Priority domains, aims, and testable hypotheses for implementation research: A scoping review and evidence map protocol

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Abstract
Background: The challenge of implementing evidence-based innovations within practice settings is a significant public health issue the field of implementation research (IR) is focused on addressing. Significant amounts of funding, time, and effort have been invested in IR to date, yet there remains significant room for advancement, especially regarding IR’s development of scientific theories as defined by the National Academy of Sciences (i.e., a comprehensive explanation of the relationship between variables that is supported by a vast body of evidence). Research priority setting (i.e., promoting consensus about areas where research effort will have wide benefits to society) is a key approach to helping accelerate research advancements. Thus, building upon existing IR, general principles of data reduction, and a general framework for moderated mediation, this article identifies priority domains, aims, and testable hypotheses for IR and describes a scoping review protocol to identify and map the extent to which IR has examined these priorities to date.

Methods: Implementation Science is the leading journal for publishing IR and receives over 800 submissions annually. Thus, this scoping review will focus on IR published in Implementation Science between its inception in 2006 and 12/31/2019. The current scoping review and evidence map protocol has been developed in accordance with the approach developed by Arksey & O’Malley and advanced by Levac, Colquhoun, and O’Brien. All research articles and short reports will be reviewed. Because scoping reviews seek to provide an overview of the identified evidence base rather than synthesize findings from across studies, we plan to use our data-charting form to provide a descriptive overview of implementation research to-date and summarize the research via one or more summary tables. We will use the priority aims and testable hypotheses (PATH) diagram, which integrates the four priority domains, three priority aims, and four priority testable hypotheses, to develop a map of the evidence (or lack thereof).

Discussion: This scoping review and evidence map is intended to help accelerate IR focused on one or more of IR’s priority aims and testable hypotheses, which in turn will accelerate IR’s development of NAS-defined scientific theories and, subsequently, improvements in public health.

Systematic review registration: Open Science Framework: https://osf.io/3vhuj/
Background
The persistence of unacceptably low rates of translating research findings into practice has led to increasing attention to implementation research (IR) as a means to significantly accelerate improvements in public health. Over a decade ago, Eccels and Mittman (2006) defined IR as “the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services and care.” Similarly, the National Institutes of Health has consistently defined IR as “the scientific study of the use of strategies to adopt and integrate evidence-based health interventions into clinical and community settings in order to improve patient outcomes and benefit population health.” Considering the significant amounts of funding, time, and effort invested in IR, it would be ideal if the field of IR had developed one or more scientific theories as defined by National Academy of Sciences (NAS; i.e., a comprehensive explanation of the relationship between variables that is supported by a vast body of evidence). However, given that IR has yet to develop scientific theories as defined by the NAS, efforts to accelerate their development are warranted. Research priority setting (i.e., promoting consensus about areas where research effort will have wide benefits to society) is one approach to accelerating research advancements. Thus, building upon a systematic program of both effectiveness research and IR that has been conducted by Garner and colleagues as well as other key IR, the Priority Aims and Testable Hypotheses for IR (PATH4IR) Project seeks to accelerate IR on several of IR’s priority domains, aims, and testable hypotheses via estimating the extent to which IR to date has (or has not) examined these priority areas. Helping accelerate IR on these priorities should accelerate IR’s development of NAS-defined scientific theories, which in turn will help accelerate improvements in public health. Below we identify, describe, and justify four priority domains, three priority aims, and four priority testable hypotheses for IR, which are the focus of the PATH4IR Project and its scoping review.

Four priority domains for implementation research
A plethora of IR models and frameworks have identified numerous IR domains. Table 1 lists the
domains of three IR models/frameworks that have guided much IR to date. Building on these IR models/frameworks,\textsuperscript{19,20,22} other IR,\textsuperscript{21} principles of data reduction,\textsuperscript{23} and a general framework for moderated mediation,\textsuperscript{24} the PATH4IR Project identified four priority domains for IR. Each priority domain is defined below and in Table 2.

**Implementation strategies.** Implementation strategies (ISs) are defined as the strategies used to put into practice a program of known dimensions (e.g., an evidence-based practice [EBP]).\textsuperscript{22,25} This domain is included in some IR models/frameworks\textsuperscript{22} but others do not explicitly include it.\textsuperscript{19,20} Given how IR has been defined and that ISs are the quintessential independent variable in IR,\textsuperscript{4-6} we consider the IS domain a priority for IR.

**Health & health-related outcomes.** Health outcomes (e.g., client/patient functioning) and health-related outcomes (e.g., health-related quality of life, quality adjusted life years) are the outcomes that IR seeks to ultimately improve.\textsuperscript{4-6} Like the IS domain, not all IR models/frameworks explicitly include the health and health-related outcomes (HRRO) domain.\textsuperscript{19,20} However, as noted by Foy et al. (2015), “If studies evaluating the effects of implementation interventions are to be of relevance to policy and practice, they should have end-points related to evidence-based processes of care.”\textsuperscript{26} Thus, the HHROs domain was identified as a priority domain for IR.

**Evidence-based measures of implementation.** Consistent with the important distinction demonstrated between a practice and an EBP,\textsuperscript{27} an important distinction has been demonstrated between an implementation outcome and an evidence-based measure of implementation (EBMI).\textsuperscript{16} More specifically, an implementation outcome is defined as “the effects of deliberate and purposive actions to implement new treatments, practices, and services,”\textsuperscript{21} whereas an EBMI is defined as “an implementation outcome measure that is predictive of improvements in key client outcomes” (i.e., HHROs).\textsuperscript{16} This means that while all EBMIs are implementation outcomes, not all implementation outcomes are EBMIs. IR has historically prioritized implementation outcomes, but as noted by Proctor and colleagues (2009), implementation outcomes should not be treated as dependent variables until
we have advanced them as consistent, valid, and efficient measures of implementations.\textsuperscript{21} Otherwise, we rely on the assumption that implementation outcomes are predictive of HHROs, without empirically demonstrating this to be true. The PATH4IR Project is the first to explicitly identify EBMI as a priority domain for IR.

**Context-related moderators/mediators.** Moderation occurs when the effect of an independent measure on a dependent variable depends on the level of another measure and mediation occurs when the effect of an independent variable on a dependent measure is transmitted through a third variable.\textsuperscript{28} Given that existing IR models/frameworks have highlighted the importance of context\textsuperscript{19,20,29} and that Edwards and Lambert’s (2007) general framework for moderated mediation\textsuperscript{24} guided identification of the priority domains for this project, Context-Related Moderators/Mediators (CRMM) was identified as a priority domain for IR. Including CRMM as a priority domain is consistent with several IR models/frameworks.\textsuperscript{19,20,29} IR models/frameworks that do not include a context-related domain\textsuperscript{22,30} are limited given the hypothesized importance of inner and outer contextual factors in EBP implementation.

**Three priority aims for implementation research**

There are numerous aims (i.e., research questions) that IR could address, but not all aims have equal significance. Relative to IR’s domains, IR’s aims have received less explicit attention. The work of Curran et al. (2012)\textsuperscript{31} is one exception. Specifically, for their type 3 effectiveness-implementation research categorization, Curran et al. recommended that the primary aim of this research category was to “determine utility of an implementation intervention/strategy” and the secondary aim was to “assess clinical outcomes associated with implementation trial.”\textsuperscript{31} Curran et al. also recommended implementation outcomes (i.e., adoption, fidelity) as dependent measures for the primary aim, with client outcomes (e.g., patient symptoms patient functioning) as dependent measures for the secondary aim.\textsuperscript{31} However, priority aims have not generally been explicitly addressed by most other IR models/frameworks.\textsuperscript{19,20,22} Given that developing or contributing to generalizable knowledge is
it is important that IR prioritize aims that seek to develop or contribute to generalizable knowledge for its priority relationships. Thus, building from the four priority domains described above, we identified the following three priority aims for IR: (1) the IS to HHRO relationship (i.e., IS → HHRO), (2) the IS to EBMI relationship (i.e., IS → EBMI), and (3) the EBMI to HRRO relationship (i.e., EBMI → HRRO). Drawing from mediational analysis literature, we have termed IR focused on the IS → HHRO relationship as Path C IR (the red triangle of Figure 1), IR focused on the IS → EBMI as Path A IR (the blue triangle of Figure 1), and IR focused on the EBMI → HHRO relationship as Path B IR (the green triangle of Figure 1). Each priority aim is defined below and in Table 3.

**Advance generalizable knowledge regarding the IS → HHRO relationship.** Advancing generalizable knowledge about the relationship between an IS and a HHRO is termed Path C IR. Given IR’s emphasis on strategies to increase the uptake of EBPs to improve patient and population health, Path C IR was identified as a priority aim for IR. However, further support for Path C IR as a priority aim is provided by Foy et al., who as noted above, suggested “If studies evaluating the effects of implementation interventions are to be of relevance to policy and practice, they should have endpoints related to evidence-based processes of care.” An example of Path C IR is a 29-site cluster randomized implementation experiment Garner et al. (2012) conducted between 2008 and 2012 that focused on testing the impact of a pay-for-performance (P4P) IS to improve the implementation and effectiveness of the Adolescent Community Reinforcement Approach (A-CRA), which is an EBP for adolescents with substance use disorders. For the primary HHRO, which was adolescent substance use recovery status at 6-month follow-up, no significant difference between IS conditions was found.

**Advance generalizable knowledge regarding the IS → EBMI relationship.** Advancing generalizable knowledge about the relationship between an IS and an EBMI is termed Path A IR. Given that an EBMI is a measure of EBP implementation found to be predictive of key client outcomes (i.e., HHROs), Path A IR was identified as a priority aim for IR. Relative to IR that has tested the impact of
an IS on implementation outcomes that do not have evidence of being a meaningful predictor of key client outcomes, IR testing the impact of an IS on EBMIs appears be limited. However, having established an EBMI for A-CRA as part of an effectiveness study,\textsuperscript{9,14} Garner et al. (2012)\textsuperscript{15} also provide an example of Path \textit{A IR}. Indeed, examining the impact of P4P on an EBMI called Target A-CRA (i.e., 10+ of the core A-CRA components delivered within no less than seven sessions), which prior research found to be significantly associated with greater reductions in adolescents’ days of abstinence at follow-up,\textsuperscript{14} Garner et al. (2012) found that relative to adolescents in the implementation-as-usual (IAU) condition, adolescents in the P4P condition had a significantly higher likelihood of receiving Target A-CRA.\textsuperscript{15}

\textbf{Advance generalizable knowledge regarding the EBMI \textrightharpoonup HHRO relationship.} Advancing generalizable knowledge about the relationship between an EBMI and HHROs is termed \textit{Path B IR}. Research by Nosek et al. (2015),\textsuperscript{38} which increased concern regarding the reproducibility of psychological science, underscores why \textit{Path B IR} is a priority. That is, it is important that significant relationships (e.g., EBMI \textrightharpoonup HHRO) supported as part of effectiveness research be examined for replicability within implementation research. As part of their IR experiment, Garner et al. (2012) provide an example of \textit{Path B IR} by replicating a significant association between Target A-CRA (i.e., the EBMI) and adolescent abstinence from substance use at follow-up (i.e., the HHRO).\textsuperscript{15}

\textbf{Four priority testable hypotheses for implementation research}

The possible testable hypotheses for IR are numerous. However, because not all hypotheses are equally significant, there is value in establishing consensus regarding the types of testable hypotheses IR should prioritize. Toward helping generate NAS-defined \textit{scientific} IR, prioritizing one or more of the four testable hypotheses shown in \textbf{Figure 2} is warranted. More specifically, there is a need to prioritize IR testable hypotheses regarding the extent to which an IS has demonstrated one or more of the following, relative to an appropriate active-control IS: \textit{superior effectiveness} (upper left quadrant [ULQ]) and/or \textit{cost-effectiveness} (upper right quadrant [URQ]), \textit{non-inferior effectiveness} (lower left quadrant [LLQ]) and/or \textit{cost-effectiveness} (lower right quadrant [LRQ]). Each priority
testable hypothesis is described below and in **Table 4**.

**Effectiveness hypotheses from a superiority trial.** Testing the extent to which an experimental IS has superior effectiveness, relative to an active-control IS, is termed IR testing an *upper left quadrant* (ULQ) hypothesis. In contrast to research on clinical treatments, where an active-control condition may not exist or be appropriate, IR should include the most appropriate active-control IS possible. One of the most appropriate active-control condition IS may be the IS used as part of an EBPs effectiveness research. To date, the “large and growing evidence base relating to the effectiveness of implementation strategies” noted by Foy et al.\(^{39}\) has tested ULQ hypotheses and supports that this testable hypothesis is and should remain a priority for IR. Indeed, given that tests of ULQ hypotheses may continue to be the most common type of IR hypotheses, it may not be much longer before results of ULQ hypothesis tests are analyzed as part of a meta-analysis.

**Cost-effectiveness hypotheses from a superiority trial.** Testing the cost-effectiveness of an IS that has been shown to have superior effectiveness, relative to an active-control IS, is termed IR testing an *upper right quadrant* (URQ) hypothesis. It is considered a priority testable hypothesis for IR as knowing the effectiveness of an intervention/strategy is not sufficient for many potential users, especially decision makers who need to know whether the benefits from the intervention/strategy are commensurate with its costs (i.e., whether it delivers value).\(^{40}\) Further, noting that economic evaluation of implementation strategies “has been neglected,” Foy et al. encouraged IR with an economic evaluation component.\(^{26}\) Building upon Garner et al. (2012),\(^{15}\) which found P4P to be an effective IS for improving the implementation and effectiveness of A-CRA in a superiority trial, Garner et al. (2018)\(^{18}\) provide an example of IR testing a URQ hypothesis. Supporting the cost-effectiveness of a P4P IS, Garner et al (2018) found that although the P4P strategy led to significantly higher average total costs compared to the IAU control condition, this average increase of 5% resulted in a 325% increase in the average number of patients who received Target A-CRA (i.e., the EBMI).\(^{18}\)

**Effectiveness hypotheses from non-inferiority trial.** Testing the extent to which an experimental IS has non-inferior effectiveness, relative to an active-control IS, is termed IR testing a
lower left quadrant (LLQ) hypothesis. Similar to how Schumi and Wittes (2011) explain non-inferiority, testing a non-inferiority hypothesis seeks to provide evidence that the IS being tested is “not unacceptably worse” than the IS being used as a control. This is a priority for IR given strategies used to study a clinical intervention’s effectiveness may not be possible in practice settings (e.g., too intensive). We are not aware of IR that has tested LLQ hypotheses. However, a close example is a non-randomized observational IR study by Stirman et al. (2017) that compared two strategies for providing post-workshop consultation in an evidence-based cognitive therapy. As detailed by Stirman et al., results of their study did not support the hypothesis of the group consultation and feedback condition being non-inferior to the gold-standard individual feedback condition.

**Cost-effectiveness hypotheses from non-inferiority trial.** Testing the cost-effectiveness of an IS shown to have non-inferior effectiveness, relative to an active-control IS, is termed IR testing a lower right quadrant (LRQ) hypothesis. Again, given decision makers desire to know the extent to which benefits from an IS are commensurate with its costs, LRQ hypotheses were identified as a priority for IR. Although not from the field of IR, an example of testing cost-effectiveness hypotheses from a non-inferiority trial is provided by Bansback et al. (2018), which extended research by Oviedo-Jockes et al. (2016) to support the non-inferiority of injectable hydromorphone hydrochloride (i.e., a narcotic pain reliever) relative to injectable diacetylmorphine hydrochloride (i.e., pharmaceutical heroin).

**Objectives**

The primary objective of the PATH4IR Project’s scoping review is to advance understanding regarding the extent to which IR to date has (or has not) examined the four priority domains, three priority aims, and four priority testable hypotheses described above. We hypothesize that IR addressing these priorities will be limited (i.e., represent significant gaps in the extant IR literature). Thus, a secondary objective of this review is to help advance understanding regarding what domains, aims, and testable hypotheses IR has focused on to date.
Methods

The scoping review approach developed by Arksey & O’Malley (2005)\(^{45}\) and advanced by Levac, Colquhoun, and O’Brien (2010)\(^{46}\) guided this scoping review protocol and is therefore organized around five stages: (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, and (5) collating, summarizing, and reporting results. Each stage is described below.

### Stage 1: Identifying the research questions

The primary research questions our research team will answer with this scoping review is: To what extent have the four priority domains, three primary aims, and four priority testable hypotheses described above been addressed by IR to date? Via an iterative process, our research team also identified the following secondary research questions: (1) which other domains have been studied by IR to date, (2) which other aims have been studied by IR to date, and (3) which other hypotheses have been examined by IR to date.

### Stage 2: Identifying relevant studies

*Implementation Science* is the leading journal for publishing IR and receives over 800 submissions annually.\(^{47}\) As such, this review will focus on IR published in *Implementation Science* since its inception in 2006. To identify relevant studies, we will search PubMed using the search strategy below and cross-reference the results with a list of publications on the journal’s website:

*Search “Implementation science IS” [Journal]*

*Filters: Publication date to 12/31/2019*

“Research articles” and “short reports” published in *Implementation Science* since its inception through 2019 are eligible. Articles labeled by the journal as “systematic review,” “methodology,” debate,” or “conference proceedings” are not eligible as this review aims to map original IR. “Protocols” were also excluded given that intended analyses do not always align with published results. Research articles and short reports will be excluded if the review team agrees that the paper’s primary objective is more aligned with an excluded article type.

### Stage 3: Study selection
Reference information and full texts for all articles published in *Implementation Science* in 2019 or earlier will be imported into an EndNote database. The articles will be sorted by a reviewer by type to identify all articles labeled by the journal as research articles or short reports. In the subsequent stages, if a reviewer encounters an article deemed ineligible (i.e., labeled by the journal as a research article or short report but is not considered primary implementation research), the reviewer will raise it with review team so that consensus around an inclusion decision can be reached.

**Stage 4: Charting the data**

Table 5 provides a list of variables to be included in the project’s data-charting form, which was developed based on discussions by the review team regarding what information should be recorded for each eligible article and a pilot test of the form with five articles. First author, title, publication year, and article type are included as article identifiers. We will extract whether and which IS, HHRO, EBMI, or CRMM was studied, which relationships between these domains were studied (i.e., Path C, A, or B), and whether URQ, ULQ, LLQ, or LRQ hypotheses were tested when studying these relationships to answer our primary question of the extent to which the priority domains, aims, and testable hypotheses have been assessed in IR to date. As a secondary question, we will seek to understand what other domains, aims, and testable hypotheses have been examined by IR to date. For example, we will extract whether studies consider implementation outcomes that are not evidence-based or contextual factors not as moderators or mediators to understand which other domains have been examined and the extent to which they have been examined. We anticipate identifying IR that focused on implementation outcomes rather than EBMIIs and therefore will record whether the IS → implementation outcome relationship was assessed. Our form also will include a space to capture other aims and testable hypotheses that IR has examined to date.

To ensure validity of the form, data will be extracted by a primary reviewer and confirmed by a secondary reviewer for approximately one-third of the included articles. Any conflicts will be discussed until consensus is reached. Clarifications and additional revisions to the data-charting form based on the types of conflicts that arise will be considered. Once the form is finalized at this stage, data from the remaining articles will be extracted by a single reviewer.
Stage 5: Collating, summarizing, and reporting the results

A PRISMA flow diagram will be used to report results of the scoping review. Additionally, we will present a descriptive overview (including tabular and/or graphical summaries) of the eligible full texts. Because scoping reviews seek to provide an overview of the identified evidence base rather than synthesize findings from across studies, we plan to use our data-charting form to provide a descriptive overview of implementation research to-date and summarize the research via one or more summary tables (e.g., for each priority aim). Additionally, we will use the priority aims and testable hypotheses (PATH) diagram (see Figure 3), which integrates the four priority domains, three priority aims, and four priority testable hypotheses, to develop a map of the evidence (or lack thereof).

Discussion

Despite significant amounts of funding, time, and effort, the field of IR has yet to develop scientific theories as defined by the NAS (i.e., a comprehensive explanation of some aspect of nature that is supported by a vast body of evidence). The findings from this project are intended to help accelerate IR focused on one or more of the identified IR priority aims and testable hypotheses, which in turn will accelerate IR’s development of NAS-defined scientific theories and, subsequently, improvements in public health. Results of this scoping review will be disseminated via presentations at professional conferences (e.g., Annual Conference on the Science of Dissemination and Implementation in Health, Society on Implementation Research Collaboration), publication in a peer-reviewed journal (e.g., Implementation Science, Implementation Research and Practice, Implementation Science Communications).

Abbreviations

A-CRA: adolescent community reinforcement approach; CRMM: context-related moderators/mediators; EBI: evidence-based implementation; EBMI: evidence-based measures of implementation; EBP: evidence-based practice; HHRO: health and health-related outcomes; IAU: implementation-as-usual; IAU: implementation-as-usual; IR: implementation research; IS: implementation strategies; LLQ: lower left quadrant; LRQ: lower right quadrant; NAS: national academy of sciences; PATH: priority aims and testable hypotheses; P4P: pay-for-performance; ULQ: upper left quadrant; URQ: upper right
quadrant;

Declarations

**Ethics approval.** Not applicable.

**Consent for publication.** Not applicable.

**Availability of data and material.** Not applicable.

**Competing interests.** None.

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Tables

Table 1. Domains included in several existing implementation research models/frameworks

| Implementation Research Model/Framework | |
|----------------------------------------|----------------------------------|
| Proctor et al. (2009) – A Conceptual Model of Implementation Research | Intervention Strategies; |
| Damschroder et al (2009) – The Consolidated Framework for Implementation Research | Intervention Characteristics; Outer Setting; Inner Setting; Characteristics of the Individuals Involved |
| Aarons et al. (2011) – Conceptual Model of Evidence-Based Practice Implementation in Public Service Sectors | Outer Context; Inner Context Developers; Innovation/System Fit |

Table 2. The priority domains for implementation research

| Priority Domain (acronym) | Brief Description |
|---------------------------|-------------------|
| Implementation Strategies (IS) | Strategies used to put into practice a program of known dimensions (e.g., EBP) |
| Health and Health-Related Outcomes (HHRO) | End-points regarding evidence-based process of care, client/patient outcomes |
| Evidence-Based Measures of Implementation (EBMI) | A measure shown to be predictive of improvement in one or more outcomes |
| Context-Related Moderators/Mediators (CRMM) | Measures of the outer setting/context or inner setting/context that moderate and/or mediate relationships between the other domain |

Note: EBP = Evidence-Based Practice.
Table 3. The priority aims for implementation research

| Priority Aim |
|---------------|
| Advance generalizable knowledge regarding the IS ↔ HHRO relationship |
| Advance generalizable knowledge regarding the IS ↔ EBMI relationship |
| Advance generalizable knowledge regarding the EBMI ↔ HHRO relationship |

**Note:** IS = Implementation Strategies; HHRO = Health and Health-Related Outcomes; EBMI = Evidence-Based Measures of Implementation.

Table 4. The priority testable hypotheses for implementation research

| Priority Testable Hypothesis |
|-------------------------------|
| Cost-effectiveness hypotheses from a superiority trial |
| Effectiveness hypotheses from a superiority trial |
| Effectiveness hypotheses from a non-inferiority trial |
| Cost-effectiveness hypotheses from a non-inferiority trial |

**Note:** URQ = Upper Right Quadrant; ULQ = Upper Left Quadrant; LLQ = Lower Left Quadrant;
Table 5. Data elements.

| Variable          | Format          | Description                                                                                       |
|-------------------|-----------------|--------------------------------------------------------------------------------------------------|
| **Article identifiers** |                |                                                                                                  |
| First author      | Free text       | Last name of the article’s first author                                                           |
| Title             | Free text       | Title of the article                                                                             |
| Publication year  | Numerical       | Year in which the article was published                                                           |
| Article type      | Categorical     | Whether the article is labeled as a research article or short report by the journal               |

**Primary question:** To what extent have the PATH4IR Project’s priority domains, aims, and testable hypotheses been studied?

| Variable | Format          | Description                                                                                       |
|----------|-----------------|--------------------------------------------------------------------------------------------------|
| IS       | Dichotomous     | Whether the study develops or assesses an IS                                                     |
|          | Categorical     | If yes, whether the implementation strategies of interest are assistance, adapt and tailor to context, develop stakeholder stakeholders, support clinicians, engage consumers, utilize fi |
|          | Free text       | If yes, lists the IS of interest                                                                  |
| HHRO     | Dichotomous     | Whether the study assesses an HHRO                                                                 |
|          | Free text       | If yes, lists the HHRO of interest                                                                |
| EBMI     | Dichotomous     | Whether the study assesses an EBMI                                                                 |
|          | Free text       | If yes, lists the EBMI of interest                                                                |
| CRMM     | Dichotomous     | Whether the study assesses a contextual factor as a modera                                       |
|          | Categorical     | If yes, whether the contextual factors of interest are related outer setting (e.g., external policies and incentives), inner se characteristics (e.g., staff perceptions about the intervention planning ahead of implementation) |
| Path C   | Dichotomous     | Whether the study assessed the IS – HHRO relationship                                             |
| Path A   | Dichotomous     | Whether the study assessed the IS – EBMI relationship                                              |
| Path B   | Dichotomous     | Whether the study assessed the EBMI – HHRO relationship                                             |
| URQ hypothesis | Dichotomous | Whether the study tested a URQ hypothesis                                                         |
| ULQ hypothesis | Dichotomous | Whether the study tested a ULQ hypothesis                                                         |
| LLQ hypothesis | Dichotomous | Whether the study tested an LLQ hypothesis                                                         |
| LRQ hypothesis | Dichotomous | Whether the study tested an LRQ hypothesis                                                         |

**Secondary question:** Which other domains have been studied in IR to date?
| Implementation outcome | Dichotomous | Whether the study assesses an implementation outcome that is not yet evidence-based |
|------------------------|-------------|----------------------------------------------------------------------------------|
|                        | Categorical | If yes, whether the implementation outcomes of interest are related to acceptability, adoption, appropriateness, feasibility, fidelity, implementation cost, penetration, or sustainability |
|                        | Free text   | If yes, lists the contextual factors of interest |
| Context generally      | Dichotomous | Whether the study considers the implementation context without assessing it as a moderator or mediator in some relationship |
|                        | Categorical | If yes, whether the contextual factors of interest are related to intervention characteristics (e.g., complexity), outer setting (e.g., external policies and incentives), inner setting (e.g., leadership engagement), individual characteristics (e.g., staff perceptions about the intervention), or the implementation process (e.g., extent of planning ahead of implementation) |
|                        | Free text   | If yes, lists the contextual factors of interest |
| Other domain           | Free text   | Lists domains other than IS, HHRO, EBMI, implementation outcomes, CRMM, or context generally that are studied |

Secondary question: Which other aims have been studied in IR to date?

| Path A-ish             | Dichotomous | Whether the study assessed the IS implementation outcome relationship |
| Other aim              | Free text   | Lists relationships other than Path C, Path A, Path A-ish, and |

Secondary question: Which other hypotheses have been tested in IR to date?

| Other hypothesis       | Free text   | Lists testable hypotheses other than URQ, ULQ, LLQ, LRQ the |

Note: URQ = Upper Right Quadrant; ULQ = Upper Left Quadrant; LLQ = Lower Left Quadrant; 
LRQ = Lower Right Quadrant.

Figures
Figure 1

Priority aims for implementation research
| Superiority Hypotheses | Non-Inferiority Hypotheses |
|------------------------|---------------------------|
| **Upper Left Quadrant (ULQ) Hypotheses** | **Lower Left Quadrant (LLQ) Hypotheses** |
| Hypotheses testing the extent to which an experimental implementation strategy has superior effectiveness relative to an appropriate implementation-as-usual strategy | Hypotheses testing the extent to which an experimental implementation strategy has non-inferior effectiveness relative to an appropriate implementation-as-usual strategy |
| **Cost-Effectiveness Analysis** | **Upper Right Quadrant (URQ) Hypotheses** |
| **Lower Right Quadrant (LRQ) Hypotheses** | Hypotheses testing the cost-effectiveness of an implementation strategy shown to have superior effectiveness relative to an appropriate implementation-as-usual strategy |

**Figure 2**

Priority hypotheses for implementation research
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

Additional File 1 - PRISMA-P checklist.docx