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Author(s): Majeed, Rabia; Hamilton, Kyra; Watts, Gerald, F.; Hagger, Martin, S.

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Social cognition correlates of self-management behaviors in patients with familial hypercholesterolemia (FH): A meta-analytic review

Rabia Majeed [a], Kyra Hamilton [b,c,d], Gerald F. Watts [e,f], Martin S. Hagger [a,b,c,d,*]

[a] Department of Psychological Sciences, University of California, Merced, United States
[b] School of Applied Psychology, Griffith University, Mt. Gravatt, Australia
[c] Health Sciences Research Institute, University of California, Merced, United States
[d] Faculty of Sport and Health Sciences, University of Jyväskylä, Jyväskylä, Finland
[e] School of Medicine, University of Western Australia, Perth, Australia
[f] Cardiometabolic Service, Department of Cardiology, Royal Perth Hospital, Perth, Australia

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ABSTRACT

Objective: Familial Hypercholesterolemia (FH) is an inherited disorder leading to increased risk of premature atherosclerotic cardiovascular disease. This risk can be ameliorated through adherence to pharmacological treatment and salient lifestyle behaviors (e.g., physical activity participation, healthy eating). Identifying theory-based, modifiable determinants of these behaviors may inform behavioral interventions promoting participation in FH self-management behaviors. We aimed to identify the belief-based social cognition constructs uniquely associated with intentions to perform, and actual participation in, FH self-management behaviors in the extant research.

Method: A systematic database search identified studies ($k = 9$, $N = 1394$) reporting relations between social cognition theory constructs and intention toward, or actual participation in, self-management behaviors in FH patients. As no studies examining prospectively-measured behaviors were identified, we tested relations among social cognition constructs, intentions, and past FH-self-management behavior using random effects multi-level meta-analysis and meta-analytic structural equation modelling.

Results: We found non-zero averaged correlations among the key social cognition constructs (attitudes, norms, risk perceptions, self-efficacy), intentions, and past behavior. A meta-analytic structural equation model indicated non-zero averaged direct effects of attitudes, norms, self-efficacy, and past behavior on FH self-management behavioral intentions. There were also non-zero averaged indirect effects of past behavior on intentions mediated by the social cognition constructs.

Conclusion: Findings provide evidence to support the proposed model and highlight the importance of personal, normative, and capacity related beliefs and past experience as unique correlates of intentions to perform FH self-management behaviors. The model may signal potential constructs that could be targeted in behavioral interventions to promote participation in FH self-management behaviors.

1. Social cognition correlates of self-management behaviors in patients with familial hypercholesterolemia: A meta-analytic review

Familial Hypercholesterolemia (FH) is an inherited dominant disorder that affects lipoprotein metabolism which, if left untreated, leads to an increased risk of early-onset atherosclerotic cardiovascular disease (ASCVD) (Migliara et al., 2017). The disorder affects 1 in 250 individuals worldwide (Lui et al., 2020). The heightened ASCVD risk associated with FH can be ameliorated through adherence to cholesterol-lowering medication (e.g., statins) coupled with regular participation in 'lifestyle' behaviors such as following a healthy diet and participating in regular moderate-to-vigorous physical activity (Watts et al., 2021). However, many FH patients fail to comply with these management guidelines (Watts et al., 2016). As a consequence, effective behavioral interventions are considered essential to promote engagement in FH self-management behaviors to improve outcomes in FH patients, and have been advocated by FH organizations as part of a

* Corresponding author. SHARPP Lab, Psychological Sciences, University of California, Merced, 5200 N. Lake Road, Merced, CA, 95343, United States.
E-mail address: mhagger@ucmerced.edu (M.S. Hagger).

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patient-centred approach to managing this condition (Krauss et al., 2000; FH diagnosis, 2021). Therefore, it is imperative to design and implement behavioral interventions that target uptake and maintenance of these self-management behaviors (Watts et al., 2016; Gidding et al., 2015).

Development of optimally efficacious behavioral interventions in this context necessitates formative research to identify the determinants of FH management behaviors and the processes by which they affect behavior. Such research may signal the potentially modifiable constructs that should be targeted for change in behavioral interventions. To this end, researchers have applied social cognition theories (Ajzen, 1991; Fishbein et al., 2001; Conner et al., 2015) to identify the belief-based correlates of intention or motivation to engage in FH self-management behaviors that may present as candidate constructs to be targeted in interventions (Hagger et al., 2019; Razali et al., 2020). These theories assume that individuals' stated beliefs about future enactment of a given target behavior will impact their formation of intentions to perform the behavior and increase their propensity to perform it in future. These beliefs summarize individuals' current and prior knowledge and dispositions toward the target behavior (Ajzen, 1991; Fishbein et al., 2001) and tend to encompass beliefs in the utility and anticipated affective value of the target behavior to produce salient outcomes (referred to as attitudes), beliefs with respect to social influence (social or subjective norms), beliefs in capacity to perform behaviors and overcome perceived barriers (self-efficacy), perceived susceptibility and severity of the illness or condition of interest (risk perceptions), and assimilated factual knowledge with respect to the future behavioral performance (Ajzen, 1991; McMillan et al., 2007). Intentions, therefore, are proposed to be the most proximal predictor of behavior, such that individuals reporting intentions to perform a behavior are more likely to participate in that behavior in future, and intentions are proposed to mediate effects of the belief-based constructs on behavior (Ajzen, 1991; Fishbein et al., 2001). Further, in order for these theories to be fit-for-purpose or *sufficient* as accounts for individuals' social decision making, their predictions should hold even when accounting for past behavior. This sufficiency hypothesis suggests that the theory should account for past behavior effects on subsequent intentions and behavior (Ajzen, 1991; Hagger et al., 2016).

Studies testing the predictions of these theories indicate that attitudes, subjective norms, risk perceptions, and self-efficacy are associated with intentions to perform behaviors in multiple health contexts. Furthermore, these studies have demonstrated consistent effects of intentions on health behavior, supported intention as mediator of the effects of the belief-based constructs on behavior, and indicated that the theory effects hold when including past behavior and mediate effects of past behavior on intentions and behavior (McEachan et al., 2011). Importantly, this theory-consistent pattern of effects has been supported in studies on FH patients for self-management behaviors such as physical activity participation, taking cholesterol-lowering medication, and following a healthy diet (Hagger et al., 2019; Razali et al., 2020).

The findings of studies applying these theories in the context of FH notwithstanding, some limitations have been observed. For example, while the generalized pattern of effects in the theories applied has been supported, variability in the size of the observed effects in the extant research, such as the effects of attitudes on intentions and of intentions on behavior, has been noted (Hagger et al., 2019; Razali et al., 2020; Claassen et al., 2010). This variability may be attributable to a number of methodological and contextual artifacts. For example, variability in observed effects may be attributable to sampling error, that is, some studies may be more representative of the 'true' population effects, with sample size an important contributing factor. However, variability may also be attributed to other sample characteristics such as sample composition (age, gender, socioeconomic status), methodological artifacts such as study quality, and contextual factors such as behavior type.

One approach to resolving this observed variability is to quantitatively synthesize the extant research applying social cognition theories in the context of FH self-management behaviors using meta-analysis. This approach would permit estimation of the average size of the correlations of the theory constructs with intentions and behavior in FH patients across studies, and, importantly, the associated 'true' variability in the correlations after correcting for sampling error using meta-analytic procedures. The value of such an analysis lies in its potential to demonstrate the extent to which researchers applying social cognition theories in this behavioral context can expect non-zero effects for the belief-based constructs on intentions and behavior, and the range of probable expected values. The analysis also has potential to afford tests of the effects of key methodological (e.g., age, gender, study quality) and contextual (e.g., behavior type) artifacts on relations among the constructs, and tests of the unique or independent effects of these constructs on intentions and behavior. This can be achieved by examining the fit of an integrated model specifying relations among these theory-based constructs and FH management intentions and behavior to the meta-analytically derived correlations among them.

1.1. Study overview and research purpose

Accordingly, our purpose in the current review was to identify studies reporting relations between social cognition constructs and intention to perform, and actual performance of, three key FH self-management behaviors: physical activity participation, taking cholesterol-lowering medication, and following a healthy diet, in patients with familial hypercholesterolemia (FH), and to estimate the size and variability of these relations across studies using meta-analysis. Specifically, we focused on studies adopting the belief-based constructs that have previously been shown as important correlates of health behaviors in research applying prominent social cognition theories to health behaviors broadly speaking (Armitage and Conner, 2001; Brewer et al., 2007; Sheeran et al., 2016a) and specifically for FH: attitudes, risk perceptions, subjective norms, self-efficacy, and knowledge (Hagger et al., 2019; Razali et al., 2020; Kinnear et al., 2020).

Our analysis was conducted in two stages. First, a systematic search was conducted for studies reporting relations between constructs from the key social cognition theories reviewed previously and intentions or behavior for self-management behaviors in patients with an FH diagnosis, followed by extraction of the zero-order correlations among the constructs, intention, and behaviors from the studies. Second, the extracted correlations were synthesized using multi-level multivariate meta-analysis. We expected the analysis to yield non-zero averaged sample-weighted correlations in each case. In addition, a model specifying unique effects of the social cognition constructs on intention and behavior as stipulated by theory was estimated using meta-analytic structural equation modelling with the matrix of correlations among the study variables derived from the multi-level multivariate meta-analysis as input. We also planned to test the indirect effects of the social cognition constructs on participation in FH self-management behaviors mediated by intention, and the mediation of past behavior on intentions and behavior through the social cognition constructs, consistent with prior theory and research (Hagger et al., 2016, 2018).

We also aimed to examine the effects of key demographic (e.g., sample age, sex) methodological (e.g., study quality), and contextual (e.g., behavior type) variables on relations among the constructs. As we expected effect sizes among model constructs to vary according to behavior type, as previously observed in studies applying social cognition theories in other health behavior contexts (McEachan et al., 2011), we aimed to examine behavior type as a moderator. By contrast, as we had no specific directional predictions for the effects of demographic and methodological variables on model effect sizes, they were treated as covariates in our analysis. Our analysis was expected to contribute to an evidence base of salient constructs that are reliably related to intentions to perform, and actual participation in, behaviors demonstrably shown to improve outcomes and levels of risk among FH patients, and lay the groundwork for identifying targets for interventions aimed at promoting

participation in these behaviors.

2. Method

2.1. Search strategy and study selection

A systematic search of four digital databases (Web of Science, PubMed, EBSCO, and ProQuest) was conducted to identify studies reporting relations between constructs from social cognition theories and intention toward, or actual participation, in three FH self-management behaviors: physical activity participation, taking cholesterol-lowering medication, and following a healthy diet. Search strings developed to identify eligible studies are provided in Appendix A (supplemental materials). In parallel, a manual search was conducted of reference sections of the identified studies, and prior narrative and systematic reviews of behavioral research on FH, to identify additional eligible studies. Our procedure followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines and was pre-registered on the Open Science Framework: https://osf.io/qydaj

Screening of title, abstract, and full text of identified items after removal of duplicates in successive stages against inclusion criteria resulted in a final pool of studies for inclusion ($k = 13$). Screening was conducted by the lead author with two trained research assistants. At each stage, research team members double screened a sub-set (10%) of the articles and inter-rater agreement was assessed to validate the screening procedure with good agreement (average Cohen's $\kappa = 0.81$). Disagreements were resolved through discussion among the research team members and the procedure amended prior to continuation of the screening procedure. A PRISMA diagram illustrating the flow of research items through the search and selection procedures is presented in Appendix B (supplemental materials).

2.2. Inclusion criteria

Studies were included in our analysis if they reported at least one effect size for an association between constructs from the social cognition theories and intention toward, or actual participation, in at least one of the three FH self-management behaviors in adult populations diagnosed with FH. Articles reporting systematic reviews and meta-analyses, qualitative studies and case reports, and those that did not report the appropriate effect sizes, were excluded.

2.3. Included studies and study characteristics

Of the 13 articles that met our inclusion criteria, seven did not provide sufficient data for analysis and the missing data could not be retrieved from contacting the authors leaving six articles eligible for inclusion in the final analysis. A full list of included studies is presented in Appendix C (supplemental materials). Studies using the same data set were combined ($k = 2$) and one study included data from multiple samples ($k = 6$), so each was treated as a separate study, increasing the number of studies included in the final analysis to 9 with a total sample size of 1394. Importantly, none of the included studies adopted a prospective measure of FH self-management behavior. Instead, studies adopted cross-sectional designs, and, therefore, measures of the self-management behaviors were treated exclusively as past behavior, in accordance with theory. This precluded estimation of the intention-behavior effect, and, by extension, the mediation of effects of the social cognition constructs on behavior by intention. In addition, there were insufficient studies reporting measures of FH knowledge for a viable analysis, so this construct was dropped from subsequent analysis. Therefore, the proposed model tested in the current study was modified such that our primary dependent variable was intention to participate in self-management behavior, with the social cognition constructs, excluding FH knowledge, as direct predictors of intention, and as mediators of the effects of past behavior on intention, with a direct past behavior-intention effect also proposed (Hagger et al., 2019). The model is presented in Fig. 1.

3. Effect size data extraction and classification of constructs

3.1. Data extraction

Available effect size data for relations among the social cognition constructs, intention, and past behavior were extracted from the included studies. The effect size metric was zero-order correlation coefficient as all included studies were correlational in design. In cases where studies did not report zero-order correlations among the social cognition construct and past behavior, we computed the zero-order correlation from other available data (e.g., chi-square values, odd ratios, *t*-ratios, *F*-ratios) provided the data were sufficient to compute the effect size. Where authors did not provide sufficient data to compute effect sizes for analysis, we requested the unavailable data from the authors via email.

3.1.1. Construct classification

In order to ensure the measures of the theory-based constructs reported in the final sample of studies were consistent with definitions of the purported constructs derived from prominent social cognition theories, we applied a systematic classification procedure to operationally define and categorize the measures used. This procedure was consistent with the published procedures used to classify social cognition constructs (McMillan et al., 2007) and used as a basis for identifying relevant constructs in prior meta-analytic syntheses of social cognition correlates of health behavior (Protogerou et al., 2018).

Social Cognition Constructs. The social cognition constructs adopted in the included studies were classified by matching the content of the measures used with consensus-based construct definitions based on social cognition theories (McMillan et al., 2007). This procedure was employed to identify the core set of constructs based on these theories utilized to predict FH self-management behaviors in the identified studies. Such an endeavor was essential given the prior conceptual and empirical work that has demonstrated considerable overlap in the belief-based constructs typically employed in these theories when applied in health behavior contexts. For instance, constructs such as self-efficacy, control beliefs, and perceived behavioral control have identical content and very similar measurement items but are referred to by different labels (McMillan et al., 2007). We therefore focused our analysis on a core set of constructs that have emerged from attempts to classify these constructs across theories via expert consensus and theoretical review (Fishbein et al., 2001; McMillan et al., 2007).

Our matching procedure is summarized as follows: measures of beliefs in the utility and affective value of the target behavior to produce salient outcomes were classified as attitudes; measures of normative beliefs and social influence were classified as subjective norms; measures of beliefs of capacity to perform behaviors and overcome perceived barriers were classified as self-efficacy; and assessments of perceived susceptibility and severity were classified as risk-perception. In addition, measures promoting individuals to report their intentions to perform the target behavior, and measures of other dispositions to act such as behavioral willingness or protection motivation, were classified as intention. It should be noted that other constructs that may have been candidate determinants in our analysis were not ultimately included because studies did not test them with sufficient frequency to be eligible for synthesis. For example, some constructs were only included in the studies once or twice (e.g., knowledge), which precluded calculation of reliable averaged effect sizes for relations between these constructs and intentions or behavior. In some cases, salient constructs (e.g., illness and treatment beliefs) were not included as correlates of intentions or behavior in any study, so were also not available for analysis.

Behavior measures. Our three key target behaviors were physical activity participation, taking cholesterol-lowering medication, and

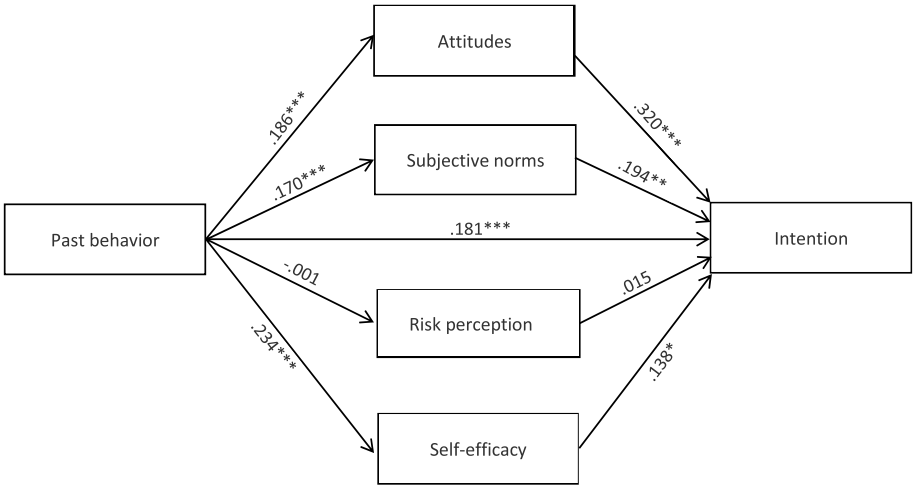

Fig. 1. Proposed model indicating hypothesized relations among social cognition constructs, intentions, and past self-management behaviour in patients with Familial Hypercholesterolemia.

following a healthy diet. All of the included studies reported multiple measures of target behaviors, and these were handled in our analysis using a multi-level approach ($k = 9$). The target behavior in each study was exclusively measured using self-report methods and standardized validated scales were used in majority of the studies, but some studies adopted bespoke, single-item frequency measures.

3.2. Moderator and covariate variable coding

Sample and study characteristics. Included studies were classified according to key sample characteristics that we planned to include as covariates in our analysis. Candidate covariates were age (e.g., studies comprising predominantly younger or predominantly older participants, or a mixed distribution of ages) and sex (i.e., samples comprising predominantly male or female participants, or a balanced sex profile). We also proposed that behavior type would affect relations among the constructs in the proposed model, so we proposed to include these as moderator variables, estimating proposed model effects in groups of studies determined by each level of the moderator. However, the extent of feasible analyses was limited by the small number of included studies: we had insufficient studies in covariate and moderator variable categories to provide moderator groups comprising a sufficient number of studies to conduct the analysis or to include as covariates. For example, all studies were classified as targeting samples with approximately equal numbers of older and younger participants, and with a balanced sex profile. However, we were able to code behavior type as a candidate moderator, with studies classified as targeting one of the three key FH self-management behaviors: physical activity participation, taking cholesterol-lowering medication, and following a healthy diet. A summary table of covariate and moderator variable coding for the included studies is presented in Appendix D (supplemental materials).

Study quality. Study quality was also included as a covariate in our analysis. We used the Quality Assessment Checklist for Survey Studies in Psychology (Q-SSP) to assess the quality of the included studies (Protogerou and Hagger, 2020). This checklist assesses the quality of a study on four quality dimensions: introduction and rationale, procedure and recruitment, data interpretation, and ethics, and yields a single overall quality score out of 20. The Q-SSP checklist and its scoring method are described in Appendix E (supplemental materials).

3.3. Data analysis

In the first stage of our analysis, we computed averaged bias-corrected zero-order correlations between each social cognition construct, intention, and past behavior measure, and associated variability estimates, using multi-level multivariate random effects meta-analysis (Wilson et al., 2016). The multi-level approach accounted for dependency in multiple effect studies extracted from the same study, for instance, studies reporting correlations of more than one measure of behavior with social cognition constructs. We also planned to adjust correlations for our study quality covariate in standard unadjusted and covariate-adjusted models. We also aimed to test effects of the behavior type moderator by estimating the model separately in groups of studies for each individual behavior.

In the second stage of our analysis, we fit our proposed model specifying the unique effects of the social cognition constructs on FH self-management behavioral intentions to the matrix of averaged bias-corrected correlations derived from the multi-level meta-analysis in the first stage using meta-analytic structural equation modelling. The analysis yielded overall model fit statistics as well as standardized parameter estimates with confidence intervals of the proposed relations among the constructs as stipulated in the model. The estimates yielded by the analysis are analogous to regression coefficients and reflect the size of the unique relations between variables within the proposed model. We also computed several tests of the heterogeneity of the averaged zero-order correlations such as Cochran's Q and the I^2 statistic (Higgins and Thompson, 2002). As with the analysis of correlations, we produced unadjusted and covariate-adjusted models. We implemented the analyses using the metafor (Viechtbauer, 2010) and metaSEM (Cheung, 2015) packages in R.

3.4. Assessment of bias and statistical power

The potential effect of selective reporting bias on relations among model constructs was assessed using a series of bias-correction methods (Carter et al., 2019). The first set of analyses were based on 'funnel' plots of study effect sizes against an estimate of their precision (e.g., the inverse standard error). These included Begg and Mazumdar's (Begg and Mazumdar, 1994) rank correlation test, Duval and Tweedie's (Duval and Tweedie, 2000) 'trim and fill' analysis, regression tests including Sterne et al.'s (Sterne et al., 2001) 'classic' regression test and two alternatives, the precision effect test (PET), and the precision effect estimate with standard error (PEESE; (Stanley and Doucouliagos, 2014)). A statistically significant rank correlation test, a large number of imputed studies in the trim and fill analysis, and statistically significant effects of the precision estimate in the regression models may signal the presence of non-trivial bias. The trim and fill and regression tests also provide ostensibly 'bias' free estimates of the correlation. These analyses were

implemented using the metafor package in R.

A second set of analyses were based on selection methods derived from Hedges' model (Hedges, 1984). These methods estimate the extent of bias in an effect size by comparing a selection model, in which certain parameters of bias are present, with a data model. The models used included Vevea and Hedges' weight function model with 0.025, 0.050, 0.500, and 1.000 as criterion values for the selection models, and two recent implementations, known as the *p*-curve and *p*-uniform* procedures. The weight-function model, *p*-curve, *p*-uniform* analyses were implemented using the weightr (Coburn and Vevea, 2017), dmetar (Harrer et al., 2019), and puniform (Van Aert, 2020) functions, respectively, in R.

The bias correction methods were implemented in the zero-order correlations using conventional random effects meta-analysis because bias detection techniques have not been implemented with multi-level models. We therefore aggregated effect sizes within studies using Hunter and Schmidt's (Hunter and Schmidt, 2015) formula and set the within-study correlation between effect sizes at 0.50 (Wampold et al., 1997) using the MAc package (Del Re and Hoyt, 2018) in R.

Finally, an analysis of the statistical power of the included studies was conducted. This provided an assessment of whether the sample sizes of the included studies were sufficient to detect the averaged effect size, as well as a panel of alternative effect sizes that were smaller and larger than the average. Our analysis was implemented using the *metameta* package in R (Quintana, 2022). Data files and analysis scripts and output are available online: https://osf.io/rkjw5.

4. Results

4.1. Zero-order correlations and tests of the proposed model

The multi-level multivariate meta-analysis revealed non-zero averaged bias-corrected correlations among the social cognition constructs, intention, and past behavior variables across the included studies (*r* range = 0.170 to 0.474, *ps* < 0.001). The only exceptions were correlations between risk perceptions and social cognition constructs, intention, and past behavior. The matrix of zero-order bias-corrected correlations is presented in Table F1, Appendix F (supplemental materials). Standardized parameter estimates with 95% confidence intervals for the direct effects of the proposed model from multi-level meta-analytic structural equation model are presented in Fig. 1, with full direct and indirect effects reported in Table 1. A full breakdown of the standardized parameter and variability estimates is provided in Table F2, Appendix F (supplemental materials). Focusing on the direct effects, consistent with our pre-registered hypotheses, we found non-zero effects of attitudes (β = 0.320, $p < 0.001$), subjective norms (β = 0.194, $p = 0.002$), and self-efficacy (β = 0.138, $p = 0.016$) on intention with small-to-medium effect sizes. There were also non-zero effects of past behavior on intention (β = 0.181, $p < 0.001$), attitudes (β = 0.186, $p < 0.001$), subjective norms (β = 0.170, $p < 0.001$), and self-efficacy (β = 0.234, $p < 0.001$) with small-to-medium effect sizes. Effects of risk perceptions on intention, and past behavior on risk perceptions were no different from zero.

Turning to the model indirect effects, there were non-zero small-sized indirect effects of past behavior on intentions mediated by attitudes (β = 0.059, $p < 0.001$), subjective norms (β = 0.033, $p = 0.008$), and self-efficacy (β = 0.033, $p = 0.020$), while the effect of past behavior on intention through risk perceptions was no different from zero. Importantly, we found a non-zero sum of indirect effects of past behavior on intention through all social cognition constructs (β = 0.125, $p < 0.001$), and, with the direct effect, a non-zero total effect (β = 0.306, $p < 0.001$). The mediation proportion statistic (P_M) (Ditlevsen et al., 2005), indicated that the sum of indirect effects of past behavior on intention through the social cognition constructs accounted for approximately two fifths of the total effect of past behavior on intention ($P_M = 0.408$). A previous version of the analysis included an additional study on a sample of dyslipidemic diabetic patients ($N = 111$, M age = 45, $SD = 9$, 39.0% female; (Saleh et al., 2011). Although dyslipidemia is a form of

Table 1
Standardized parameter estimates of direct and indirect effects in multi-level meta-analytic structural equation model unadjusted and adjusted for covariates.

Effect	Model unadjusted for covariates			Model adjusted for covariates		
	B	95% CI		β	95% CI	
		LL	UL		LL	UL
Direct effects						
ATT→INT	0.320***	0.209	0.431	0.351***	0.221	0.482
NRM→INT	0.194**	0.072	0.315	0.204**	0.067	0.341
SE→INT	0.138*	0.026	0.250	0.141*	0.016	0.266
RP→INT	0.015	−0.238	0.267	0.002	−0.251	0.255
PB→INT	0.181***	0.089	0.274	0.198***	0.100	0.296
PB→ATT	0.186***	0.102	0.269	0.269***	0.187	0.350
PB→NRM	0.170***	0.087	0.253	0.253***	0.172	0.334
PB→SE	0.234***	0.157	0.312	0.316***	0.240	0.392
PB→RP	−0.001	−0.242	0.240	0.089	−0.144	0.322
Indirect effects						
PB→ATT→INT	0.059***	0.027	0.091	0.094***	0.051	0.137
PB→NRM→INT	0.033**	0.008	0.057	0.052**	0.015	0.088
PB→SE→INT	0.032**	0.005	0.059	0.045*	0.005	0.084
PB→RP→INT	−0.000	−0.004	0.004	0.000	−0.022	0.023
Sums of indirect effects						
PB→INT[a]	0.125***	0.082	0.167	0.191***	0.139	0.243
Total effects						
PB→INT[b]	0.306***	0.223	0.389	0.388***	0.307	0.470
Correlations						
ATT↔NRM	0.365***	0.279	0.451	0.414***	0.330	0.499
ATT↔SE	0.276***	0.196	0.355	0.322***	0.242	0.401
SE↔NRM	0.349***	0.267	0.431	0.395***	0.314	0.476

Note. Model parameters are adjusted for the following covariates: specific behaviour type and study quality. [a]Sum of indirect effects of past behaviour on intention through all social cognition constructs; [b]Total effect of past behaviour on intention and direct effect of past behaviour on intention. β = Standardized path coefficient; 95% CI = 95% confidence interval of parameter estimate; LL = Lower limit of 95% CI.; INT = Intention; ATT = Attitudes; SE = Self-efficacy; RP = Risk perceptions; PB = Past behaviour; NRM = Norms.
***$p < 0.001$ **$p < 0.01$ *$p < 0.05$.

hypercholesterolemia this study did not strictly meet our inclusion criteria which was exclusively focused on FH and should have been excluded. As this study contributed only one effect size to our analysis the pattern of effects across analyses was identical. For transparency we report the findings of the previous analysis in our supplemental materials (see Table F3, Appendix F, supplemental materials).

4.2. Covariate and moderator variables in the analysis

We were unable to examine effects of our planned behavior type moderator variable on relations among constructs by estimating our proposed model separately in studies for each behavior due to insufficient number of studies in each moderator group. As an alternative, we adjusted our input correlation matrix for the behavior type moderator variable alongside the study quality score covariate and estimated unadjusted and adjusted versions of our model and compared the differences in the parameter estimates across the two versions. Our analysis revealed few systematic differences in model parameter estimates of the unadjusted and covariate models and did not alter our conclusions on the pattern or size of these effects. As a consequence, we have reported the findings of the unadjusted model. Findings for the adjusted model are presented in Table 1 for comparison.

4.3. Assessment of publication bias and statistical power

Results of the publication bias analyses suggested limited evidence of systematic publication bias in the correlations in the present study. Results of the publication bias analyses are presented in Table F4, Appendix F (supplemental materials). Only a small number of instances of non-zero bias was identified, and bias corrected correlations from these analyses were also not appreciably different from the correlations reported in the original analysis. In addition, our statistical power analysis estimates indicated that our analysis was sufficiently powered to detect small-to-medium effect sizes, with the exception of correlations with risk perceptions. A summary of the power analyses is provided in Appendix G (supplemental materials).

5. Discussion

The current meta-analysis identified the salient belief-based psychological constructs (attitudes, subjective norms, risk perceptions, self-efficacy) from social cognition theories associated with intentions to perform self-management behaviors in studies on adults with FH, and also the effect that past experience with these behaviors had on these constructs and intentions. Our findings revealed averaged, positive zero-order correlations among these constructs, with the notable exception of risk perceptions. We also identified unique effects of attitudes, subjective norms, and self-efficacy on intentions to perform FH self-management behaviors. In addition, we found indirect effects of past behavior on intentions mediated by social cognition constructs, as well as a residual past behavior effect. Our results corroborate the theoretically consistent pattern of effects observed in primary research studies on FH (Hagger et al., 2019; Razali et al., 2020; Claassen et al., 2010), highlighting the importance of attitudes, subjective norms, and self-efficacy, but not risk perceptions, in the prediction of intentions to these behaviors in FH patients.

The headline finding of the current analysis is the robust evidence across multiple studies supporting the effects of belief-based constructs from social cognition theories, namely attitudes, subjective norms, and self-efficacy, on intentions to perform FH self-management behaviors. Attitudes had the largest effect on intentions indicating the beliefs in the utility or usefulness of these management behavior towards achieving desired FH outcomes are foremost for individuals when forming their intentions. Subjective norms and self-efficacy, which reflect beliefs in social influences (e.g., the desires of significant others) and beliefs relating to ability or capacity to perform the behavior (e.g., confidence in performing the behaviors, capacity to overcome barriers to self-management), respectively, were also salient correlates of intention, albeit with smaller effect sizes. While the general pattern of averaged effects of these constructs in the current study is consistent with those observed in meta-analyses of research in other health behavior contexts (Hagger et al., 2016, 2018; McEachan et al., 2011), we note that the relative contribution of each construct to the prediction of intention and behavior varies according to behavior type. For example, we observed a larger averaged effect size for the effect of attitudes on intention in the current study relative to the averaged effect observed for general health behaviors for meta-analyses in other contexts (McEachan et al., 2011). Importantly, we also observed that this larger effect of attitudes was consistent with the averaged effect of attitudes on intention in meta-analyses of studies focused on preventive behaviors (McEachan et al., 2011) and, importantly, in studies conducted in behavioral contexts we reasoned would be similar to FH, such as individuals suffering from forms of cardiovascular disease (Belitsi et al., 2023; Fai et al., 2017; Khani Jeihooni et al., 2021; Pan et al., 2022).

These findings have value because they provide FH researchers with typical or 'yardstick' estimates of the contribution that individuals' beliefs make to explaining patients' intentions to perform key behaviors linked to the successful FH management. They also point to the specific beliefs that might be targeted in messaging interventions aimed at promoting intentions to participate in these behaviors. In the context of FH self-management behavior, it seems that attitudes had the largest effect on behavior relative to the other social cognition constructs. Attitudes reflect beliefs regarding the expected usefulness (e.g., beliefs that the behavior will assist keeping cholesterol levels in check, or reduce future likelihood of clinical procedures) and anticipated affective experience (e.g., beliefs that the behavior will result in positive emotional experiences such as relief and satisfaction) resulting from participating in behaviors like regular exercise and dietary control (Hardcastle et al., 2015). As a consequence, the current research provides preliminary evidence that behavior change interventions that target change in these beliefs should be front and center of interventions aimed at promoting participation in FH self-management behaviors. Alongside this, given the consistent association between intentions and behavior, these findings highlight the value of identifying the determinants of intentions to perform FH self-management behaviors. This is corroborated in research that demonstrates that changing intentions through intervention leads to change in behavior (Sheeran et al., 2016a).

An unexpected finding in the present study was a relatively small effect for risk perceptions on intention. Although this finding contrasts with previous theory (Conner et al., 2015) and research (Ferrer and Klein, 2015) that indicate risk perceptions as an important correlate of health protection behaviors (Conner et al., 2015), there is precedent for the modest contribution of risk perceptions in prior meta-analytic research. For example, Zhang et al. (2019) and Protogerou et al. (2018) indicated that the size of the effect of risk perceptions on health behavior intentions was very small relative to other social cognition constructs. We speculate two possible explanations for this pattern of effects. First, the lack of symptomatic information for those with FH may lead to an 'optimistic bias' in patients when estimating their level of risk, as identified in prior research (Fowler and Geers, 2014). Since FH patients lack proximal symptomatic information indicating a health threat, their perception of the threat may not be as highly salient in informing their intentions to engage in self-management behaviors when compared to other beliefs. Second, the current study and prior meta-analyses (Protogerou et al., 2018; Zhang et al., 2019) examined the effects of risk perceptions on intentions alongside other belief-based constructs like attitudes and self-efficacy. It seems these beliefs are more salient to the formation of intentions for FH self-management behaviors, as well as other health behaviors, perhaps because any risks to health arising from not performing these behaviors are too temporally distal.

The consistent effects of past behavior on each of the belief-based predictors of intention in our model suggest that past behavior serves as a source of information for individuals' formation of beliefs regarding their future performance of self-management behaviors (Ajzen, 1991; Hagger et al., 2023a). Unsurprisingly, individuals draw substantially from their past experience with the behaviors in question when making decisions to participate in them in future. It also demonstrates that the current model mediates the past behavior effect on intentions, at least in part. This suggests that the model is sufficient in accounting for prior decision making consistent with theory hypotheses (Ajzen, 1991). It also provides preliminary evidence to indicate the potential that change in the mediating beliefs may be an avenue for changing behavior - if past behavior was the only predictor of behavior with null effects for these constructs, the model would be redundant. However, it is also important to note that the mediation was partial with a substantive residual effect of past behavior on intention. This residual effect may reflect effects of unmeasured constructs that may independently relate to intention formation such as implicit cognition (e.g., implicit attitudes or identity) (Ajzen, 1991), habitual responding that tends to coincide with motives (Hagger et al., 2023a), or other unmeasured beliefs (e.g., moral norms, self-identity) (Rivis et al., 2009). Future studies should expand the portfolio of candidate beliefs that may serve to explain this past behavior effect.

The current research has practical value in that it contributes robust evidence to an expanding database of belief-based constructs that are reliably related to intentions to perform FH self-management behaviors. Researchers have indicated that these constructs are readily modifiable through the strategies or *techniques* used in behavior change interventions, such as persuasive messaging and prompts (Hamilton et al., 2020). The current research may signal the key belief that may be targeted by such techniques and, therefore, serve to inform the development of interventions aimed at promoting intentions to participate in self-management behaviors in FH patients. However, it should be cautioned that the current research does not definitively demonstrate that changing these beliefs lead to concomitant change in FH self-management intentions or behavior. Such inferences would require examining effects of interventions adopting specific techniques on behavior and the mediation of the effect through the theoretical constructs targeted. For example, studies might examine effects of interventions adopting messages that highlight benefits and allay concerns regarding the behavior, thus targeting attitudes, or prompt successful practice of the behavior, thus targeting self-efficacy, on FH patients' intentions to perform, and actual participation in, self-management behaviors in future. Mediation of the effects of each message interventions on intentions and behavior by attitude and self-efficacy, respectively would provide an important mechanism test.

6. Contribution, limitations, and avenues for future research

The current study provides the first synthesis of research examining effects of belief-based constructs on intentions to perform self-management behaviors in FH patients. Findings highlight the expected size and variability of the effects of belief-based constructs on FH patients' intentions to perform these clinically important behaviors, and may signpost potential targets for behavioral interventions in this context. However, some salient limitations should be considered when interpreting the current findings. One notable limitation is the small number of included studies. Although our analysis indicated that the included studies had sufficient statistical power to reliably detect the averaged effect sizes among the study variables, there was heterogeneity associated with each correlation. This indicated the presence of possible moderator variable, but the small sample of included studies precluded an analysis of potential moderator, such as examining whether model effects varied according to the type of self-management behavior adopted. Some mitigation of this concern is afforded by the inclusion of moderators in our adjusted analyses, which revealed little variation in the pattern of effects. However, this analysis does not provide definitive evidence for consistency in the effects and future syntheses should seek to conduct such comparisons as the research in this area proliferates. In addition, while we adopted an inclusive strategy for studies identified in our searches, the lack of diversity in the samples targeted in the included studies, particularly in terms of age range and ethnicity, places, limits the applicability of the results to a broader population. Accounting for a broader demographic range in samples examining the determinants of FH self-management behaviors should, therefore, be considered a priority.

It is important to consider that the current meta-analytic review primarily focused on the key individual psychological constructs from social cognition theories as determinants of self-management behaviors and, therefore, did not account for effects of socio-structural variables that represent the influence of environmental or contextual factors on these behaviors. That said there is tacit assumption among social cognition theorists that the influence of environmental or contextual factors on individuals' decision making will be reflected in the constructs themselves (e.g., attitudes, subjective norms, self-efficacy, and risk perceptions). According to this perspective, individuals prompted to report their judgments regarding future behavioral performance will implicitly or explicitly take the constraints or facilitating effects of the social structure into account when responding (Ajzen et al., 2020; Godin et al., 2010; Hagger and Hamilton, 2021). This consideration notwithstanding, we also recognize that social cognition constructs do not fully mediate effects of socio-structural variables on behavior with non-trivial residual effects observed in these studies. So future applications of these theories should consider inclusion of socio-structural variables (e.g., socio-economic status, education level, healthcare access) as direct and indirect determinants of FH self-management behaviors.

Further, the theoretical approach adopted in the current research focused exclusively on the determinants of intentions – an approach that is generally considered to represent deliberative decision-making processes. However, there is considerable theory and research indicating that such approaches neglect other processes salient to behavioral enactment, such as those outlined in dual-phase and dual-process models of behavior. Specifically, dual-phase models outline the role of planning as a means to address the observed 'gap' between intentions and behavior and dual-process approaches contend that behavioral enactment is not always governed by intentions but may be enacted through non-conscious processes (Sheeran and Webb, 2016; Deutsch et al., 2020). This has led to researchers advocating for the inclusion of constructs that may assist in modeling these additional processes. For example, planning (e.g., formation of action or if-then plans) is conceived as a moderator of intention-behavior relations (Hagger and Luszczynska, 2014) and constructs such as habit or implicit attitudes have been identified as direct predictors of behavior (Hagger et al., 2023b). Researchers should consider including measures of these additional constructs in future studies to further elucidate the processes that lead to FH self-management behavior enactment.

It should also be noted that a number of studies that measured the appropriate social cognition constructs in the context of FH self-management behavior were excluded due to a lack of available data reported in eligible articles which could not subsequently be obtained through direct contact with the authors. One alternative would have been to narratively review the general trends reported in these articles alongside the meta-analytic synthesis. While such an analysis may permit drawing very general descriptive trends of effects, such conclusions would be subject to the sampling error associated with each study and rely exclusively on the statistical significance or individual effect sizes reported. This may lead to biased or contradictory conclusions which would be difficult to reconcile. Our meta-analytic approach allowed us to correct our effect size estimates for sampling error and estimate the expected average and variability estimates in the effect sizes for each model construct on intentions toward, and actual participation in, FH self-management behaviors using all the available data.

However, it should be acknowledged that our analysis was confined to studies that reported or provided data, a limitation to which most meta-analyses are subject. We therefore encourage researchers conducting research in this field to make their data available for synthesis and urge journal editors to instigate supportive mandates for authors to do so.

Finally, we acknowledge that all of the included studies adopted correlational, cross-sectional research designs. Such data precludes inference of causal and directional relations among model constructs, so it should be stressed that the current relations and associated mediated effects are inferred from theory, rather than the data. We therefore advocate future research that adopts experimental (Sheeran et al., 2016b) and longitudinal panel (Hagger and Hamilton, 2023) designs so as to better infer causal and directional effects.

7. Conclusion

The current meta-analysis is the first to synthesize relations between constructs from social cognition theories and intention to perform self-management behaviors in FH patients across the extant literature and provide evidence supporting a model testing the unique effects of these constructs on intention and the mediation of the effect of past behavior on intention by social cognition constructs. Findings suggest potentially modifiable constructs that could be targeted in interventions aimed at promoting intentions to participate in FH self-management behaviors (e.g., physical activity participation, medication adherence, healthy eating). Although this study alone does not provide sufficient evidence to definitively recommend that these constructs should be targeted in behavior change interventions, it provides basis for future experimental and intervention studies that may provide further supportive data. Such studies should adopt manipulations or content such as persuasive messaging that highlight benefits and allay concerns, which target attitudes, or prompting successful practice, which target self-efficacy, and examine their effects on FH patients' intentions to perform, and actual participation in, self-management behaviors.

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CRediT authorship contribution statement

Rabia Majeed: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Kyra Hamilton:** Writing – review & editing. **Gerald F. Watts:** Writing – review & editing. **Martin S. Hagger:** Writing – review & editing, Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft.

Declaration of competing interest

The authors declare no conflicts of interest.

Data availability

Data files and data analysis code and output are archived online: https://osf.io/rkjw5.

Appendices. Supplementary Material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2024.116968.

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