (16.7%) focussed on patients with chronic kidney disease (CKD). In one of these papers, patients were receiving haemodialysis to treat their CKD, and in the second, individuals had received a kidney transplant. The remaining two studies (16.7%) included in the review did not focus on a specific condition, but included participants with a range of high-risk health conditions.

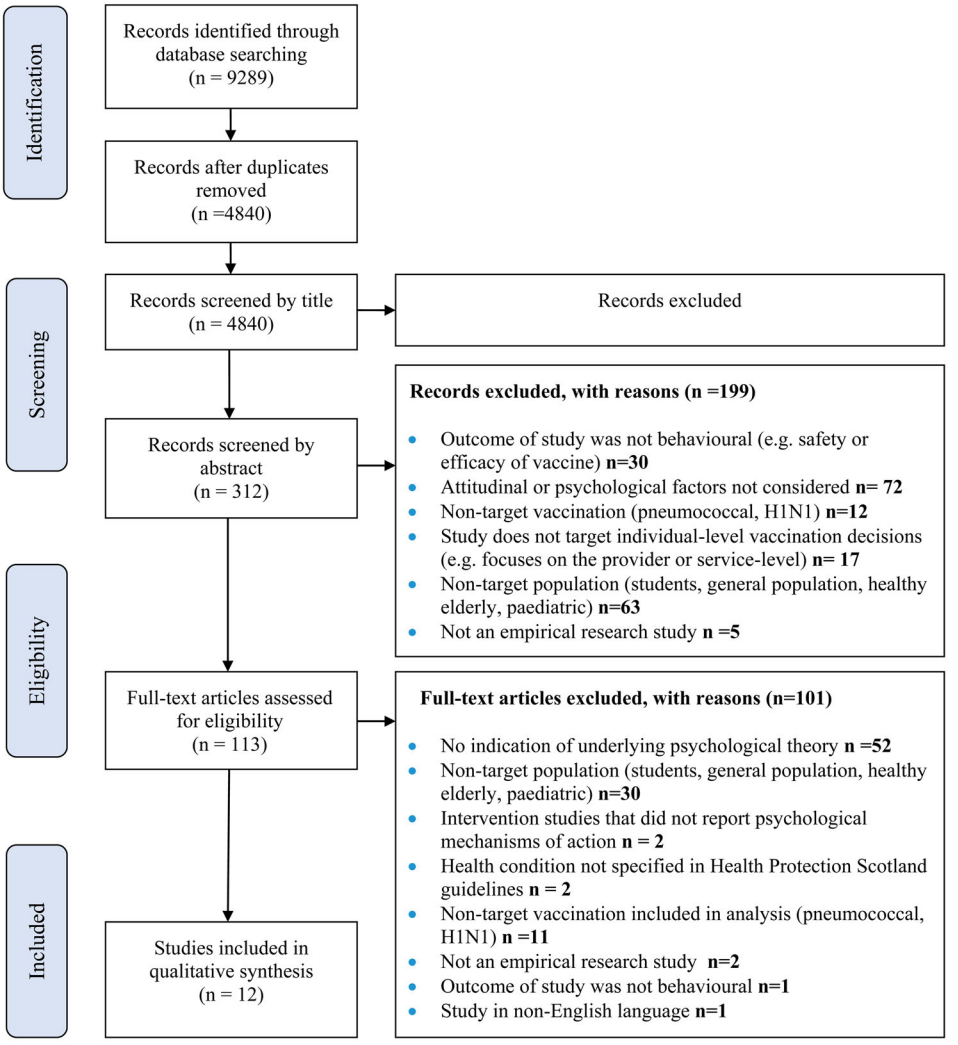

Figure 1. PRISMA flow diagram of paper search and selection process (Moher et al., 2009).

Vaccination uptake

Vaccination uptake was assessed in different ways, with some studies exploring multiple outcomes of vaccination behaviour (e.g. uptake during the last season and future intentions). All studies relied on self-reported measurements. Two studies (13.3%) asked participants if they had been vaccinated against seasonal influenza vaccine in their lifetime, nine studies (60%) asked whether the vaccine had been received during the last season, one study (6.7%) asked whether the vaccine was received every year, two studies (13.3%) measured future vaccination intentions and one paper (6.7%) adopted a prospective design, assessing vaccination behaviour two months after an intervention had been delivered. Uptake levels also differed across studies. The lowest uptake of 22.9% was reported in a mixed sample of adults with a high-risk health condition in Hong Kong (Tsui et al., 2013). Payaprom et al. (2011) reported the highest

Table 2. Summary of studies included in the systematic review.

Study (year) *country*	Population (N) *Gender Age*	Constructs of psychological model (s) used	Application/ measurement of psychological constructs	Design	Measurement of vaccination uptake (reported uptake in sample) *measurement tool*	Main findings	Quality rating (MMAT)
Verger et al. (2018) *France*	Diabetes patients (19) *M = 9, F = 10 18–34 years (10.5%) 35–49 years (10.5%) 50–64 years (36.8%) 65+ years (42.1%)*	Health Belief Model	HBM mentioned in introduction/ discussion	Qualitative. Themes generated for whole sample. Quotes presented separately for vaccinated and unvaccinated participants	Self-reported vaccine uptake during previous season (8 unvaccinated and 11 vaccinated) *interview question*	Vaccination decisions were anchored in past experience. Compensatory health beliefs and misbeliefs about vaccination contributed to non-uptake.	*****
Payaprom et al. (2011) *Thailand*	Individuals with one or more chronic diseases for which vaccination is recommended including diabetes heart disease, asthma (201; HAPA intervention group N = 99, standard leaflet group N = 102) *F = 66.7%, M = 33.3% Mean age: 62.4 years*	Health Action Process Approach	Knowledge, outcome expectancies, self-efficacy, risk perception, action planning (implementation intentions) measured using a reliable but non-validated self-report questionnaire.	Controlled before and after trial Variables compared within groups at T1 and T2 and between groups. Regression analyses used to identify predictors of vaccination intentions & behaviour	Self-reported vaccination status two months after the intervention (87.06%) and vaccination intentions *questionnaire*	Planning ($\beta = .17$, $p = .003$) change in outcome expectancies ($\beta = .40$, $p < .001$) and self-efficacy in arranging time and transportation ($\beta = .31$, $p < .001$) were significant predictors of vaccination intentions in multivariate analysis. Vaccine intentions (OR = 3.89, $p < .001$) and self-efficacy (OR = 1.70, $p = .016$) for arranging time and transport predicted behaviour in a multivariate logistic regression	***
Adams et al. (2014) *USA*	Chronic kidney disease patients receiving haemodialysis (215) *Gender not reported Mean age: 59.4 years*	Health Belief Model	All HBM constructs measured using a self-report questionnaire validated by an expert panel	Descriptive, cross-sectional Comparison between vaccinated and unvaccinated participants on HBM domains	Self-reported receipt of the vaccine in the past (52.56%) *questionnaire*	Participants who received vaccine reported lower mean barriers (1.64 vs 1.88, $p = .002$, Cohen's $d = -0.27$). Other HBM domains were not significantly different between groups.	**

(*continued*)

Table 2. Continued.

Study (year) *country*	Population (N) *Gender Age*	Constructs of psychological model (s) used	Application/ measurement of psychological constructs	Design	Measurement of vaccination uptake (reported uptake in sample) *measurement tool*	Main findings	Quality rating (MMAT)
Yu et al. (2014) *Taiwan*	Adults with Type 2 diabetes (691) *M = 48.0%, F = 52.0%* *Mean age: 64.7 years (SD = 10.7)*	Health Belief Model	All HBM constructs measured using a reliable self-report questionnaire. Face validity was checked.	Cross-sectional Comparison between vaccinated and unvaccinated participants on HBM domains Regression analysis to identify predictors of behaviour	Self-reported receipt of the vaccine in the previous season (35%) *questionnaire*	Vaccinated individuals reported higher benefits (19.57 vs 17.29, $p < .001$, Cohen's $d = 0.59$), lower cues to action (13.63 vs 14.56, $p = .018$, Cohen's $d = -0.19$) and lower barriers (16.49 vs 21.44, $p < .001$, Cohen's $d = -0.90$) than unvaccinated participants. Higher perceived benefits (OR = 1.13, $p < .001$) and lower perceived barriers (OR = 0.86, $p < .001$,) were significant predictors of vaccination uptake in multivariate analysis.	***
Turner et al. (2015) *Canada*	Patients with implantable cardiac defibrillators (229) *Vaccinated group: M = 87%, F = 13%* *Mean age: 71 years* *Unvaccinated group: M = 79%, F = 21%* *Mean age: 65 years*	Health Belief Model (barriers & cues to action)	HBM outlined in introduction. Only four questions asked exploring; perceived lack of effectiveness and side effects (costs) and accessibility (cues)	Cross-sectional Differences between vaccinated and unvaccinated groups compared using rank agreement Statistical predictors of vaccination were identified	Self-reported receipt of the vaccine in the previous season (78%) *questionnaire*	Vaccinated individuals more likely to disagree with 'the flu shot will make me sick' (Cohen's $d = 0.77$) and 'the flu shot is not effective' (Cohen's $d = 0.31$). Disagreement with the statement 'the flu vaccine will make me sick' was the only factor independently associated with vaccination uptake in multivariate regression (OR = 5.56, $p = .01$)	**
Cheung and Mak (2016) *Hong Kong*	Chronic respiratory disease (255) *18–40 years (14.1%)* *41–54 years (16.9%)* *55–64 years*	Health Belief Model and the model of Psychological Flexibility	All HBM dimensions and psychological flexibility were measured using valid self-report questionnaires	Cross-sectional Comparisons were made between vaccinated and unvaccinated individuals Statistical	Self-reported receipt of the vaccine in the previous season (32.9%) *questionnaire*	Vaccinated participants reported significantly higher susceptibility 2.51 vs 2.25, $p < .001$, Cohen's $d = 0.72$), severity (2.67 vs 2.32, $p < .001$, Cohen's $d = 1.02$), cues to action (2.48 vs 2.26, $p = .005$, Cohen's $d = 0.39$) and lower psychological inflexibility (33.35 vs 45.90,	**

(*continued*)

Table 2. Continued.

Study (year) *country*	Population (N) *Gender Age*	Constructs of psychological model (s) used	Application/ measurement of psychological constructs	Design	Measurement of vaccination uptake (reported uptake in sample) *measurement tool*	Main findings	Quality rating (MMAT)
	(33.3%) 65+ years (35.7%) M = 68.2%, F = 31.8%			predictors of vaccination were identified		$p < .001$, Cohen's $d = .039$) than unvaccinated participants. Perceived susceptibility (OR = 3.04, $p = .015$), severity (OR = 3.04, $p = .004$) and psychological flexibility (OR = 49.37, $p < .001$) were significant predictors of vaccination uptake in a multivariate regression model.	
Lyn-Cook et al. (2007) *USA*	Individuals with persistent asthma (167) *Vaccine adherents: F = 88%, M = 12% Vaccine non-adherents: F = 84%, M = 16% 48.5 years (13.3 SD)*	Health Belief Model	All HBM constructs measured using a self-report questionnaire validated by previous research	Cross-sectional Comparisons were made between each health belief for vaccinated and unvaccinated individuals Statistical predictors of vaccination were identified	Self-reported receipt of the vaccine in the previous season (71%) *questionnaire*	Vaccinated participants scored significantly higher than unvaccinated participants on 3/4 items measuring benefits, on all items measuring cues to action. They scored lower on 3/4 measures of barriers. There were no significant differences for susceptibility or severity. HP recommendation (OR = 14.71, $p < .001$) and the belief that the vaccine protects against asthma attacks (OR = 7.21, $p = .001$) predicted vaccination adherence in multivariate analyses.	*****
Keenan et al. (2007) *UK*	Asthma (136) *M = 40.4%, F = 59.6% Median age: 44.5 years*	Health Belief Model	All HBM constructs measured using non-validated questionnaire. Some domains measured with one item	Cross sectional Individual beliefs compared between vaccinated and unvaccinated participants Regression analysis to determine predictors	Self-reported receipt of the vaccine in the previous season (40.2%) *questionnaire*	There were significant differences between groups on all beliefs about the influenza vaccine with the exception of current perceived health status (a susceptibility item). Belief that influenza complications are dangerous (OR = 1.34, $p = .023$), belief in vaccine efficacy (OR = 4.06, $p < .001$) and HP recommendations (OR = 2.30, $p = .021$) predicted uptake. Disagreement with the statement 'influenza is not a serious problem for me (OR = 0.74, $p = .03$) and 'the vaccine can make you unwell' (OR = 0.72, $p = .024$) also predicted uptake.	**

(*continued*)

Table 2. Continued.

Study (year) *country*	Population (N) *Gender Age*	Constructs of psychological model (s) used	Application/ measurement of psychological constructs	Design	Measurement of vaccination uptake (reported uptake in sample) *measurement tool*	Main findings	Quality rating (MMAT)
Chong et al. (2018) *South Korea*	Chronic kidney disease patients who have received a kidney transplant (180) *M = 67.8%, F = 32.2%* *Age < 45: 33.3%* *Age ≥ 45: 66.7%* *Duration after transplant:* *<10 years: 62.8%* *≥ 10 years:37.2%*	Health Belief Model	All HBM constructs measured using a reliable self-report questionnaire. Face and content validity were checked	Cross-sectional Regression analysis to identify predictors of vaccine behaviour	Self-reported receipt of the vaccine in the previous season (47.2%) *questionnaire*	Lower perceived barriers (OR = 0.44, p = .019) and higher perceived benefits (OR = 2.77, p = .006) were significant predictors of vaccine receipt in a multivariate analysis.	**
Tsui et al. (2013) *Hong Kong*	People with one of the following conditions; hypertension, diabetes, heart, renal, liver disease, cancer, CRD (704) *M = 33.5%, F = 66.5%* *Age: <40 years (10.8%)* *40–49 years (21.5%)* *≥50 years (67.8%)*	Health Belief Model	Measured all HBM domains. A non-validated questionnaire informed by the HBM model tested; perceived effectiveness (benefit), side-effects (barriers), susceptibility, severity and vaccine facilitators (cues). Vaccine knowledge and willingness to pay were also assessed.	Cross-sectional Regression analyses used to determine predictors of; lifetime vaccination behaviour, vaccination during the last year and future intentions.	Self-reported intentions (32.9%), self-reported receipt of the vaccine in lifetime (35.8%) and previous season (22.7%) *questionnaire*	Knowledge that IV is required annually (OR = 3.83), perceived severity of influenza (OR = 3.72), uncertainty about the consequences of influenza (OR = 4.35), or the severity for chronically ill people (OR = 3.45), willingness to pay $1-$150HK (OR = 2.05) or <$150HK (OR = 2.26) and HP recommendation (OR = 5.23) predicted lifetime vaccination behaviour in multivariate analysis Knowledge that IV is required annually (OR = 4.04), perceived severity of flu (OR = 2.82) and HP recommendation (OR = 3.25) were associated with uptake during last season. Perceived side effects (OR = 0.35) and uncertainty about side effects (OR = 0.23) predicted non-uptake. Knowledge about IV reducing risks (OR = 1.70), knowledge that IV is required	**

(*continued*)

Table 2. Continued.

Study (year) *country*	Population (N) *Gender Age*	Constructs of psychological model (s) used	Application/ measurement of psychological constructs	Design	Measurement of vaccination uptake (reported uptake in sample) *measurement tool*	Main findings	Quality rating (MMAT)
						annually (OR = 6.68), perceived severity (OR = 2.34), willingness to pay $1-$150HK (OR = 2.53) or <$150HK (OR = 2.05) and HP recommendation (OR = 2.85) predicted future intentions. Perceived side effects (OR = 0.42) and uncertainty about side effects (OR = 0.31) predicted lower intentions.	
Gallagher et al. (2011) *Netherlands*	Patients with heart failure (333) *M = 66%, F = 34%* *Mean age: 72 years (SD = 11)*	Framework of Social Support	The framework was described in the introduction and the questionnaire was designed based on this model. The instrument was not validated but showed good reliability	Cross-sectional Participants were divided into three groups according to level of social support being received (low, medium, high). Groups were compared	Self-reported uptake of the vaccine each year (uptake rate not reported) *questionnaire*	Participants with high vs. low levels of social support more likely to have received a vaccination (1.91 vs 1.43, p = .007, Cohen's d = 0.19). No effect was found for high vs. medium or medium vs. low support).	****
Bundesmann and Kaplowitz (2011) *USA*	Type 2 diabetes patients (1438) *M = 59.4%, F = 50.6%* *Mean age: 68.2 years*	Health Belief Model (cues to action)	The model was described in the introduction. The cues to action domain was loosely assessed through participant recall of provider behaviour	Cross-sectional Comparisons were made between vaccinated and unvaccinated individuals	Self-reported receipt of the vaccine in the past 12 months (65.9%) *telephone questionnaire*	The combined effect of three provider variables (information, modelling and exposure to a diabetes educator) was significantly associated with vaccine receipt ($X^2(3) = 7.7$, $p < .01$).	**

IV = influenza vaccination; HP = health provider; CRD = Chronic Respiratory Disease; HBM = Health Belief Model.
Quality assessment key: *very poor quality (20%), **poor quality (40%) ***medium quality (60%), ****high quality (80%), *****very high quality (100%).
Cohen's d effect sizes: d = 0.2 (small), d = 0.5 (medium), d = 0.8 (large); Cohen's f^2 effect sizes: $f^2 \geq 0.02$ (small), $f^2 \geq 0.15$ (medium), $f^2 \geq 0.35$ (large).

uptake in their sample of adults with a high-risk condition in Thailand; however, this followed the delivery of a vaccine promotion intervention. The average vaccination rate across studies was 50.1%.

Psychological models/factors

The Health Belief Model (HBM; Rosenstock et al., 1988), the model of Psychological Flexibility (Hayes et al., 2006), The Health Action Process Approach (HAPA; Schwarzer & Luszczynska, 2008) and House, Umberson & Landis' (1988) Framework of Social Support were the theoretical frameworks adopted by the identified studies. Out of 12 included papers, eight (66.6%) tested the whole of their selected model. Four studies (33.3%) drew on particular domains from their chosen theory. These studies also only referred to the model in introduction and discussion sections of the paper without directly applying theory to the study design. The HBM was the most commonly applied theory, with ten out of 12 studies (83.3%) drawing on this model. Studies reported different outcomes in terms of identifying the most pertinent psychological factors in determining uptake within their given sample. These factors are discussed below, framed primarily around the HBM as the framework that was applied most often. Constructs from other models including Psychological Flexibility, knowledge and social support are also discussed:

Perceived susceptibility

A total of eight studies (66.7%) measured this construct. Five studies applied the Health Belief Model in a robust way, using validated questions to assess perceptions of susceptibility. Two used non-validated questionnaires that were more loosely based on the model and one was a qualitative study that identified a theme related to perceived vulnerability to influenza. Out of seven quantitative studies testing this construct, two (28.6%) reported a significant association between perceptions of susceptibility and vaccination behaviour.

In their qualitative study, Verger et al. (2018) reported that most vaccinated participants described an increased sense vulnerability to influenza due to their perceived health status; however, this was not consistent across all participants. Some vaccinated participants also explicitly reported feeling that their diabetes put them at no extra risk of contracting influenza. There was also mixed evidence across quantitative studies. Two papers conducted in asthma and chronic respiratory disease populations reported that vaccinated and unvaccinated individuals differed significantly in their ratings of perceived susceptibility (Cheung & Mak, 2016; Keenan et al., 2007). It is possible that individuals with respiratory problems may feel more susceptible to influenza compared to those with other chronic illnesses; however, it is worth noting that these papers were both of low methodological quality (Cheung & Mak, 2016; Keenan et al., 2007) and a high-quality study conducted in a sample of asthmatic participants did not report the same findings (Lyn-Cook et al., 2007). In most studies, particularly those using validated questions, perceived susceptibility was not found to be a predictor of vaccination behaviour (Adams et al., 2014; Chong et al., 2018; Lyn-Cook et al., 2007; Tsui et al., 2013; Yu et al., 2014).

Two studies reported links between perceived susceptibility and other study variables. Older age, having influenza in the past year and family member's having received the vaccine were associated with increased ratings of perceived susceptibility (Adams et al., 2014; Chong et al., 2018).

Perceived severity

Nine studies (75%) considered beliefs about the severity of influenza. One paper was a qualitative study which indicated that diabetic participants who received the vaccine were more likely to discuss fears about the perceived seriousness of influenza, whereas those who declined the vaccine were more likely to trivialise the severity of influenza. Eight papers measured severity beliefs quantitatively. Of these, five used validated questionnaires, two used non-validated tools and one paper measured risk perceptions, an aggregated conceptualisation of participants' perceived risk of developing influenza (susceptibility) and the consequences to their lives (severity). Out of eight studies testing perceived severity, three (37.5%) reported a significant association with vaccination behaviour.

Three studies reported that vaccinated and unvaccinated participants differed in their beliefs about how serious the influenza virus was (Cheung & Mak, 2016; Keenan et al., 2007; Tsui et al., 2013). Tsui et al. (2013) also reported that perceived severity influenza was a significant predictor of lifetime vaccination behaviour, vaccination in the last year and future vaccination intentions in regression analyses. It is worth noting that the study questionnaire was not a validated tool for assessing HBM constructs. Studies that used established HBM measures generally reported non-significant differences between vaccinated and unvaccinated participant's beliefs about the severity of influenza (Adams et al., 2014; Chong et al., 2018; Lyn-Cook et al., 2007; Yu et al., 2014). The study that measured risk perception also did not find this to be a significant predicator of vaccination intentions or behaviour.

Two studies investigated the associations between perceptions of influenzas severity and other factors. Verger et al. (2018) reported that perceptions about severity of influenza seemed to be heightened in participants with personal experience of the illness and Yu et al. (2014) reported individuals with self-reported good or fair health status were more likely to believe that influenza is a serious illness.

Benefits

Eight studies (66.7%) considered the construct of perceived vaccine benefits. One paper explored this qualitatively, whereas other measured it quantitively. A valid tool was used to measure perceived benefits in five studies and a non-validated instrument was used in two papers. Out of seven quantitative studies testing this construct, five (71.4%) reported a significant association between perceived benefits and vaccination behaviour. There were significant differences reported between vaccinated and unvaccinated participants across studies in asthmatic and diabetes samples (Keenan et al., 2007; Lyn-Cook et al., 2007; Yu et al., 2014). In four studies, either an average score for vaccine benefits or specific beliefs about the benefits of vaccination were identified as being significant predictors of vaccination behaviour in multivariate analyses (Chong et al., 2018; Keenan et al., 2007; Lyn-Cook et al., 2007; Yu et al., 2014)

Perceived vaccine benefits was not predictive of uptake in all studies (Adams et al., 2014; Cheung & Mak, 2016). Although these studies used validated tools to assess HBM benefits, both were poor in methodological quality. Overall, the evidence seemed to suggest that perceived vaccine benefits play a role in determining vaccine behaviour. Yu et al. (2014) reported that having influenzas in the past year, being vaccinated in the previous year and beliefs about being at heightened risk of influenza if unvaccinated were associated with higher ratings of perceived vaccine benefits.

Barriers

A total of ten studies (83.3%) measured this construct. Five studies applied the Health Belief Model in a robust way, using validated questions to assess perceived barriers to vaccination. Three used non-validated questionnaires that were loosely based on the HBM. One study was qualitative and another measured 'outcome expectancies', a conceptually similar construct.

Out of nine quantitative studies testing this construct, eight (88.8%) found a significant relationship between lower perceived barriers and increased likelihood of vaccination behaviour. Five studies identified that vaccinated individuals reported significantly lower barriers than their unvaccinated counterparts (Adams et al., 2014; Keenan et al., 2007; Lyn-Cook et al., 2007; Turner et al., 2015; Yu et al., 2014). Furthermore, in regression analyses, lower average scores for barriers were found to predict increased vaccine uptake across a range of health conditions (Chong et al., 2018; Keenan et al., 2007; Tsui et al., 2013; Turner et al., 2015; Yu et al., 2014). One study identified associations between perceived barriers and other variables, reporting that vaccination during the previous year was linked with a reduced perception of barriers.

The evidence supported an association between increased vaccination behaviour and having a lower than average score on perceived barriers to vaccination. Disagreement with the belief that the vaccination can causes side effects or illness also seemed to be independently associated with increase uptake (Keenan et al., 2007; Tsui et al., 2013; Turner et al., 2015). Findings from the qualitative study supported the idea that unvaccinated participants were more fearful of side effects, although they noted that vaccinated participants also had some concerns or uncertainties about side effects.

The study that explored outcome expectancies found that lower outcome expectancies (expecting a less favourable outcome following vaccination) were associated with reduced vaccination intentions, but they did not predict change in vaccination behaviour. They also identified that higher self-efficacy in one's ability to arrange a time and transportation to receive the vaccine was predictive of increased vaccination intentions and likelihood of carrying out the behaviour. This suggests that identification of barriers may not necessarily impede uptake of the behaviour if participants are confident in their ability to overcome such obstacles. A similar theme was identified in the qualitative study. Unvaccinated participants were more likely to suggest that internal motivational or practical barriers such as lack of time or procrastination could affect their behaviour.

Overall, there was good evidence to indicate that lower perceived barriers to vaccination was linked with increased vaccination behaviour. There was tentative

evidence to suggest that increasing self-efficacy to overcome practical constraints might increase the likelihood of vaccination for some individuals.

Cues to action

Cues to action refers to prompts or triggers in the environment that encourage an individual to enact a behaviour. Ten studies (83.3%) in the current review investigated the impact of cues to action on vaccination behaviour. Five used validated questionnaires to assess cues to action as conceptualised in the HBM. A further two drew on the HBM but used unvalidated measures. One study assessed cues to action using qualitative methods and another measured the use of 'if-then' plans (implementation intentions). The final study measured health-provider behaviour (information, modelling and education) through participant recall. This study reported a significant association between provider behaviours and vaccination uptake when three health provider behaviours were collapsed into a single variable (Bundesmann & Kaplowitz, 2011). The contributions of this study must be interpreted with caution however, as patients were not asked whether they received a specific recommendation from a health professional to get a flu vaccine. Out of nine quantitative studies, five (55.5%) reported a significant association between cues to action and vaccination behaviour.

There was some evidence to suggest that cues to action in the form of health provider recommendation was associated with increased vaccination behaviour. A number of studies reported significant differences in cues to action scores between vaccinated and vaccination participants (Cheung & Mak, 2016; Lyn-Cook et al., 2007; Yu et al., 2014). These studies had all used a validated instrument to assess HBM domains. Cues to action in general and endorsement of the belief that a healthcare professional had recommended the vaccine was a significant predictor of vaccination behaviour in regression analyses across a number of studies (Keenan et al., 2007; Lyn-Cook et al., 2007; Tsui et al., 2013). Although this association was not identified in all studies (Adams et al., 2014; Cheung & Mak, 2016; Chong et al., 2018).

One study reported investigated the use of 'if-then' plans (implementation intentions) as a motivational prompt to increase vaccination uptake (Payaprom et al., 2011). They identified that participants were more likely to intend to receive the vaccine when they had been prompted to actively plan when and where they would receive the vaccine; however, there was no significant effect on subsequent behaviour.

There was evidence to suggest that recommendation from a healthcare professional increased vaccination likelihood, but the evidence linking the broader cues to action construct with vaccination behaviour was mixed. Findings from the qualitative study reported that both vaccinated and unvaccinated participants seemed to trust the advice offered by health professionals; however, unvaccinated individuals seemed to harbour mistrust towards government and pharmaceutical companies, which may have affected their decisions about uptake.

Knowledge

Two studies measured the effects of knowledge on vaccination behaviour. One of these studies (50%) reported a significant association between these two variables. This study measured participants awareness that the vaccine is required each year and

reduces risk of hospitalisation. Knowledge that the vaccine is required each year was associated with both past vaccination uptake and future intentions (Tsui et al., 2013). The other study assessed knowledge using a repeated measures design to assess the efficacy of a HAPA-informed intervention. They measured participant's knowledge of influenza through asking about symptomology and knowledge of the vaccine by asking about side effects. No significant differences in knowledge were detected between standard leaflet and HAPA leaflet groups; however, vaccine uptake rates were highest in this study compared to others included in the review. Shaping knowledge through the distribution of any informative materials may therefore have helped to promote uptake. There was enough evidence to tentatively suggest that knowledge about the vaccine might be helpful for encouraging vaccination behaviour; however, an insufficient number of studies investigated this construct to allow firm conclusions to be drawn.

Psychological flexibility

One study drew on the concept of Psychological Flexibility and identified a significant association with vaccination behaviour. Broadly speaking, this concept refers to an individual's ability to accept rather than avoid negative thoughts and emotions about a particular experience (Hayes et al., 2006). Cheung and Mak (2016) reported that individuals with chronic respiratory disease with higher reported levels of psychological flexibility were more likely to receive the seasonal influenza vaccination. Vaccinated participants scored significantly higher than unvaccinated individuals on this construct, indicating greater levels of acceptance towards their high-risk condition. Furthermore, a higher level of psychological flexibility was an independent statistical predictor of vaccination uptake in this sample. The findings suggested that this might be a helpful construct for further investigation, although it is worth noting that this study was low in methodological quality. There is insufficient evidence available at this stage to conclude that psychological flexibility is associated with vaccination behaviour.

Social support

Two studies explored the role of social support in determining vaccination behaviour. One did this qualitatively while the other applied House et al. (1988) Framework of Social Support (Gallagher et al., 2011). The qualitative study highlighted how social influences can shape vaccination decisions. Unvaccinated individuals were more likely to draw on information from informal sources such as friends and family, whereas vaccinated individuals relied on official channels and personal experience to inform their decision. The only quantitative testing this variable found a significant association between social support and vaccination behaviour. They identified a significant difference in vaccination uptake between those receiving highest levels of support compared those receiving the lowest. However, the overall regression model was a poor fit to the data, so these results must be interpreted accordingly. These studies demonstrated good methodological quality; however, there was an insufficient number of studies investigating the role of social influences to determine whether this influenced vaccination behaviour.

Quality

Most papers included in this review scored were identified as being low or medium quality as assessed by the MMAT (Hong et al., 2018). Some studies failed to report a sample size calculation or justify how they arrived at their selected sample. In some cases, there was also a lack of consideration of how inclusion and exclusion criteria may affect the generalisability of results to the wider population being examined; for example, in two studies exploring vaccination uptake in patients with diabetes, all potential participants with Type 1 diabetes were deemed ineligible to take part. The use of non-validated instruments to assess psychological constructs was a further limitation of several papers included in this review. No studies were excluded on the basis of methodological quality; however, it is necessary to interpret findings with an appropriate level of caution based on the lack of methodological rigour.

Discussion

This review identified 12 empirical studies that explored the association between theoretically-derived psychological factors and seasonal influenza vaccination uptake among adults with a high-risk physical health condition. The HBM was the most commonly applied psychological theory, with ten out of 12 papers drawing on this model. Support was generally found for the application of this model, with different domains emerging as being most influential in predicting uptake across different research populations. Participants across studies seemed to vary in the extent to which beliefs about susceptibility and severity informed decisions about vaccination uptake. Therefore, interventions that seek to shape risk perceptions will likely vary in their effectiveness. Some studies have highlighted how message-framing interventions can be used to shape perceptions of vulnerability to influenza among at-risk groups (Frew et al., 2014; O'Connor et al., 1996). However, evidence to support their effectiveness in changing vaccination behaviour is limited (Brewer et al., 2017).

Positive beliefs about influenza vaccination were generally associated with increased uptake. Conversely, doubts about vaccine efficacy and fear of side effects seemed to contribute to vaccine hesitancy. Similar findings have been reported in reviews among other clinical risk groups (Bish et al., 2011; Schmid et al., 2017). It is important for vaccination strategies to promote the benefits of vaccination whilst minimising the associated costs. Information campaigns have been used extensively to highlight the benefits of vaccination and address common misconceptions (including the belief that the vaccine itself can induce influenza). Brewer et al. (2017) reported that such interventions can promote more positive attitudes towards vaccination; however, there is limited evidence to suggest that these strategies change behaviour (Brewer et al., 2017; Williams et al., 2013). Provision of information is likely to be most helpful for individuals who are considering the vaccination for the first time, as those who have previous experience of being offered the vaccine have likely formed more entrenched beliefs about the personal risks and rewards associated with uptake. Several papers included in this review demonstrated the importance of past behaviour through highlighting how vaccination decisions remained relatively stable over time (Chong et al., 2018; Lyn-Cook et al., 2007; Tsui et al., 2013; Verger et al., 2018).

Furthermore, individuals have tendency to selectively attend to information that confirms their existing beliefs, and actively dismiss evidence to the contrary which is one explanation for why information campaigns often fail to change behaviour (Brewer et al., 2017; Klayman, 1995).

Since most studies in this review identified cues to action as being important for shaping vaccination behaviour, delivering vaccine promotion messages through health professional interactions seems appropriate. It is widely recognised the communication with health professionals can shape vaccination intentions and behaviour among high-risk groups (Brewer et al., 2017; Evans et al., 2007). Verger et al. (2018) noted that health professional input had seemed particularly influential for participants whose vaccination status seemed to be at a discord with some of their beliefs. For example, a provider recommendation had led some participants to receive the vaccine despite their initial concerns that there may be adverse side effects. Most studies in this review limited their definition of cues to action to recommendations from health professionals; however, in the included qualitative study, participants referred to other prompts such as advertising campaigns and conversation with friends and family. The role that these other prompts play in vaccination decision making warrants further exploration in future research.

Since the HAPA, House's Framework of Social Support and ACT frameworks were each applied in only one study, it was difficult to draw firm conclusions about their utility in explaining vaccination uptake behaviour. Payaprom et al. (2011) reported that vaccination intentions could be predicted by outcome expectancies, implementation intentions and self-efficacy in arranging time and transportation to receive the vaccine. Vaccination behaviour was predicted by intentions and to a lesser degree by self-efficacy in arranging time and transportation. While the HAPA-informed intervention did not lead to significant changes in vaccination intentions or behaviour when compared to a standard leaflet, these underlying mechanisms may be promising areas to target with future interventions. Cheung and Mak (2016) also reported promising findings in relation to the role of psychological flexibility (PF) in vaccination uptake, this should be explored further in future research.

Although Gallagher et al. (2011) found limited support for the applicability of House's social support framework in predicting heart failure self-care behaviours, the influence of social processes in shaping vaccination behaviour should not be overlooked. Brewer et al. (2017) suggested that vaccination decision making is influenced by social norms and interactions. Health provider recommendations, motivation to protect others through vaccination receipt, and receiving advice from social networks are ways in which vaccination decisions can be shaped by socialisation. Bish et al. (2011) identified social pressure as a significant predictor of pandemic flu vaccination uptake and Kumar et al. (2012) reported that interpersonal (social) processes accounted for a similar amount of variance in vaccination uptake as intrapersonal (individual) processes; 47% compared to 53%. Future research should therefore consider adopting a social ecological approach, considering the impact of both individual and contextual processes in shaping vaccination uptake behaviour.

Limitations

Overall, this review provided useful insight into how psychological models, particularly the HBM can influence vaccination uptake among individuals with a high-risk physical health condition. However, there were several limitations that should be taken into consideration before using these findings to inform intervention development. Firstly, the search strategy drew on vaccination recommendations prepared by Health Protection Scotland, and other countries may have different guidelines for eligible groups. Morbid obesity (BMI >40) has been listed as a high-risk condition on these guidelines since 2015 (Health Protection Scotland, 2016); however, in other countries such as Italy, individuals with a BMI above 30 are advised to receive the vaccine (Barbadoro et al., 2016). In terms of the review process, a second reviewer screened a portion of articles at abstract and full-text levels; however, data extraction, coding, quality appraisal and synthesis were conducted independently by one reviewer, which may have increased risk of bias.

With regards to the studies identified during the search, only a small number drew on psychological theory in explaining vaccination uptake, highlighting the need for more theoretically-driven research in this field. A large degree of heterogeneity was identified between papers in terms of the health condition studied, the geographical location of the research and the reported findings. Availability and access to the vaccine (including the financial cost) vary between countries and this likely to have influenced vaccination behaviour. Only one study explicitly measured participant's willingness to pay for the vaccine and they reported that vaccinated participants were willing to pay more for the vaccine that unvaccinated individuals (Tsui et al., 2013). Although influenza vaccination is recommended for all individuals with a high-risk health condition, there are likely to be differences in psychological factors that contribute to vaccination uptake between different health conditions. Within this review, there were not enough studies focussing on any specific disease-population to allow such patterns to be explored.

Most of the studies included in this review adopted a retrospective design, reporting the relationship between psychological factors and self-reported vaccination status from the previous year. This means that causation cannot be inferred. Results may also have been affected by participant recall bias and their motivation to reduce dissonance by selecting responses in support of the choice they made. The reliance on self-reported vaccination status was a further limitation of this review, particularly as some papers asked about uptake over the lifespan.

Studies were retained in this review if they drew on psychological theory in any section of the paper. As a result of this, there was variation in the extent to which theories were applied. Four of the included studies (33.3%) only referred to their selected theory in the introduction or discussion sections without directly explaining how it shaped the study design. Other studies applied theoretical frameworks more robustly, and those of a higher methodological quality also used established measures of psychological constructs. The undertaking of this systematic review highlighted the need for rigorously designed studies in the field of vaccination behaviour, particularly those using validated tools in their assessment of psychological constructs. This evidence would help to inform the development of effective vaccine promotion interventions.

Conclusions

The aim of this review was to examine psychosocial and psychological factors associated with the uptake of seasonal influenza vaccination among adults with a high-risk physical health condition. The HBM was the most frequently applied model, and support was found for the application of this model, particularly perceived benefits, perceived barriers domains. These may be helpful constructs to target in vaccination promotion strategies. Due to the limited number of studies drawing on other psychological theories, it was not possible to draw conclusions about their utility in predicting vaccination uptake. This review highlighted the need for further research to be conducted in the vaccination behaviour field, particularly prospective studies of high methodological quality, drawing on a wider scope of psychological theories.

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