



BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Built to last? The sustainability of healthcare system improvements, programs and interventions: A systematic integrative review

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-036453
Article Type:	Original research
Date Submitted by the Author:	17-Dec-2019
Complete List of Authors:	Braithwaite, Jeffrey; Macquarie University, Australian Institute of Health Innovation Ludlow, Kristiana; Macquarie University, Australian Institute of Health Innovation Testa, Luke; Macquarie University, Australian Institute of Health Innovation Herkes, Jessica; Macquarie University, Australian Institute of Health Innovation Augustsson, Hanna; Macquarie University, Australian Institute of Health Innovation Lamprell, Gina; Macquarie University, Australian Institute of Health Innovation McPherson, Elise; Macquarie University, Australian Institute of Health Innovation Zurynski, Yvonne; Macquarie University, Australian Institute of Health Innovation
Keywords:	Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Change management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

**BUILT TO LAST? THE SUSTAINABILITY OF HEALTHCARE SYSTEM
IMPROVEMENTS, PROGRAMS AND INTERVENTIONS: A SYSTEMATIC
INTEGRATIVE REVIEW**

**Jeffrey Braithwaite^{1,2*}, Kristiana Ludlow¹, Luke Testa¹, Jessica Herkes¹, Hanna
Augustsson¹, Gina Lamprell¹, Elise McPherson¹, Yvonne Zurynski^{1,2}**

¹Centre for Healthcare Resilience and Implementation Science, Australian Institute of Health
Innovation, Macquarie University, Sydney, Australia

²NHMRC Partnership Centre in Health System Sustainability, Australian Institute of Health
Innovation, Macquarie University, Sydney, Australia

*Corresponding author: Jeffrey Braithwaite

Address: Level 6, 75 Talavera Rd, North Ryde, NSW 2109, Australia; Phone: + 61 2 9850
2401; Email: jeffrey.braithwaite@mq.edu.au

Word count

3994

Keywords

Organisation of health services; Health policy; Change management; Quality in health care

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

ABSTRACT

Introduction: The sustainability of healthcare delivery systems is challenged by ageing populations, complex systems, increasing rates of chronic disease, increasing costs associated with new medical technologies, and growing expectations by healthcare consumers, all within a climate of fiscal restraint. Healthcare programs, innovations and interventions are increasingly implemented at the front-lines of care in order to increase effectiveness and efficiency, however, little is known about how sustainability is conceptualised and measured when such programs are evaluated.

Objectives: We aimed to describe theoretical frameworks, definitions and measures of sustainability, as applied in published evaluations of healthcare improvement programs and interventions.

Design: Systematic integrative review.

Methods: We searched six academic databases (July 2011-March 2018) for peer-reviewed journal articles in English. Articles were included if they assessed program sustainability or sustained outcomes of a program at the healthcare system level. Six reviewers conducted the abstract and full-text review, and extracted data on study characteristics, definitions, terminology, theoretical frameworks, methods and tools. Hawker’s Quality Assessment Tool was applied to included studies.

Results: Of the 91 included studies, 74.7% were classified as high quality. Twenty-six (28.6%) studies provided 32 different definitions of sustainability. Terms used interchangeably for sustainability included continuation, maintenance, follow-up or long-term. Seventy-nine studies (86.8%) clearly reported the time points at which sustainability was evaluated; 43% assessed sustainability at 1-2 years, and 11.4% at <12 months. Eighteen studies (19.8%) used a theoretical framework to conceptualise or assess program

sustainability, including frameworks that were not specifically designed to assess sustainability.

Conclusions: The body of literature is limited by use of inconsistent definitions and measures of program sustainability. Evaluations of service improvement programs and interventions seldom used theoretical frameworks. Embedding implementation science and healthcare services researchers into the healthcare system is a promising strategy to improve the rigour of program sustainability evaluations.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The review was conducted in accordance with PRISMA guidelines.
- The search strategy was developed in collaboration with a clinical librarian to capture the diversity of healthcare programs, study methodologies and study settings.
- Regular team meetings, verification of data extraction accuracy, and quality assessment of included publications enhanced the rigour of the review.
- The review was limited to peer-reviewed articles and excluded program evaluations published in the grey literature.
- The focus on outcomes at the healthcare systems level meant that programs that assessed patient and/or community outcomes only were excluded from this review.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

**BUILT TO LAST? THE SUSTAINABILITY OF HEALTHCARE SYSTEM
IMPROVEMENTS, PROGRAMS AND INTERVENTIONS: A SYSTEMATIC
INTEGRATIVE REVIEW**

INTRODUCTION

Background

Healthcare systems across the world strive to provide safe, high quality care and deliver the best possible health outcomes for the populations they serve. At the same time, fiscal constraints necessitate the delivery of healthcare in an efficient and cost effective way.[1] This creates a challenge to the sustainability of healthcare systems globally.[2, 3] Lead international agencies, including the World Health Organization (WHO), the Organization for Economic Cooperation and Development (OECD) and the World Economic Forum (WEF), have recently highlighted significant threats to the sustainability of healthcare system performance.[1, 3, 4] Ageing populations and the rapidly increasing burden of chronic conditions also pose challenges to healthcare system sustainability.[5-7] The introduction of new medical technologies, including new diagnostic tests, new drugs, medical equipment and digital healthcare services,[8] as well as a growing “consumer-culture”, have led to demands for higher standards of patient safety and quality of care and lower costs.[9] At the same time, the level of wasteful spending on low-value care has remained static, at approximately 30%, while high-value care which aligns with level I evidence or best practice consensus guidelines accounts for approximately 60% of delivered care and has done for two decades.[10-15]

Sweeping policy and healthcare system “big bang” reforms are relatively rare, mainly because they require enormous efforts to mobilise multiple stakeholders who work within

entrenched cultures, structures and approaches that make up complex healthcare systems.[16-19] Much of the change implementation to improve healthcare system sustainability occurs closer to the front-lines of care, through innovative projects, improvement programs and interventions, referred to as “programs” from this point forward.

To maximise the benefits of program innovation in healthcare, we need the ability to rigorously assess whether programs are adaptable to real-world settings, and sustainable beyond the program trial period.[20] Stirman et al.’s 2012 systematic review of the sustainability of implemented healthcare programs reported that few of the included studies that were published before June 2011 provided a definition of sustainability.[21] The authors considered articles in which studies assessed the continuation of programs after initial implementation efforts, staff training periods, or funding had ended.[21] They found that when defining sustainability, the majority of included studies referred to Scheirer’s definition[22] which is based on the work of Shediach-Rizkallah and Bone.[23] Scheirer proposed three levels of analysis for program sustainability: 1. Individual level: continuing to deliver beneficial services (outcomes) to consumers; 2. Organisational level: maintaining the program and/or its activities, even if modified; and 3. Community level: maintaining the capacity of a community to deliver program activities.[22] In a subsequent paper, Scheirer and Dearing defined sustainability as “the continued use of program components and activities for the continued achievement of desirable program and population outcomes”. [24](p.2060)

More recently, Moore et al.[25] proposed five constructs for the assessment of program sustainability: (1) following a defined period of time, (2) a continuation of a program and/or (3) the maintenance of individual behaviour change, (4) evolution or adaption of the program, and individual behaviour change may occur while (5) continuing to produce benefits for individuals/systems. In a review published the following year, Lennox et al.[26] found

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

continuation of program activities and continued health benefits as the most commonly reported sustainability constructs.[26] Guided by Stirman et al.[21] and previously established definitions, for this current review, sustainability was conceptualised as the continuation of program or program components, or the continuation of outcomes, after initial implementation efforts, staff training, or funding has ended. In terms of outcomes, our review was concerned with healthcare system outcomes (Scheirer’s organisation level of analysis), rather than patient or community outcomes.[22]

In addition to the limited use of operationalised definitions, Stirman et al.[21] also found that included studies often lacked methodological rigour and seldom used theoretical frameworks or defined measures to evaluate program sustainability.[21] Although theories and frameworks abound, with new ones continually proposed,[26] there is limited recent information about the application of theories and frameworks in the healthcare system to underpin the assessment of system-level sustainability of implemented programs.

Objectives

With an increasing emphasis on the potential threats to healthcare system sustainability as an impetus, we aimed to describe to what extent studies of healthcare improvement programs, as implemented in the healthcare delivery system, report on program sustainability. We also aimed to determine which theoretical frameworks have been applied, and how sustainability is defined, conceptualised and measured.

The current systematic integrative review builds on the work of Stirman et al.,[21] and is part of a larger project investigating healthcare system sustainability.[27] A detailed account of barriers and facilitators to the sustainability of implemented healthcare programs will be reported separately.

METHODS

Protocol and registration

The published protocol for this review[27] can be found at the following web address:

<https://bmjopen.bmj.com/content/7/11/e018568>. Since publishing the protocol, we re-aligned our focus with Schreier's organisational level analysis as we were interested in system and organisational level outcomes for implemented programs in the healthcare delivery system. Modifications to our protocol are explained and justified in the corresponding sections.

Search strategy

This review was carried out in line with the Preferred Reporting Items for Systematic Review and Meta-analyses statement (PRISMA).[28] The search strategy was developed by KL, JH, LT, EM and a clinical librarian (MS). Six academic databases were searched: CINAHL, EMBASE, Ovid MEDLINE, Emerald Management, Scopus and Web of Science (see Box 1 for example). Emerald Management was added after the publication of the study protocol in order to capture publications related to management or operations. To capture relevant articles not discovered by database searches we used snowballing by hand searching reference lists of systematic reviews.

Box 1: Search strategy example: EMBASE

- | | |
|---|---|
| 1 | (Sustainab* OR continuation OR continual OR institutional* OR resilien* or durab* OR viab* OR stability OR stable OR persist* OR maintenance OR routin*).ti,ab. |
| 2 | exp program sustainability/ |
| 3 | (Improve* OR innovation OR reform* OR intervention OR program* OR strateg* OR project OR plan OR change management).ti,ab. |
| 4 | health program/ or health promotion/ or organization/ |

5	health care delivery/ or integrated health care system/
6	1 OR 2
7	3 OR 4
8	5 AND 6 AND 7
9	limit 8 to (human and English language and yr= "2011 -Current" AND (article or article in press OR "review") AND journal)
10	remove duplicates from 9
* Indicates truncation	

Study selection

Data were downloaded into EndNote and duplicates removed. Table 1 outlines the selection criteria applied when reviewing abstracts and full-text publications. In order to establish inter-rater reliability, six reviewers (KL, LT, HA, JHe, GL and EM) completed a blinded review of a random 5% sample of abstracts. Any discrepancies between reviewers' decisions were discussed by the author group, with JB and YZ acting as arbitrators. The remaining publications were randomly allocated between the reviewers who reviewed study abstracts. Rayyan, a web and mobile app for systematic reviews,[29] was used for the blinded and full abstract review. Publications that met the inclusion criteria were subject to a full-text review using the selection criteria.

Table 1: Selection criteria

Criteria	Inclusion	Exclusion
1. Language	English-language	Languages other than English
2. Types of publications	Peer-reviewed journal articles	Posters; conference proceedings; thesis dissertations
3. Types of research	Primary empirical research including secondary analyses of data	Systematic reviews; protocols; grey literature; and 'lessons learned' documents (unless presenting empirical data analysis)
4. Publication data	Published July 2011-March 2018	Published before July 2011 or after March 2018
5. Setting	Healthcare settings including hospitals, primary care, residential aged care, mental health and community health	Settings other than healthcare, such as environmental sustainability and primary high school education
6. Evaluation	Evaluated programs, interventions or change strategies, including studies of multiple projects	Models of care; evaluations of new centres; and government reforms or policies, e.g., health insurance
7. Sustainability	Assesses sustainability of a program from a systems or organisational view point: a) Evaluation of a program after funding has ended, or after the initial training or implementation phase c) Explicitly assesses sustainability, for example, stakeholders' views of sustainability even if a program is in its implementation phase d) Longitudinal studies consisting of follow-up assessments or evaluations conducted over multiple time points	Studies that reported on outcomes for patients or clients only; broad public health programs or community initiatives that did not report on system-based or organisational outcomes or impacts; pilots and studies of early implementation
8. Systems outcomes	Focus is on changes or improvements to the healthcare system	Public health or prevention programs, e.g., physical activity, immunisation, smoking, contraceptive use, screening;

patient-based outcomes only; community-based outcomes only;
and studies of cost-effectiveness if only projected or hypothetical
savings—not actual cost-savings

For peer review only

6/bmjopen-2019-036453 on 1 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 10, 2024 by guest. Protected by copyright.

Data collection processes and data items

Data were extracted by reviewers into a purpose-designed Microsoft Excel Spreadsheet. Data items are summarised in Box 2. These categories were derived from an initial review of key papers on the topic of healthcare sustainability. During regular team meetings the categories were further refined, and descriptions were amended as the team progressed with full-text review and data extraction. Data were extracted on study characteristics; definitions and terminology; program evaluations, funding and evolution; theoretical frameworks; and methods and tools used to assess program sustainability (Box 2).

Box 2: Data items extracted from included publications

Study characteristics

- Study design
- Method
- Setting type
- Country
- Description of the program

Defining sustainability

- Definitions
- Terminology

Conceptualising sustainability

- Evaluation of sustainability: whether the focus of the evaluation was a) the sustainability of the program, b) the continuation of systems-based outcomes, or c) both a and b
- Funding of the program
- Evaluation timepoints
- Evolution of the program

Theoretical frameworks

- Name of framework
- Framework details
- How the framework was used
- Stage of framework use (program design, implementation or evaluation)

Assessing sustainability

- Methods used
- Tools used

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

We recorded the timepoints at which the continuation of the program or systems outcomes were assessed. We included evaluations of programs which were deemed to have continued and reported system or organisational outcomes after the initial implementation phase, staff training, or program funding had ended. The reporting of multiple evaluation timepoints in many of the publications was ambiguous and therefore, not reported in our review. For articles reporting on more than one program, the longest timeframe was recorded. “Evolution of programs” referred to whether the program had been changed, modified or adapted from the its initial design during implementation.

Data analysis and synthesis

Our analysis and synthesis was guided by Miles and Huberman[30] and Whitemore and Knafl.[31] The data reduction stage involved extracting data using the purpose-designed Excel spreadsheet and frequency counting techniques. Data were displayed using matrices to aid comparisons and synthesis across studies. Data were compared and synthesised to summarise study characteristics, definitions of sustainability and terminology, healthcare program features (e.g., funding), the use of theoretical frameworks, and assessments of sustainability. Verification of the accuracy and meanings of the extracted data was undertaken by KL and LT, with YZ and JB arbitrating when questions arose.

Quality assessment

The quality of individual studies was assessed by KL, LT, HA, JHe and GL using Hawker’s Quality Assessment Tool.[32] This tool comprises the following domains: abstract and title; introduction and aims; method and data; sampling; data analysis; ethics and bias; results; transferability (generalisable); and implications and practice. An overall quality rating of low, medium or high was assigned to each study based on Lorenc et al.[33] The reviewers first

completed a blinded quality assessment of 6% of studies before each assessing a proportion of the remainder. Although in our protocol we planned to use the Cochrane Collaboration's tool to assess risk of bias, Hawker's Quality Assessment Tool was deemed more appropriate as it is specifically designed for assessing quality across different study methodologies.

Patient and public involvement

The NHMRC Partnership Centre in Health System Sustainability includes among its members the Consumers Health Forum of Australia (CHF). Members of the CHF were present at meetings of the PCHSS and had opportunity to comment on this study.

RESULTS

Study selection

The search of academic databases identified 5,679 records, with an additional 118 records obtained through snowballing. The agreement rate between the six reviewers of the blinded 5% abstract review was 92%. This high rate, along with a high proportion of exclusion decisions, had the potential to reduce the value of Fleiss' kappa, resulting in a misrepresentative kappa score.[34] To account for this, Brennan-Prediger's kappa was calculated at 0.84 (95% CI: 0.78-0.90).[35] The results of the review strategy are detailed in Figure 1. After removal of duplicates, the abstracts and titles of 4,973 records were screened using the selection criteria. Four hundred and forty records were retained for full-text review, yielding 91 articles for inclusion in data synthesis.

<Inset Figure 1 here>

Figure 1: PRISMA flow diagram[28] summarising the review process and reasons for article exclusion.

Study characteristics and Quality Assessment

Most included studies used quantitative methods and had longitudinal study designs (Table 2). Sixty-eight studies (74.7%) were classified as high quality, 20 (22.0%) were medium quality and three (3.3%) were rated as low quality (Supplementary file 1). Studies came from 33 countries. The studies covered high-income (n=10, 30.3%), upper-middle-income (n=5, 15.1%), lower-middle-income (n=8, 24.2%), and low-income (n=10, 30.3%) countries as classified by the World Bank[36] (Table 2). Almost half of the studies (n=43, 47.7%) originated from North America, and of these, 35 (81.4%) were conducted in the United States of America. The second most common setting was the United Kingdom (n=9, 9.9%), followed by the Netherlands (n=8, 8.8%) and Canada (n=7, 7.7%).

Table 2: Study characteristics

		Number of studies	%
Method	Quantitative	47	51.6
	Qualitative	23	25.3
	Mixed-methods/qualitative and quantitative components	21	23.1
Study design	Longitudinal	38	41.8
	Case study	25	27.5
	Cross-sectional	12	13.2
	Randomised control trial	9	9.9
	Quasi-experimental	6	6.6
	Natural experiment	1	1.1

Geographical region^a	North America	43	43
	Europe	25	25
	Africa	18	18
	Asia	8	8
	South America	3	3
	Oceania	3	3
		Number of countries	%
World Bank income group classification	Low-income	10	30.3
	Lower-middle-income	8	24.3
	Upper-middle-income	5	15.1
	High-income	10	30.3

^a Four studies were conducted in more than one country and the percentage was adjusted accordingly.

Defining sustainability

Definitions

Over half of studies (n=52, 57.1%) explicitly referred to sustainability as part of the study aim. Only 26 studies (28.6%) defined sustainability, whether this was in reference to an established definition, a composite of established definitions, or authors' own definition (see Table 3). Thirty-two definitions were identified across the included studies, and in four, the authors provided their own definitions (Table 3). Nine pre-existing definitions were cited by multiple studies. Collectively, the two most frequently cited definitions from Shediach-Rizkallah and Bone's[23] and Scheirer and Dearing's[24] were cited by 14 of the 26 studies (53.8%) that defined sustainability. There were 19 additional previously published definitions identified, each cited by single studies.

Terminology

The terminology used to describe sustainability varied greatly (Table 3). The most commonly used terms were a variation of “sustainability” or “sustained”, followed by “continuation”, “maintenance”, “follow-up” and “long-term”.

Table 3: Definitions of sustainability and terminology use

Defined sustainability	Number of studies	Percentage ^b
Yes	26	28.6
No	65	71.4
Definition	Number of studies ^a	Percentage ^{a,c}
Shediac-Rizkallah and Bone[23]	9	34.6
Scheirer and Dearing[24]	5	19.2
Pluye, Potvin, Denis, and Pelletier[37]	4	15.4
Scheirer[22]	3	11.5
Buchanen et al.[38]	2	7.7
Stirman et al.[21]	2	7.7
Slaghuis et al.[39]	2	7.7
Procter et al.[40]	2	7.7
Gruen et al.[41]	2	7.7
Other pre-existing definitions ^d	19	73.1
Authors’ own definition	4	15.4
Terminology	Number of studies ^a	Percentage ^{a,b}
Sustainability/sustainable/sustainably	69	75.8
Sustain/sustained/sustaining/ sustainment/sustainers	68	74.7
Continuation/continues/continued/ continuance/continue	46	50.5
Maintenance/maintained	45	49.5
Follow-up/followed-up	42	46.2
Long-term/longer term	41	45.1

Adoption/adopted/adopt/adopters	35	38.5
Post/after/following: trial/intervention/phase/program/training/ design/inception/project/initiation/establishment/ competition/assessment/test/funding/enrolment	30	33.0
Post-implementation/after implementation/ following implementation	24	26.4
Routine/routinisation/routinely	22	24.2
Institutionalised/institutional/ institutionalisation/institutionalizing	13	14.3
Discontinuation/discontinued/discontinuity/not continued	12	13.2
Durability/durable	3	3.3
Scalability/scale-up	2	2.2
Other	3	3.3

^a The number of studies and associated percentage exceeds the total number of included studies and 100%, respectively, as some studies referred to more than one definition or term

^b As a proportion of total studies

^c As a proportion of studies defining sustainability

^d Definitions each cited by single studies

Conceptualising sustainability

Sustainability focus

Over a third of studies (n=32, 35.2%) focused on the sustainability of a program, or its components. Thirty-seven studies (40.7%), looked at the continuation or improvement of healthcare systems outcomes such as length of stay, hospital costs, quality of care and hand hygiene compliance. Twenty-two studies (24.2%) examined both the sustainability of programs, and on systems outcomes.

Funding of programs

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

A quarter of studies (n=22, 24.4%) specified whether funding had ended (n=12, 13.2%) or was ongoing (n=10, 11.0%), and two studies (2.2%) indicated that funding was not applicable. Sixteen studies (17.6%) did not report funding. The remaining 51 studies (56.0%) referred to funding or specified funding organisation(s), however it was not clear what the length of funding was or whether funding had ended or was ongoing.

Time points at which sustainability was assessed

The majority of studies (n=79, 86.8%) provided a clear timeframe between the end of initial implementation, staff training or funding, and the final evaluation timepoint. An additional ten studies (11.0%) specified that evaluations occurred post-implementation, however, a final clear evaluation timepoint was not provided. Two programs (2.2%) were still in their implementation phase but were included in this review as stakeholders were interviewed about the future sustainability of the program. The evaluation periods from the 79 studies providing clear final evaluation timepoints ranged from several months to years, with the longest evaluations reported at 10,[42] 12,[43] and 16 years.[44] The mean evaluation period was 40 months. For most studies (n=34, 43.0%), the final evaluation time point was between 1-2 years post-implementation, -training or -funding. Nine studies (11.3%) used an evaluation time of less than a year.

Only eleven of the 91 studies (12.1%) reported that evaluation occurred after initial program funding had ended. Of these 11, nine studies (81.8%) evaluated program sustainability, one (9.1%) evaluated the continuation of systems-level outcomes, and one (9.1%) evaluated the sustainability of both program and outcomes. Eight of the 11 studies (72.7%) clearly specified the evaluation period after funding had ended, ranging from eight months to six years (mean=35 months). For the other three studies (27.3%), it was not clear when the funding ended in relation to the evaluation.[45-47]

Evolution of program

Thirty-three studies (36.3%) described evolution, adaptation or modification of programs, which included for example, flexibility of the program,[48] adjustments to suit local context,[49-51] incorporating feedback from front-line staff,[52, 53] evolution of the program over time,[54, 55] and establishing a dedicated team responsible for continuous monitoring and making adaptations to programs.[56]

Theoretical frameworks

Eighteen of the 91 included studies (19.8%) used a sustainability-related theoretical framework (Supplementary file 2). Fourteen of the 18 studies using a framework (77.8%) made explicit reference to sustainability in the study aims (Supplementary file 2). The other four studies (22.2%) reported on sustainability, despite not referring to the concept in the aims. Some frameworks were purpose-designed to evaluate sustainability (e.g., Gruen et al.'s *dynamic model of health program sustainability*.[41] Other frameworks were originally designed for other purposes and not for the assessment of sustainability, for example, the Consolidated Framework for Implementation Research,[57] Atun et al.'s conceptual framework for analysing integration of targeted health interventions into health systems,[58] or Greenhalgh et al.'s Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Service Delivery and Organization.[59] The *Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework*,[60] was designed to examine success across the lifecycle of a program, including its sustainability (maintenance), and was used by two studies (Supplementary file 2).

Reasons for using frameworks

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Seventeen of the 18 studies reported using a framework (94.4%) to underpin program evaluation, with three key purposes: 1. To assess quantitative data related to outcomes; 2. To frame interview guides; and 3. To inform, structure, map or verify qualitative findings. Six studies (33.3%) used frameworks for multiple purposes (Supplementary file 2).

Only one of the 18 studies (5.6%) used a framework to support implementation. Licskai et al. used the *Canadian Institutes of Health Research ‘knowledge-to-action’ framework* to implement an asthma guidelines program.[61] As part of this cycle, a key action phase was “sustained knowledge use”. No studies reported using frameworks to support the design of programs.

Measuring sustainability

Methods used

The most common research method used (n=46, 50.5%) to measure sustainability was the analysis of routinely collected data by healthcare organisations, (e.g., patient length of stay, admissions/readmission, financial data). Interviews were used in 40 studies (44.0%) and surveys in 28 (30.8%). Other methods included checklists, observations, cost-effectiveness evaluations, and focus group discussions. Forty-six of the studies (50.5%) used more than one method, including mixed methods approaches.

Tools used

A small proportion of studies (n=6, 6.6%) used purpose-designed tools to evaluate sustainability. Three studies[62-64] used the NHS Sustainability Model and associated index.[65] Despite using the same tool, the three studies reported different names: the British National Health Service Sustainability Index, the NHS Sustainability Survey and the NHS Institute for Innovation and Improvement Sustainability Model self assessment tool. Two

studies[66, 67] used the Routinization Instrument developed by Slaghuis et al.[39] and one study[68] used Goodman's Level of Institutionalization Scales.[69]

DISCUSSION

We need health systems and programs that are built to last, but studies purporting to assess such systems and programs lack definitional consistency and rigour. Our study provides a unique summary of the current application of theoretical concepts and frameworks to assess the sustainability of implemented healthcare programs. Surprisingly, over 60% of studies describing programs that referred to sustainability or related concepts in the title, abstract or keywords had to be excluded at full-text review because they did not assess or report on program sustainability. Just over 57% of studies explicitly referred to sustainability in their aims, whilst only 28% of studies provided an operational definition of program sustainability. This is even lower than the 35% of studies included in Stirman's review published in 2012,[21] but higher than Moore et al.'s 2017 review on definitions of sustainability, where only 11.5% of included articles provided a definition.[25] Unlike Stirman and colleagues,[21] the majority (84.6%) of the studies in our review that provided a definition of sustainability cited a pre-existing definition in the literature suggesting that evaluators are increasingly looking to the literature for definitions of program sustainability.

The lack of a unified definition of sustainability across the literature, manifested in our review through a 16-year variation in time points at which the authors assessed the sustainability of their programs or program outcomes. Of the 79 studies reporting a clear final evaluation timepoint, the majority (n=34, 43.0%) measured sustainability of a program or continuation of outcomes 1-2 years after initial implementation, staff training, or funding ended. This was similar to the 64% reported by Stirman et al.[21] Just over 11% (n=9) of the

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

79 studies used an evaluation time of less than a year which is higher than the 6% reported by Stirman et al.[21] Furthermore, some studies assessed program sustainability only a few months after the end of initial implementation or program funding.[48, 70, 71] Whilst programs and approaches to implementation may differ, time is an important construct of sustainability, and it must be clearly articulated and justified as part of an operational definition of sustainability before undertaking an evaluation.[25] The timing of a sustainability evaluation is dependent on the individual program, outcomes of interest, and whether sustainability is viewed as an outcome or as a process.[25, 26] Lennox et al.’s systematic review, investigating approaches to healthcare sustainability evaluation, found that the measurement over time approach was used in the majority of studies.[26] Although we attempted to identify studies that assessed sustainability at multiple time points, this was methodologically impossible as the timepoints reported were varied and often ambiguous. Formative evaluation feedback loops are thought to be essential to support successful program implementation processes,[72] however, only about a third of our included studies reported on some aspects of program evolution, adaptation or modification, with ongoing monitoring and evaluation running along-side the implementation.

Stirman et al. argued that researchers should be guided by appropriate theoretical frameworks in order to advance healthcare program sustainability research.[21] Many theoretical frameworks have been published to support the implementation, monitoring and assessment of healthcare program sustainability.[26] Our review suggests that in recent years, there has been little improvement in the use of theoretical frameworks to underpin assessment of the sustainability of healthcare programs implemented in the healthcare delivery system. Stirman et al. reported that 16% of studies included in their review used a theoretical framework[21] and approximately 20% of our included studies did so.[21] Furthermore, studies that applied frameworks, mostly reported doing so at the evaluation stage rather than at the inception of

program design or implementation. This post-hoc approach limits the rigour and validity of evaluation results for these programs.[73] Robust comparisons across studies were difficult because only 6.6% of studies used published tools to assess sustainability. Although three studies used the same tool (The National Health Service [NHS] Institute for Innovation and Improvement Sustainability Model), they published different names for this tool, further challenging the ability to compare across studies.

Study Implications

Our review revealed a lack of consistency in the way sustainability is defined, conceptualised, assessed, and reported on. Furthermore, we found little improvement since Stirman's review in 2012, with ongoing limited use of sustainability-related theoretical frameworks and assessment tools. We recommend that future evaluations of programs mobilise operational definitions of sustainability, theoretically rigorous frameworks, clear and appropriate timepoints and validated assessment tools such as the Routinization Instrument[39] to evaluate sustainability of healthcare programs. This will build a needed evidence base to support policy and investment decisions about scaling-up and spreading healthcare programs, and for them ultimately to be longer-lasting.

A concerted effort is needed to move theory into practice and to support ongoing engagement between the healthcare sector and implementation science and healthcare services researchers.[74] Embedding healthcare services researchers with skills in implementation science and systems science expertise in the healthcare system is one potential solution.[75] Closer links at organisational level between academic and research institutes and organisations at the front-lines of the healthcare system may also be helpful.

Strengths and limitations

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

The search strategy was designed in collaboration with a medical librarian to enable us to capture the diversity of healthcare programs and the disparate nature of the study methodologies and settings. We ensured our methods were rigorous through team discussions and a double blinded sample review to ensure consistency of study inclusion and interpretation. Regular team meetings were necessary to resolve queries and divergence of opinions about which healthcare programs to include and what constitutes sustainability. Our review is limited to English-language studies published in the peer review literature, however, we know that many healthcare program evaluations are not published in the public domain, or are published in the grey literature. We used a systems sustainability lens for our review and programs that assessed patient and community outcomes only were excluded; we acknowledge that positive system outcomes do not necessarily translate to positive patient or community outcomes. Additional analyses are needed to describe the complex inter-relationships among patient, community and system aspects of healthcare program sustainability.

CONCLUSIONS

Our review uncovered lack of conceptual clarity, poor consistency of purpose, and inconsistencies in defining and assessing the sustainability of programs implemented in healthcare systems. Many studies discussed the sustainability of healthcare programs but failed to adequately define or measure program sustainability. Furthermore, few studies reported using sustainability-related frameworks to support program evaluations. There is a need therefore to upskill and build capacity in teams that design, implement and evaluate healthcare programs to ensure conceptual clarity and rigorous methodology. Consistent and unified definitions of program sustainability are needed to enable comparisons among evaluation studies and to generate a systematic evidence base on which to make decisions

about program sustainability. The effectiveness of embedding implementation science and healthcare services researchers into the healthcare system to form collaborative teams with decision-makers and clinicians should be trialled.

STATEMENTS

Acknowledgements

The authors would like to thank Ms Mary Simons, clinical librarian, Macquarie University, who assisted with the development of the search strategy, and Ms Johanna Holt for helping to refine the selection criteria. They would also like to thank Ms Hsuen P. Ting, biostatistician at the Australian Institute of Health Innovation, Macquarie University, for calculating the kappa coefficient for the blinded 5% sample abstract review and Dr Margie Campbell, Research Fellow, Centre for Health Economics Research and Evaluation, University of Technology Sydney, for identifying additional articles to include in the review via snowballing techniques.

Competing interests

There are no competing interests.

Funding

This work was supported by the NHMRC Partnership Centre in Health System Sustainability (Grant ID 9100002) and NHMRC Investigator Grant APP1176620.

Author's Contributions

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

JB conceptualised the study and lead the team’s work. KL, LT, JHe and EM developed the search strategy. KL, LT, JHe, HA, GL and EM conducted the abstract review, full-text review and data extraction, with JB and YZ acting as arbitrators. The quality assessment of included articles was conducted by KL, LT, JHe, HA and GL. KL and LT undertook the synthesis of data. KL, LT and YZ wrote the draft manuscript, with all authors providing feedback and approving the final version.

Data sharing

No additional data available.

REFERENCES

1. Organisation for Economic Cooperation and Development. Tackling wasteful spending on health. Paris, France: OECD; 2017. Available from: <https://www.oecd.org/health/tackling-wasteful-spending-on-health-9789264266414-en.htm>

2. Braithwaite J, Mannion R, Matsuyama Y, et al., editors. Healthcare Systems: Future Predictions for Global Care. Boca Raton, FL: Taylor & Francis 2018.

3. World Economic Forum. Sustainable health systems. Visions, strategies, critical uncertainties and scenarios. Geneva, Switzerland: WEF; 2013. Available from: <https://www.weforum.org/reports/sustainable-health-systems-visions-strategies-critical-uncertainties-and-scenarios>

4. World Health Organization. Everybody’s business. Strengthening health systems to improve health outcomes. WHO’s framework for action. Geneva, Switzerland: WHO; 2007. Available from: https://www.who.int/healthsystems/strategy/everybodys_business.pdf

5. Braithwaite J, Vincent C, Nicklin W, et al. Coping with more people with more illness. Part 2: New generation of standards for enabling healthcare system transformation and sustainability. *IJQHC*. 2018;31(2):159-63. doi: 10.1093/intqhc/mzy236.

6. World Health Organization. World report on ageing and health 2015. Geneva, Switzerland: WHO; 2015. Available from: <https://www.who.int/ageing/events/world-report-2015-launch/en/>
7. Australian Institute of Health and Welfare. Australia's health 2018: In brief. Canberra, Australia: AIHW; 2018. Available from: <https://www.aihw.gov.au/reports/australias-health/australias-health-2018-in-brief/contents/about>
8. Saini V, Brownlee S, Elshaug AG, et al. Addressing overuse and underuse around the world. *Lancet*. 2017;390(10090):105-7. doi: 10.1016/s0140-6736(16)32573-9.
9. Institute of Medicine (US) Roundtable on Evidence-Based Medicine, Yong PL, Saunders RS, et al. Consumers-directed policies. In: Institute of Medicine (US) Roundtable on Evidence-Based Medicine, Yong PL, Saunders RS, Olsen LA, eds. *The Healthcare Imperative: Lowering Costs and Improving Outcomes: Workshop Series Summary*. Washington, DC: Institute of Medicine (US); 2010.
10. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: Assessing the appropriateness of health care delivery in Australia. *Med J Aust*. 2012;197(2):100-5. doi: 10.5694/mja12.10510.
11. Braithwaite J. Changing how we think about healthcare improvement. *BMJ*. 2018;361:k2014. doi: 10.1136/bmj.k2014.
12. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348(26):2635-45. doi: 10.1056/NEJMsa022615.
13. Mangione-Smith R, DeCristofaro AH, Setodji CM, et al. The quality of ambulatory care delivered to children in the United States. *N Engl J Med*. 2007;357(15):1515-23. doi: 10.1056/NEJMsa064637.
14. Braithwaite J, Hibbert PD, Jaffe A, et al. Quality of health care for children in Australia, 2012-2013. *JAMA*. 2018;319(11):1113-24. doi: 10.1001/jama.2018.0162.
15. Ferlie E, Montgomery K, Reff A, et al. Patient safety and quality. In: Ferlie E, Montgomery K, Reff A, eds. *The Oxford Handbook of Health Care Management*. Oxford, UK: Oxford University Press; 2016:325-51.
16. Lipsitz LA. Understanding health care as a complex system: The foundation for unintended consequences. *JAMA*. 2012;308(3):243-4. doi: 10.1001/jama.2012.7551.
17. World Economic Forum. Misaligned stakeholders and health system underperformance. Cologny, Switzerland: WEF; 2016. Available from:

<https://www.weforum.org/whitepapers/misaligned-stakeholders-and-health-system-underperformance>

18. Toth F. Integration vs separation in the provision of health care: 24 OECD countries compared. *Health Econ Policy Law*. 2018;1-13. doi: 10.1017/S1744133118000476.
19. Organisation for Economic Cooperation and Development. Caring for quality in health: Lessons learnt from 15 reviews of health care quality. Paris, France: OECD; 2017. Available from: <https://www.oecd.org/health/caring-for-quality-in-health-9789264267787-en.htm>
20. Shelton RC, Cooper BR, Stirman SW. The sustainability of evidence-based interventions and practices in public health and health care. *Annu Rev Public Health*. 2018;39:55-76. doi: 10.1146/annurev-publhealth-040617-014731.
21. Stirman SW, Kimberly J, Cook N, et al. The sustainability of new programs and innovations: A review of the empirical literature and recommendations for future research. *Implement Sci*. 2012;7:17. doi: 10.1186/1748-5908-7-17.
22. Scheirer MA. Is Sustainability possible? a review and commentary on empirical studies of program sustainability. *Am J Eval*. 2005;26(3):320-47. doi: 10.1177/1098214005278752.
23. Shediak-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: Conceptual frameworks and future directions for research, practice and policy. *Health Educ Res*. 1998;13(1):87-108. doi: 10.1093/her/13.1.87.
24. Scheirer M, A., Dearing JW. An agenda for research on the sustainability of public health programs. *Am J Public Health*. 2011;101(11):2059-67. doi: 10.2105/AJPH.2011.300193.
25. Moore JE, Mascarenhas A, Bain J, et al. Developing a comprehensive definition of sustainability. *Implement Sci*. 2017;12(1):110. doi: 10.1186/s13012-017-0637-1.
26. Lennox L, Maher L, Reed J. Navigating the sustainability landscape: A systematic review of sustainability approaches in healthcare. *Implement Sci*. 2018;13(1):27. doi: 10.1186/s13012-017-0707-4.
27. Braithwaite J, Testa L, Lamprell G, et al. Built to last? The sustainability of health system improvements, interventions and change strategies: A study protocol for a systematic review. *BMJ Open*. 2017;7(11):e018568. doi: 10.1136/bmjopen-2017-018568.
28. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535.

29. Ouzzani M, Hammady H, Fedorowicz Z, et al. Rayyan — A web and mobile app for systematic reviews. *Syst Rev*. 2016;5:210. doi: 10.1186/s13643-016-0384-4.
30. Miles MB, Huberman AM. *Qualitative Data Analysis*. Thousand Oaks, CA: Sage Publications; 1994.
31. Whitemore R, Knafl K. The integrative review: Updated methodology. *J Adv Nurs*. 2005;52(5):546-53. doi: 10.1111/j.1365-2648.2005.03621.x.
32. Hawker S, Payne S, Kerr C, et al. Appraising the evidence: Reviewing disparate data systematically. *Qual Health Res*. 2002;12(9):1284-99. doi: 10.1177/1049732302238251.
33. Lorenc T, Petticrew M, Whitehead M, et al. Crime, fear of crime and mental health: Synthesis of theory and systematic reviews of interventions and qualitative evidence. *PHR*. 2014;2(2):1-398. doi: 10.3310/phr02020.
34. Feinstein AR, Cicchetti DV. High agreement but low kappa: I. The problems of two paradoxes. *J Clin Epidemiol*. 1990;43(6):543-9. doi: 10.1016/0895-4356(90)90158-1.
35. Gwet KL, editor. *Handbook of Inter-Rater Reliability: The Definitive Guide to Measuring the Extent of Agreement Among Raters 4th Edition*. Gaithersburg, MD: Advanced Analytics, LLC.
36. World Bank. *World Bank Country and Lending Groups* Washington, DC: World Bank; 2019. Available from: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.
37. Pluye P, Potvin L, Denis J-L. Making public health programs last: Conceptualizing sustainability. *Eval Program Plann*. 2004;27(2):121-33. doi: 10.1016/j.evalprogplan.2004.01.001.
38. Buchanan D, Fitzgerald L, Ketley D, et al. No going back: A review of the literature on sustaining organizational change. *Int J Manag Rev*. 2005;7(3):189-205. doi: 10.1111/j.1468-2370.2005.00111.x.
39. Slaghuis SS, Strating MMH, Bal RA, et al. A framework and a measurement instrument for sustainability of work practices in long-term care. *BMC Health Serv Res*. 2011;11(1):314. doi: 10.1186/1472-6963-11-314.
40. Proctor E, Luke D, Calhoun A, et al. Sustainability of evidence-based healthcare: research agenda, methodological advances, and infrastructure support. *Implement Sci*. 2015;10:88. doi: 10.1186/s13012-015-0274-5.

41. Gruen RL, Elliott JH, Nolan ML, et al. Sustainability science: An integrated approach for health-programme planning. *Lancet*. 2008;372(9649):1579-89. doi: 10.1016/s0140-6736(08)61659-1.
42. Paul DL, McDaniel RR. Facilitating telemedicine project sustainability in medically underserved areas: A healthcare provider participant perspective. *BMC Health Serv Res*. 2016;16(1):148. doi: 10.1186/s12913-016-1401-y.
43. Oliveira SRA, Medina MG, Figueiro AC, et al. Strategic factors for the sustainability of a health intervention at municipal level of Brazil. *Cad Saude Publica*. 2017;33(7):e00063516. doi: 10.1590/0102-311x00063516.
44. Sorensen TD, Pestka D, Sorge LA, et al. A qualitative evaluation of medication management services in six Minnesota health systems. *Am J Health Syst Pharm*. 2016;73(5):307-14. doi: 10.2146/ajhp150212.
45. Druss BG, von Esenwein SA, Compton MT, et al. Budget impact and sustainability of medical care management for persons with serious mental illnesses. *The American Journal of Psychiatry*. 2011;168(11):1171-8. doi: 10.1176/appi.ajp.2011.11010071.
46. MacLean S, Berends L, Mugavin J. Factors contributing to the sustainability of alcohol and other drug interventions in Australian community health settings. *Aust J Prim Health*. 2013;19(1):53-8. doi: 10.1071/py11136.
47. Seppey M, Ridde V, Touré L, et al. Donor-funded project's sustainability assessment: A qualitative case study of a results-based financing pilot in Koulikoro region, Mali. *Global Health*. 2017;13(1):86. doi: 10.1186/s12992-017-0307-8.
48. Bridges J, May C, Fuller A, et al. Optimising impact and sustainability: A qualitative process evaluation of a complex intervention targeted at compassionate care. *BMJ Qual Saf*. 2017;26(12):970-7. doi: 10.1136/bmjqs-2017-006702.
49. Rubin FH, Neal K, Fenlon K, et al. Sustainability and scalability of the hospital elder life program at a community hospital. *J Am Geriatr Soc*. 2011;59(2):359-65. doi: 10.1111/j.1532-5415.2010.03243.x.
50. Brewster AL, Curry LA, Cherlin EJ, et al. Integrating new practices: A qualitative study of how hospital innovations become routine. *Implement Sci*. 2015;10(1):168. doi: 10.1186/s13012-015-0357-3.
51. Singh M, Gmyrek A, Hernandez A, et al. Sustaining Screening, Brief Intervention and Referral to Treatment (SBIRT) services in health-care settings. *Addiction*. 2017;112(S2):92-100. doi: 10.1111/add.13654.

52. Hovlid E, Bukve O, Haug K, et al. Sustainability of healthcare improvement: What can we learn from learning theory? *BMC Health Serv Res*. 2012;12(1):235. doi: 10.1186/1472-6963-12-235.
53. Rask K, Gitomer R, Spell N, et al. A two-pronged quality improvement training program for leaders and frontline staff. *Jt Comm J Qual Saf*. 2011;37(4):147-53.
54. Regagnin DA, da Silva Alves DS, Maria Cavaleiro A, et al. Sustainability of a program for continuous reduction of catheter-associated urinary tract infection. *Am J Infect Control*. 2016;44(6):642-6. doi: 10.1016/j.ajic.2015.11.037.
55. King K, Christo J, Fletcher J, et al. The sustainability of an Australian initiative designed to improve interdisciplinary collaboration in mental health care. *Int J Ment Health Syst*. 2013;7(1):10. doi: 10.1186/1752-4458-7-10.
56. Agarwal H, Saville B, Slayton J, et al. Standardized postoperative handover process improves outcomes in the intensive care unit: A model for operational sustainability and improved team performance. *Crit Care Med*. 2012;40(7):2109-15.
57. Ament SMC, Gillissen F, Maessen JMC, et al. Sustainability of short stay after breast cancer surgery in early adopter hospitals. *Breast*. 2014;23(4):429-34. doi: 10.1016/j.breast.2014.02.010.
58. Atun R, de Jongh T, Secci F, et al. Integration of targeted health interventions into health systems: A conceptual framework for analysis. *Health Policy Plan*. 2010;25(2):104-11. doi: 10.1093/heapol/czp055.
59. Greenhalgh T, Robert G, Macfarlane F, et al. Diffusion of innovations in service organizations: Systematic review and recommendations. *Milbank Q*. 2004;82(4):581-629. doi: 10.1111/j.0887-378X.2004.00325.x.
60. Glasgow RE, McKay HG, Piette JD, et al. The RE-AIM framework for evaluating interventions: What can it tell us about approaches to chronic illness management? *Patient Educ Couns*. 2001;44(2):119-27.
61. Licskai C, Sands T, Ong M, et al. Using a knowledge translation framework to implement asthma clinical practice guidelines in primary care. *Int J Qual Health Care*. 2012;24(5):538-46. doi: 10.1093/intqhc/mzs043.
62. Ford JH, 2nd, Krahn D, Wise M, et al. Measuring sustainability within the Veterans Administration Mental Health System Redesign initiative. *Qual Manag Health Care*. 2011;20(4):263-79. doi: 10.1097/QMH.0b013e3182314b20.

63. Kastner M, Sayal R, Oliver D, et al. Sustainability and scalability of a volunteer-based primary care intervention (Health TAPESTRY): A mixed-methods analysis. *BMC Health Serv Res*. 2017;17(1):514. doi: 10.1186/s12913-017-2468-9.
64. Mahomed OH, Asmall S, Voce A. Sustainability of the integrated chronic disease management model at primary care clinics in South Africa. *African journal of primary health care & family medicine*. 2016;8(1):e1-e7. doi: 10.4102/phcfm.v8i1.1248.
65. Maher L, Gustafson D, Evans A. NHS Sustainability Model and Guide London, UK: NHS Improvement; 2017. Available from: <https://improvement.nhs.uk/resources/Sustainability-model-and-guide/>.
66. Cramm JM, Nieboer AP. Short and long term improvements in quality of chronic care delivery predict program sustainability. *Soc Sci Med*. 2014;101:148-54. doi: 10.1016/j.socscimed.2013.11.035.
67. Makai P, Cramm JM, van Grotel M, et al. Labor productivity, perceived effectiveness, and sustainability of innovative projects. *J Healthc Qual*. 2014;36(2):14-24. doi: 10.1111/j.1945-1474.2012.00209.x.
68. Zakumumpa H, Bennett S, Ssengooba F. Accounting for variations in ART program sustainability outcomes in health facilities in Uganda: A comparative case study analysis. *BMC Health Serv Res*. 2016;16(1):584. doi: 10.1186/s12913-016-1833-4.
69. Goodman RM, McLeroy KR, Steckler AB, et al. Development of level of institutionalization scales for health promotion programs. *Health Educ Q*. 2003;20(2):161-78.
70. Khanal S, Ibrahim MI, Shankar PR, et al. Evaluation of academic detailing programme on childhood diarrhoea management by primary healthcare providers in Banke district of Nepal. *J Health Popul Nutr*. 2013;31(2):231-42. doi: 10.3329/jhpn.v31i2.16388.
71. Lean M, Leavey G, Killaspy H, et al. Barriers to the sustainability of an intervention designed to improve patient engagement within NHS mental health rehabilitation units: A qualitative study nested within a randomised controlled trial. *BMC Psychiatry*. 2015;15(1):209. doi: 10.1186/s12888-015-0592-9.
72. Braithwaite J, Westbrook M, Nugus P, et al. A four-year, systems-wide intervention promoting interprofessional collaboration. *BMC Health Serv Res*. 2012;12(1):99. doi: 10.1186/1472-6963-12-99.
73. Dixon-Woods M. How to improve healthcare improvement—An essay by Mary Dixon-Woods. *BMJ*. 2019;367:l5514. doi: 10.1136/bmj.l5514.

74. Brownson RC, Colditz GA, Proctor EK, editors. *Dissemination and Implementation Research in Health – Translating Science to Practice*. Oxford, UK: Oxford University Press; 2012.
75. Churruca K, Ludlow K, Taylor N, et al. The time has come: Embedded implementation research for health care improvement. *J Eval Clin Pract*. 2019;25(3):373-80. doi: 10.1111/jep.13100.
76. Ament SMC, Gillissen F, Moser A, et al. Factors associated with sustainability of 2 quality improvement programs after achieving early implementation success. A qualitative case study. *J Eval Clin Pract*. 2017;23(6):1135-43. doi: 10.1111/jep.12735.
77. Damschroder LJ, Aron DC, Keith RE, et al. Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. *Implement Sci*. 2009;4(1):50. doi: 10.1186/1748-5908-4-50.
78. May C, Finch T. Implementing, embedding, and integrating practices: An outline of Normalization Process Theory. *Sociology*. 2009;43(3):535-54. doi: 10.1177/0038038509103208.
79. Burlew R, Puckett A, Bailey R, et al. Assessing the relevance, efficiency, and sustainability of HIV/AIDS in-service training in Nigeria. *Hum Resour Health*. 2014;12(1):20. doi: 10.1186/1478-4491-12-20.
80. Cresswell KM, Sadler S, Rodgers S, et al. An embedded longitudinal multi-faceted qualitative evaluation of a complex cluster randomized controlled trial aiming to reduce clinically important errors in medicines management in general practice. *Trials*. 2012;13:78. doi: 10.1186/1745-6215-13-78.
81. Rogers E, editor. *Diffusion of Innovations*, 5th ed. New York, NY: Free Press; 2003.
82. De Neve J-W, Garrison-Desany H, Andrews KG, et al. Harmonization of community health worker programs for HIV: A four-country qualitative study in Southern Africa. *PLOS Medicine*. 2017;14(8):e1002374. doi: 10.1371/journal.pmed.1002374.
83. Greenhalgh T, Macfarlane F, Barton-Sweeney C, et al. "If we build it, will it stay?" A case study of the sustainability of whole-system change in London. *Milbank Q*. 2012;90(3):516-47. doi: 10.1111/j.1468-0009.2012.00673.x.
84. Øvretveit J. Implementing, spreading and sustaining quality improvement. In: Berman S, eds. *From Front Office to Front Line: Essential Issues for Health Care Leaders* 2nd ed. Oak Brooke, IL: Joint Commission Resources; 2011:159–76.

85. Bisset S, Potvin L. Expanding our conceptualization of program implementation: Lessons from the genealogy of a school-based nutrition program. *Health Educ Res*. 2007;22(5):737-46. doi: 10.1093/her/cyl154.
86. Kirchner JE, Ritchie MJ, Pitcock JA, et al. Outcomes of a partnered facilitation strategy to implement primary care-mental health. *J Gen Intern Med*. 2014;29 Suppl 4(Suppl 4):904-12. doi: 10.1007/s11606-014-3027-2.
87. Graham ID, Logan J, Harrison MB, et al. Lost in knowledge translation: Time for a map? *J Contin Educ Health Prof*. 2006;26(1):13-24. doi: 10.1002/chp.47.
88. Palinkas LA, Ell K, Hansen M, et al. Sustainability of collaborative care interventions in primary care settings. *J Soc Work*. 2010;11(1):99-117. doi: 10.1177/1468017310381310.
89. Pomey M-P, Clavel N, Amar C, et al. Wait time management strategies for total joint replacement surgery: Sustainability and unintended consequences. *BMC Health Serv Res*. 2017;17(1):629-. doi: 10.1186/s12913-017-2568-6.
90. Parsons T, editor. *Social Systems and the Evolution of Action Theory*. New York, NY: Free Press; 1977.
91. Bloomrosen M, Starren J, Lorenzi NM, et al. Anticipating and addressing the unintended consequences of health IT and policy: A report from the AMIA 2009 Health Policy Meeting. *J Am Med Inform Assoc*. 2011;18(1):82-90. doi: 10.1136/jamia.2010.007567.
92. Seppey M, Ridde V, Toure L, et al. Donor-funded project's sustainability assessment: A qualitative case study of a results-based financing pilot in Koulikoro region, Mali. *Global Health*. 2017;13(1):86. doi: 10.1186/s12992-017-0307-8.
93. Johnson K, Hays C, Center H, et al. Building capacity and sustainable prevention innovations: A sustainability planning model. *Eval Program Plann*. 2004;27(2):135-49. doi: 10.1016/j.evalprogplan.2004.01.002.
94. Chambers DA, Glasgow RE, Stange KC. The dynamic sustainability framework: Addressing the paradox of sustainment amid ongoing change. *Implement Sci*. 2013;8(1):117. doi: 10.1186/1748-5908-8-117.
95. Moullin JC, Sabater-Hernandez D, Fernandez-Llimos F, et al. A systematic review of implementation frameworks of innovations in healthcare and resulting generic implementation framework. *Health Res Policy Syst*. 2015;13:16. doi: 10.1186/s12961-015-0005-z.
96. Kotter J, editor. *Leading Change*. Boston, MA: Harvard Business School; 1996.

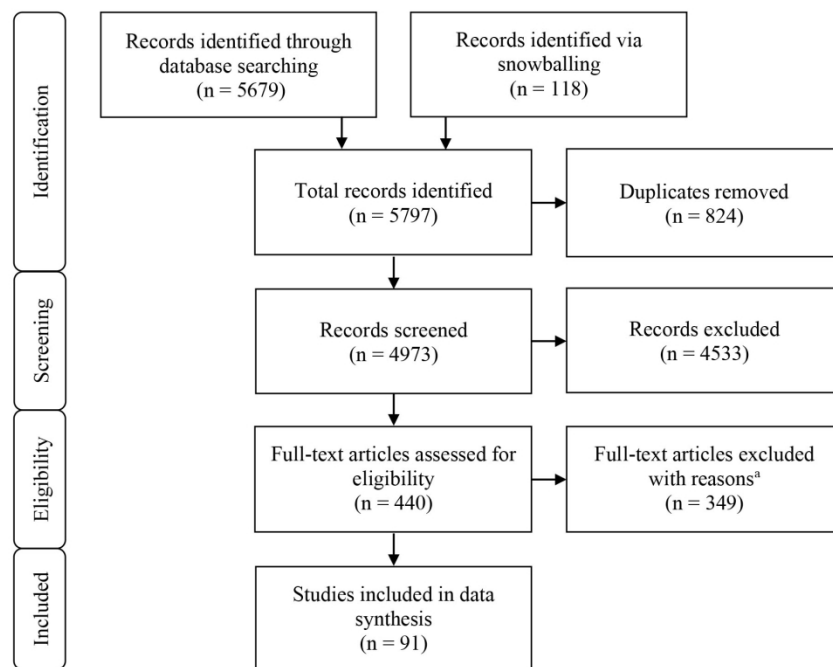
- 1
2
3 97. Tjia J, Field T, Mazor K, et al. Dissemination of evidence-based antipsychotic
4 prescribing guidelines to nursing homes: A cluster randomized trial. *J Am Geriatr Soc*.
5 2015;63(7):1289-98. doi: 10.1111/jgs.13488.
6
7
8 98. Tomioka M, Braun KL. Examining sustainability factors for organizations that
9 adopted stanford's chronic disease self-management program. *Front Public Health*.
10 2015;2:140-. doi: 10.3389/fpubh.2014.00140.
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

FIGURE LEGEND

Figure 1: PRISMA flow diagram[28] summarising the review process and reasons for article exclusion.

For peer review only



^a Exclusion criteria	Number of studies ^b
1 Full-text not available	0
2 Not English language	0
3 Not published in a peer-reviewed journal article	3
4 Not empirical or primary research	41
5 Published before July 2011	13
6 Not healthcare setting	4
7 Does not evaluate programs, interventions or change strategies	85
8 Focus is not on changes or improvements to the healthcare system	67
9 Does not assess sustainability (or discontinuation) of a program, intervention or change strategy	149

^b The number of studies in this column exceeds the total number of articles excluded at the full-text stage as some studies meet one or more of the exclusion criteria.

Figure 1: PRISMA flow diagram[28] summarising the review process and reasons for article exclusion.

171x220mm (300 x 300 DPI)

Supplementary file 1: Included publications

Reference	Method	Study design	Measurements	Country	Country income classification	Quality score (max. 36)	Quality rating
Agarwal et al., 2012	Quantitative	Longitudinal	Survey & Organisation/system data	USA	High income	29	Medium
Agarwal et al., 2016	Quantitative	Longitudinal	Survey	USA	High income	27	Medium
Allegranzi et al., 2013	Quantitative	Longitudinal	Observation	Costa Rica, Italy, Mali, Pakistan, and Saudi Arabia	Low income - High income	29	Medium
Ament et al., 2014	Quantitative	Case study	Organisation/system data	The Netherlands	High income	35	High
Ament et al., 2017	Qualitative	Case study	Interview	The Netherlands	High income	33	High
Assuncao et al., 2014	Quantitative	Case study	Organisation/system data & Cost-effectiveness evaluation	Brazil	Upper-middle income	30	High
Balfour et al., 2017	Quantitative	Quasi-experimental	Organisation/system data	USA	High income	27	Medium
Barfar et al., 2017	Quantitative	RCT	Survey & Cost-effectiveness evaluation	Iran	Upper-middle income	34	High
Barsky et al., 2013	Quantitative	RCT	Survey & Interview	USA	High income	32	High

Benn et al., 2012	Quantitative	Longitudinal	Survey	UK	High income	33	High
Benzer et al., 2014	Quantitative	Longitudinal	Organisation/system data	USA	High income	31	High
Blanchet & James, 2014	Quantitative and qualitative components	Case study	Interview & Organisation/system data	Ghana	Lower-middle income	33	High
Block et al., 2018	Quantitative	Longitudinal	Survey & Observation	USA	High income	33	High
Breckenridge-Sproat et al., 2017	Quantitative and qualitative components	Longitudinal	Survey, Interview, Checklist & Organisation/system data	USA	High income	32	High
Brewster et al., 2015	Qualitative	Cross-sectional	Interview	USA	High income	29	Medium
Bridges et al., 2017	Qualitative	Longitudinal	Survey & Interview	UK	High income	27	Medium
Burlew et al., 2014	Quantitative and qualitative components	Case study	Survey & Interview	Nigeria	Lower-middle income	27	Medium
Casati & Bjugn, 2012	Quantitative	Longitudinal	Organisation/system data	Norway	High income	33	High
Chandani et al., 2017	Mixed methods	Longitudinal	Survey	Malawi and Rwanda	Low income	32	High
Cramm & Nieboer, 2014	Quantitative	Longitudinal	Survey	The Netherlands	High income	29	Medium
Cresswell et al., 2012	Qualitative	Longitudinal	Interview & Focus group	UK	High income	34	High

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

De Neve et al., 2017	Qualitative	Case study	Interview & Organisation/system data	Lesotho, Mozambique, South Africa, and Swaziland	Low-income - upper-middle income	34	High
Deri Armstrong et al., 2016	Quantitative	RCT	Organisation/system data	Canada	High income	35	High
Druss et al., 2011	Quantitative	Longitudinal	Interview & Organisation/system data	USA	High income	30	High
Eichler et al., 2014	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	Switzerland	High income	31	High
Fieldston et al., 2016	Quantitative and qualitative components	Longitudinal		USA	High income	21	Low
Fleischer et al., 2016	Qualitative	Case study	Interview	Canada	High income	35	High
Ford et al., 2011	Mixed methods	Cross-sectional	Survey & Interview	USA	High income	29	Medium
Gillissen et al., 2015	Quantitative	Longitudinal	Organisation/system data	The Netherlands	High income	33	High
Greenhalgh et al., 2012	Mixed methods	Case study	Interview, Organisation/system data & Observation	UK	High income	34	High
Hernández et al., 2015	Quantitative	RCT	Organisation/system data	Spain	High income	35	High

Hoque et al., 2014	Quantitative	Longitudinal	Survey & Observation	Bangladesh	Lower-middle income	32	High
Hovlid et al., 2012	Qualitative	Case study	Interview	Norway	High income	34	High
Ilott et al., 2016	Qualitative	Case study	Interview & Organisation/system data	UK	High income	33	High
Jansink et al., 2013	Quantitative	RCT	Checklist & Video and audio recordings	The Netherlands	High income	27	Medium
Jonasson et al., 2014	Qualitative	Cross-sectional	Interview	Sweden	High income	28	Medium
Kanamori et al., 2015	Qualitative	Longitudinal	Survey & Interview	Senegal	Low income	33	High
Kastner et al., 2017	Mixed methods	Cross-sectional	Survey & Interview	Canada	High income	32	High
Khanal et al., 2013	Quantitative	RCT	Survey	Nepal	Low income	33	High
King et al., 2013	Qualitative	Cross-sectional	Focus group	Australia	High income	36	High
Kirchner et al., 2014	Quantitative	Quasi-experimental	Organisation/system data	USA	High income	35	High
Lean et al., 2015	Qualitative	RCT	Focus group	UK	High income	33	High
Levchenko et al., 2014	Quantitative	Case study	Electronic monitoring technologies	Canada	High income	29	Medium
Licskai et al., 2012	Quantitative	Case study	Interview, Organisation/system data & Cost-effectiveness evaluation	Canada	High income	32	High

1									
2									
3	Long et al., 2014	Quantitative	Longitudinal	Organisation/system data	USA	High income	32		High
4									
5	MacLean et al., 2013	Qualitative	Cross-sectional	Interview & Organisation/system data	Australia	High income	31		High
6									
7									
8									
9									
10	Magadzire et al., 2015	Quantitative and qualitative components	Case study	Interview & Focus group	South Africa	Upper-middle income	31		High
11									
12									
13									
14	Mahomed et al., 2016	Quantitative	Cross-sectional	Observation, self-assessment tool	South Africa	Upper-middle income	32		High
15									
16									
17									
18	Makai et al., 2014	Quantitative	Longitudinal	Survey	The Netherlands	High income	32		High
19									
20	Marten, 2017	Qualitative	Cross-sectional	Interview	Tanzania and USA	Low income & high income	23		Low
21									
22									
23									
24									
25	Martin et al., 2016	Quantitative	Longitudinal	Organisation/system data	Switzerland	High income	30		High
26									
27									
28	Mayer et al., 2011	Quantitative and qualitative components	Quasi-experimental	Survey & Observation	USA	High income	28		Medium
29									
30									
31	McKinnon, 2013	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	USA	High income	35		High
32									
33									
34									
35									
36	Morris et al., 2012	Quantitative	Longitudinal	Survey & Organisation/system data	UK	High income	31		High
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									

Mottes et al., 2013	Quantitative	Longitudinal	Organisation/system data	USA	High income	29	Medium
Najafizada et al., 2017	Qualitative	Cross-sectional	Interview & Focus group	Afghanistan	Low income	32	High
Neufeld & Case, 2013	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	USA	High income	31	High
Ohinmaa et al., 2016	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	Canada	High income	35	High
Oliveira et al., 2017	Qualitative	Case study	Interview	Brazil	Upper-middle income	28	Medium
Ostermann et al., 2012	Quantitative	Longitudinal	Organisation/system data	Austria	High income	33	High
Palinkas et al., 2011	Qualitative	Cross-sectional	Interview & Focus group	USA	High income	32	High
Parchman et al., 2013	Quantitative	Longitudinal	Survey	USA	High income	34	High
Paul & McDaniel, 2016	Quantitative and qualitative components	Case study	Interview	USA	High income	33	High
Pearson et al., 2017	Quantitative	Quasi-experimental	Organisation/system data	UK	High income	34	High

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Peterson et al., 2014	Quantitative and qualitative components	Longitudinal	Interview & On-site fidelity assessment	USA	High income	31	High
Pomey et al., 2017	Qualitative	Case study	Interview & Organisation/system data	Canada	High income	32	High
Prashanth et al., 2014	Quantitative and qualitative components	Case study	Survey & Interview	India	Lower-middle income	32	High
Qian et al., 2011	Quantitative	Longitudinal	Organisation/system data	USA	High income	32	High
Rakha et al., 2013	Quantitative	Longitudinal	Survey & Organisation/system data	Egypt	Lower-middle income	30	High
Rask et al., 2011	Quantitative and qualitative components	Case study	Interview	USA	High income	30	High
Regagnin et al., 2016	Quantitative	Quasi-experimental	Checklist & Organisation/system data	Brazil	Upper-middle income	29	Medium
Rubin et al., 2011	Quantitative	Longitudinal	Organisation/system data	USA	High income	26	Medium
Schaffzin et al., 2013	Quantitative	Case study	Organisation/system data	USA	High income	22	Low
Schuller et al., 2015	Qualitative	Case study	Interview	USA	High income	33	High
Scullin et al., 2012	Quantitative	Natural experiment	Organisation/system data	UK	High income	35	High

1									
2									
3	Seppey et al., 2017	Qualitative	Case study	Interview	Mali	Low income	32		High
4	Singh et al., 2017	Quantitative and qualitative components	Cross-sectional	Survey & Interview	USA	High income	33		High
5									
6									
7									
8	Sorensen et al., 2016	Qualitative	Case study	Interview	USA	High income	32		High
9	Stirman et al., 2015	Qualitative	Longitudinal	Interview & Organisation/system data	USA	High income	31		High
10									
11									
12									
13									
14	Storm-Versloot et al., 2012	Mixed methods	Longitudinal	Survey, Organisation/system data & Focus group	The Netherlands	High income	30		High
15									
16									
17									
18	Sullivan et al., 2014	Quantitative and qualitative components	Longitudinal	Interview & Organisation/system data	Australia	High income	34		High
19									
20									
21									
22	Tanguturi et al., 2016	Quantitative	Longitudinal	Organisation/system	USA	High income	30		High
23									
24									
25	Tjia et al., 2015	Quantitative and qualitative components	RCT	Organisation/system & Observation	USA	High income	33		High
26									
27									
28									
29	Tomioaka & Braun, 2015	Qualitative	Case study	Interview	USA	High income	27		Medium
30									
31	van Rossum et al., 2016	Quantitative	Cross-sectional	Survey	The Netherlands	High income	31		High
32									
33									
34	Weir et al., 2016	Quantitative	Longitudinal	Organisation/system	USA	High income	29		Medium
35	Weobong et al., 2017	Quantitative	RCT	Organisation/system data & Cost-	India	Lower-middle income	36		High
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									

				effectiveness evaluation					
	Wysham et al., 2014	Quantitative	Quasi- experimental	Survey & Checklist	USA	High income	29		Medium
	Zakumumpa et al., 2016(a)	Quantitative and qualitative components	Case study	Survey & Interview	Uganda	Low income	35		High
	Zakumumpa et al., 2016(b)	Mixed methods	Longitudinal	Survey & Interview	Uganda	Low income	35		High
	Zakumumpa et al., 2017	Mixed methods	Case study	Survey & Interview	Uganda	Low income	35		High

Supplementary file 2: Theoretical frameworks

Publication	Explicit reference to sustainability in the study aims (yes/no)	Framework	Details	Use in study	Stage of use
Ament et al.[76]	Yes	Consolidated Framework for Implementation Research (CFIR)[77]	Thirty-nine constructs organised into five domains related to the effective implementation of programs	a) Framing interview guide b) Categorising factors related to sustainability (study findings) under the five domains of the framework	Evaluation
Bridges et al.[48]	Yes	Normalisation Process Theory (NPT)[78]	Four dynamic processes involved in implementing and integrating new innovations	a) Guiding interview schedule b) Comparing emerging theories of implementation processes (study findings) with NTP framework	Evaluation
Burlew et al.[79]	Yes	In-Service Training (IST) Improvement Framework	Forty recommendations for improving the effectiveness, efficiency and sustainability of IST	a) Developing the survey tool	Evaluation
Cresswell et al.[80]	No	Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Service	Not specified by authors	a) Guiding the interpretation of results	Evaluation

1						
2						
3						
4			Delivery and Organization[59];			
5			Rogers' work on the diffusion of			
6			innovation[81]			
7	De Neve et	Yes	Conceptual framework for	Five components	a) Inform the design of semi-	Evaluation
8	al.[82]		analyzing the harmonization of	based on Atun et	structured questionnaires	
9			CHW programs	al.'s[58] framework	b) Mapping mediators of	
10				for analysing	harmonisation of programs	
11				integration of	(study findings) to the	
12				targeted health	framework components	
13				interventions into		
14				health systems		
15						
16	Ford et al.[62]	Yes	National Health Service (NHS)	Ten factors,	a) Assessing participants'	Evaluation
17			Institute for Innovation and	organised into three	perceptions of sustainability	
18			Improvement Sustainability	domains, identified	via sustainability scores	
19			Model ^a [65]	to increase the		
20				likelihood of		
21				sustainability and		
22				continuous		
23				improvement of		
24				projects		
25						
26						
27	Greenhalgh et	Yes	Framework developed by	Adapted from	a) Informing the synthesis of	Evaluation
28	al.[83]		Øvretveit[84]; Conceptual	Øvretveit[84];	qualitative and quantitative	
29			framework for sustainability of	Scheirer and	findings	
30			public health programs[24];	Dearing[24]; Gruen		
31			Modified Dynamic model of health	et al.[41]; and		
32			program sustainability[41]; Actor-	Bisset and		
33			Network Theory[85]	Potvin[85]		
34						
35						
36	Kastner et	Yes	National Health Service (NHS)	Ten factors,	a) Assessing participants'	Evaluation
37	al.[63]		Institute for Innovation and	organised into three	perceptions of sustainability	
38				domains, identified	via sustainability scores	
39						
40						
41						
42						
43						
44						
45						
46						

			Improvement Sustainability Model ^a [65]	to increase the likelihood of sustainability and continuous improvement of projects		
	Kirchner et al.[86]	No	Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework[60]	Five domains related to health behaviour interventions	a) Evaluating outcomes. Outcomes for effectiveness, adoption and implementation measured at the late implementation phase. Each measure was measured again at the maintenance phase measure the degree to which the intervention outcomes were sustained	Evaluation
	Licskai et al.[61]	No	Canadian Institute of Health Research 'knowledge-to-action' framework[87]	Knowledge-to-action' cycle comprising process elements common to planned-action models. 'Sustained knowledge use' was an action phase of implementation	a) Implementing asthma guidelines.	Implementation
	Mahomed et al.[64]	Yes	National Health Service (NHS) Institute for Innovation and Improvement Sustainability Model ^a [65]	Ten factors, organised into three domains, identified to increase the likelihood of sustainability and	a) Assessing participants' perceptions of sustainability via sustainability scores	Evaluation

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

			continuous improvement of projects		
Palinkas et al.[88]	Yes	Author developed model of collaborative care sustainability	Eight themes mapping to three categories	a) Mapping study findings	Evaluation
Pomey et al.[89]	Yes	A conceptual framework [unnamed]; Integrated model of unintended consequences within healthcare organizations[81]	Four dimensions adapted from Parsons[90]; four consequences adapted from Bloomrosen et al.[91]; Rogers[81].	a) Guiding analysis of transcripts b) Categorizing consequences (study findings)	Evaluation
Sepey et al.[92]	Yes	Author developed sustainability framework	Adapted from Johnson et al.[93]; Chambers et al.[94]; Pluye, Potvin and Denis[37]; Moullin et al.[95]	a) Guiding open-ended questions b) Informing thematic analysis	Evaluation
Sorensen et al.[44]	Yes	Kotter’s 8-Steps Change Model[96]	An eight step process mapping to three stages of change. The third change is ‘Implementing and sustaining change’	a) Framing the question guide b) Structuring themes (study findings)	Evaluation
Tjia et al.[97]	No	Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework[60]	Five domains related to health behaviour interventions	a) Evaluating outcomes. Maintenance (i.e. sustainability) evaluated by	Evaluation

					measuring outcome 12 months after the intervention	
					a) Developing the interview guide	Evaluation
1						
2						
3						
4						
5						
6	Tomiooka & Braun[98]	Yes	Modified sustainability framework[22]	Modified from Scheirer. [22] Five sustainability factors, with the addition a sixth factor identified from a literature search	a) Developing the interview guide	Evaluation
7						
8						
9						
10						
11						
12						
13						
14						
15						
16	Zakumumpa et al.[68]	Yes	Framework for conceptualizing program sustainability[23]	Three levels that influence that influence health program sustainability	a) Structuring study findings	Evaluation
17						
18						
19						
20						
21						

^a Three studies presented different names for the same tool. The “National Health Service (NHS) Institute for Innovation and Improvement Sustainability Model” has been adopted for consistency.



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Table 1 (p. 9)
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Box 1 (pp. 7-8)
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Box 2 (11)
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12-13
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	12

1136/bmjopen-2019-036453 on 1 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 19, 2024 by guest. Protected by copyright.



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICO, follow-up period) and provide the citations.	14-15
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	n/a
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	15-20
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	21-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	23-24
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	24
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data; role of funders for the systematic review).	25

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open

Built to last? The sustainability of healthcare system improvements, programs and interventions: A systematic integrative review

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-036453.R1
Article Type:	Original research
Date Submitted by the Author:	24-Feb-2020
Complete List of Authors:	Braithwaite, Jeffrey; Macquarie University, Australian Institute of Health Innovation Ludlow, Kristiana; Macquarie University, Australian Institute of Health Innovation Testa, Luke; Macquarie University, Australian Institute of Health Innovation Herkes, Jessica; Macquarie University, Australian Institute of Health Innovation Augustsson, Hanna; Macquarie University, Australian Institute of Health Innovation Lamprell, Gina; Macquarie University, Australian Institute of Health Innovation McPherson, Elise; Macquarie University, Australian Institute of Health Innovation Zurynski, Yvonne; Macquarie University, Australian Institute of Health Innovation
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Change management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

**BUILT TO LAST? THE SUSTAINABILITY OF HEALTHCARE SYSTEM
IMPROVEMENTS, PROGRAMS AND INTERVENTIONS: A SYSTEMATIC
INTEGRATIVE REVIEW**

**Jeffrey Braithwaite^{1,2*}, Kristiana Ludlow¹, Luke Testa¹, Jessica Herkes¹, Hanna
Augustsson¹, Gina Lamprell¹, Elise McPherson¹, Yvonne Zurynski^{1,2}**

¹Centre for Healthcare Resilience and Implementation Science, Australian Institute of Health
Innovation, Macquarie University, Sydney, Australia

²NHMRC Partnership Centre in Health System Sustainability, Australian Institute of Health
Innovation, Macquarie University, Sydney, Australia

*Corresponding author: Jeffrey Braithwaite

Address: Level 6, 75 Talavera Rd, North Ryde, NSW 2109, Australia; Phone: + 61 2 9850
2401; Email: jeffrey.braithwaite@mq.edu.au

Word count

4106

Keywords

Organisation of health services; Health policy; Change management; Quality in health care

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

ABSTRACT

Introduction: The sustainability of healthcare delivery systems is challenged by ageing populations, complex systems, increasing rates of chronic disease, increasing costs associated with new medical technologies, and growing expectations by healthcare consumers. Healthcare programs, innovations and interventions are increasingly implemented at the front-lines of care in order to increase effectiveness and efficiency, however, little is known about how sustainability is conceptualised and measured in programs evaluations.

Objectives: We aimed to describe theoretical frameworks, definitions and measures of sustainability, as applied in published evaluations of healthcare improvement programs and interventions.

Design: Systematic integrative review.

Methods: We searched six academic databases, CINAHL, EMBASE, Ovid MEDLINE, Emerald Management, Scopus and Web of Science, for peer-reviewed English journal articles (July 2011-March 2018). Articles were included if they assessed program sustainability or sustained outcomes of a program at the healthcare system level. Six reviewers conducted the abstract and full-text review. Data were extracted on study characteristics, definitions, terminology, theoretical frameworks, methods and tools. Hawker’s Quality Assessment Tool was applied to included studies.

Results: Of the 92 included studies, 75.0% were classified as high quality. Twenty-seven (29.3%) studies provided 32 different definitions of sustainability. Terms used interchangeably for sustainability included continuation, maintenance, follow-up or long-term. Eighty studies (87.0%) clearly reported the time points at which sustainability was evaluated; 43.0% at 1-2 years and 11.3% at <12 months. Eighteen studies (19.6%) used a

theoretical framework to conceptualise or assess program sustainability, including frameworks that were not specifically designed to assess sustainability.

Conclusions: The body of literature is limited by use of inconsistent definitions and measures of program sustainability. Evaluations of service improvement programs and interventions seldom used theoretical frameworks. Embedding implementation science and healthcare services researchers into the healthcare system is a promising strategy to improve the rigour of program sustainability evaluations.

Funding: NHMRC (9100002 and APP1176620).

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The review was conducted in accordance with PRISMA guidelines.
- The search strategy was developed in collaboration with a clinical librarian to capture the diversity of healthcare programs, study methodologies and study settings.
- Regular team meetings, verification of data extraction accuracy, and quality assessment of included publications enhanced the rigour of the review.
- The review was limited to peer-reviewed articles and excluded program evaluations published in the grey literature.
- The focus on outcomes at the healthcare systems level meant that programs that assessed patient and/or community outcomes only were excluded from this review.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

**BUILT TO LAST? THE SUSTAINABILITY OF HEALTHCARE SYSTEM
IMPROVEMENTS, PROGRAMS AND INTERVENTIONS: A SYSTEMATIC
INTEGRATIVE REVIEW**

INTRODUCTION

Background

Healthcare systems across the world strive to provide safe, high quality care and deliver the best possible health outcomes for the populations they serve. At the same time, fiscal constraints necessitate the delivery of healthcare in an efficient and cost effective way.[1] This creates a challenge to the sustainability of healthcare systems globally.[2, 3] Lead international agencies, including the World Health Organization (WHO), the Organization for Economic Cooperation and Development (OECD) and the World Economic Forum (WEF), have recently highlighted significant threats to the sustainability of healthcare system performance.[1, 3, 4] Ageing populations and the rapidly increasing burden of chronic conditions also pose challenges to healthcare system sustainability.[5-7] The introduction of new medical technologies, including new diagnostic tests, new drugs, medical equipment and digital healthcare services,[8] as well as a growing “consumer-culture”, have led to demands for higher standards of patient safety and quality of care and lower costs.[9] At the same time, the level of wasteful spending on low-value care has remained static, at approximately 30%, while high-value care which aligns with level I evidence or best practice consensus guidelines accounts for approximately 60% of delivered care and has done for two decades.[10-15]

Sweeping policy and healthcare system “big bang” reforms are relatively rare, mainly because they require enormous efforts to mobilise multiple stakeholders who work within

entrenched cultures, structures and approaches that make up complex healthcare systems.[16-19] Much of the change implementation to improve healthcare system sustainability occurs closer to the front-lines of care, through innovative projects, improvement programs and interventions, referred to as “programs” from this point forward.

To maximise the benefits of program innovation in healthcare, we need the ability to rigorously assess whether programs are adaptable to real-world settings, and sustainable beyond the program trial period.[20] Stirman et al.’s 2012 systematic review of the sustainability of implemented healthcare programs reported that few of the included studies that were published before June 2011 provided a definition of sustainability.[21] The authors considered articles in which studies assessed the continuation of programs after initial implementation efforts, staff training periods, or funding had ended.[21] They found that when defining sustainability, the majority of included studies referred to Scheirer’s definition[22] which is based on the work of Shediach-Rizkallah and Bone.[23] Scheirer proposed three levels of analysis for program sustainability: 1. Individual level: continuing to deliver beneficial services (outcomes) to consumers; 2. Organisational level: maintaining the program and/or its activities, even if modified; and 3. Community level: maintaining the capacity of a community to deliver program activities.[22] In a subsequent paper, Scheirer and Dearing defined sustainability as “the continued use of program components and activities for the continued achievement of desirable program and population outcomes”. [24](p.2060)

More recently, Moore et al.[25] proposed five constructs for the assessment of program sustainability: (1) following a defined period of time, (2) a continuation of a program and/or (3) the maintenance of individual behaviour change, (4) evolution or adaption of the program, and individual behaviour change may occur while (5) continuing to produce benefits for individuals/systems. In a review published the following year, Lennox et al.[26] found

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

continuation of program activities and continued health benefits as the most commonly reported sustainability constructs.[26] Guided by Stirman et al.[21] and previously established definitions, for this current review, sustainability was conceptualised as the continuation of program or program components, or the continuation of outcomes, after initial implementation efforts, staff training, or funding has ended. In terms of outcomes, our review was concerned with healthcare system outcomes (Scheirer’s organisation level of analysis), rather than patient or community outcomes.[22]

In addition to the limited use of operationalised definitions, Stirman et al.[21] also found that included studies often lacked methodological rigour and seldom used theoretical frameworks or defined measures to evaluate program sustainability.[21] Although theories and frameworks abound, with new ones continually proposed,[26] there is limited recent information about the application of theories and frameworks in the healthcare system to underpin the assessment of system-level sustainability of implemented programs.

Objectives

With an increasing emphasis on the potential threats to healthcare system sustainability as an impetus, we aimed to describe to what extent studies of healthcare improvement programs, as implemented in the healthcare delivery system, report on program sustainability. We also aimed to determine which theoretical frameworks have been applied, and how sustainability is defined, conceptualised and measured.

The current systematic integrative review builds on the work of Stirman et al.,[21] and is part of a larger project investigating healthcare system sustainability.[27] A detailed account of barriers and facilitators to the sustainability of implemented healthcare programs will be reported separately.

METHODS

Protocol and registration

The published protocol for this review[27] can be found at the following web address:

<https://bmjopen.bmj.com/content/7/11/e018568>. Since publishing the protocol, we re-aligned our focus with Schreier's organisational level analysis as we were interested in system and organisational level outcomes for implemented programs in the healthcare delivery system. Modifications to our protocol are explained and justified in the corresponding sections.

Search strategy

This review was carried out in line with the Preferred Reporting Items for Systematic Review and Meta-analyses statement (PRISMA).[28] The search strategy was developed by KL, JH, LT, EM and a clinical librarian (MS). Six academic databases were searched: CINAHL, EMBASE, Ovid MEDLINE, Emerald Management, Scopus and Web of Science (see Box 1 for example). Emerald Management was added after the publication of the study protocol in order to capture publications related to management or operations. To capture relevant articles not discovered by database searches we used snowballing by hand searching reference lists of systematic reviews.

Box 1: Search strategy example: EMBASE

- | | |
|---|---|
| 1 | (Sustainab* OR continuation OR continual OR institutional* OR resilien* or durab* OR viab* OR stability OR stable OR persist* OR maintenance OR routin*).ti,ab. |
| 2 | exp program sustainability/ |
| 3 | (Improve* OR innovation OR reform* OR intervention OR program* OR strateg* OR project OR plan OR change management).ti,ab. |
| 4 | health program/ or health promotion/ or organization/ |

5	health care delivery/ or integrated health care system/
6	1 OR 2
7	3 OR 4
8	5 AND 6 AND 7
9	limit 8 to (human and English language and yr= "2011 -Current" AND (article or article in press OR "review") AND journal)
10	remove duplicates from 9
* Indicates truncation	

Study selection

Data were downloaded into EndNote and duplicates removed. Table 1 outlines the selection criteria applied when reviewing abstracts and full-text publications. In order to establish inter-rater reliability, six reviewers (KL, LT, HA, JHe, GL and EM) completed a blinded review of a random 5% sample of abstracts. Any discrepancies between reviewers' decisions were discussed by the author group, with JB and YZ acting as arbitrators. The remaining publications were randomly allocated between the reviewers who reviewed study abstracts. Rayyan, a web and mobile app for systematic reviews,[29] was used for the blinded and full abstract review. Publications that met the inclusion criteria were subject to a full-text review using the selection criteria.

Table 1: Selection criteria

Criteria	Inclusion	Exclusion
1. Language	English-language	Languages other than English
2. Types of publications	Peer-reviewed journal articles	Posters; conference proceedings; thesis dissertations
3. Types of research	Primary empirical research including secondary analyses of data	Systematic reviews; protocols; grey literature; and 'lessons learned' documents (unless presenting empirical data analysis)
4. Publication data	Published July 2011-March 2018	Published before July 2011 or after March 2018
5. Setting	Healthcare settings including hospitals, primary care, residential aged care, mental health and community health	Settings other than healthcare, such as environmental sustainability and primary high school education
6. Evaluation	Evaluated programs, interventions or change strategies, including studies of multiple projects	Models of care; evaluations of new centres; and government reforms or policies, e.g., health insurance
7. Sustainability	Assesses sustainability of a program from a systems or organisational view point: a) Evaluation of a program after funding has ended, or after the initial training or implementation phase c) Explicitly assesses sustainability, for example, stakeholders' views of sustainability even if a program is in its implementation phase d) Longitudinal studies consisting of follow-up assessments or evaluations conducted over multiple time points	Studies that reported on outcomes for patients or clients only; broad public health programs or community initiatives that did not report on system-based or organisational outcomes or impacts; pilots and studies of early implementation
8. Systems outcomes	Focus is on changes or improvements to the healthcare system	Public health or prevention programs, e.g., physical activity, immunisation, smoking, contraceptive use, screening;

patient-based outcomes only; community-based outcomes only;
and studies of cost-effectiveness if only projected or hypothetical
savings—not actual cost-savings

For peer review only

6/bmjopen-2019-036453 on 1 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 10, 2024 by guest. Protected by copyright.

Data collection processes and data items

Data were extracted by reviewers into a purpose-designed Microsoft Excel Spreadsheet. Data items are summarised in Box 2. These categories were derived from an initial review of key papers on the topic of healthcare sustainability. During regular team meetings the categories were further refined, and descriptions were amended as the team progressed with full-text review and data extraction. Data were extracted on study characteristics; definitions and terminology; program evaluations, funding and evolution; theoretical frameworks; and methods and tools used to assess program sustainability (Box 2).

Box 2: Data items extracted from included publications

Study characteristics

- Study design
- Method
- Setting type
- Country
- Description of the program

Defining sustainability

- Definitions
- Terminology

Conceptualising sustainability

- Evaluation of sustainability: whether the focus of the evaluation was a) the sustainability of the program, b) the continuation of systems-based outcomes, or c) both a and b
- Funding of the program
- Evaluation timepoints
- Evolution of the program

Theoretical frameworks

- Name of framework
- Framework details
- How the framework was used
- Stage of framework use (program design, implementation or evaluation)

Assessing sustainability

- Methods used
- Tools used

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

We recorded the timepoints at which the continuation of the program or systems outcomes were assessed. We included evaluations of programs which were deemed to have continued and reported system or organisational outcomes after the initial implementation phase, staff training, or program funding had ended. The reporting of multiple evaluation timepoints in many of the publications was ambiguous and therefore, not reported in our review. For articles reporting on more than one program, the longest timeframe was recorded. “Evolution of programs” referred to whether the program had been changed, modified or adapted from the its initial design.

Data analysis and synthesis

Our analysis and synthesis was guided by Miles and Huberman[30] and Whitemore and Knafl.[31] The data reduction stage involved extracting data using the purpose-designed Excel spreadsheet and frequency counting techniques. Data were displayed using matrices to aid comparisons and synthesis across studies. Data were compared and synthesised to summarise study characteristics, definitions of sustainability and terminology, healthcare program features (e.g., funding), the use of theoretical frameworks, and assessments of sustainability. Verification of the accuracy and meanings of the extracted data was undertaken by KL and LT, with YZ and JB arbitrating when questions arose.

Quality assessment

The quality of individual studies was assessed by KL, LT, HA, JHe and GL using Hawker’s Quality Assessment Tool.[32] This tool comprises the following domains: abstract and title; introduction and aims; method and data; sampling; data analysis; ethics and bias; results; transferability (generalisable); and implications and practice. An overall quality rating of low, medium or high was assigned to each study based on Lorenc et al.[33] The reviewers first

completed a blinded quality assessment of 6% of studies before each assessing a proportion of the remainder. Although in our protocol we planned to use the Cochrane Collaboration's tool to assess risk of bias, Hawker's Quality Assessment Tool was deemed more appropriate as it is specifically designed for assessing quality across different study methodologies.

Patient and public involvement

The NHMRC Partnership Centre in Health System Sustainability includes among its members the Consumers Health Forum of Australia (CHF). Members of the CHF were present at meetings of the PCHSS and had opportunity to comment on this study.

RESULTS

Study selection

The search of academic databases identified 5,679 records, with an additional 118 records obtained through snowballing. The agreement rate between the six reviewers of the blinded 5% abstract review was 92%. This high rate, along with a high proportion of exclusion decisions, had the potential to reduce the value of Fleiss' kappa, resulting in a misrepresentative kappa score.[34] To account for this, Brennan-Prediger's kappa was calculated at 0.84 (95% CI: 0.78-0.90).[35] The results of the review strategy are detailed in Figure 1. After removal of duplicates, the abstracts and titles of 4,973 records were screened using the selection criteria. Four hundred and forty records were retained for full-text review, yielding 92 articles for inclusion in data synthesis.

<Inset Figure 1 here>

Figure 1: PRISMA flow diagram[28] summarising the review process and reasons for article exclusion.

Study characteristics and Quality Assessment

Most included studies used quantitative methods and had longitudinal study designs (Table 2). Sixty-nine studies (75.0%) were classified as high quality, 20 (21.7%) were medium quality and three (3.3%) were rated as low quality (Supplementary file 1). Studies came from 33 countries. The studies covered high-income (n=10, 30.3%), upper-middle-income (n=5, 15.1%), lower-middle-income (n=8, 24.2%), and low-income (n=10, 30.3%) countries as classified by the World Bank[36] (Table 2). Almost half of the studies (n=44, 47.8%) originated from North America, and of these, 36 (81.8%) were conducted in the United States of America. The second most common setting was the United Kingdom (n=9, 9.8%), followed by the Netherlands (n=8, 8.7%) and Canada (n=7, 7.6%).

Table 2: Study characteristics

		Number of studies	%
Method	Quantitative	47	51.1
	Qualitative	24	26.1
	Mixed-methods/qualitative and quantitative components	21	22.8
Study design	Longitudinal	39	42.4
	Case study	25	27.2
	Cross-sectional	12	13.0
	Randomised control trial	9	9.8
	Quasi-experimental	6	6.5
	Natural experiment	1	1.1

Geographical region^a	North America	44	47.8
	Europe	25	27.2
	Africa	18	19.6
	Asia	8	8.7
	South America	3	3.3
	Oceania	3	3.3
		Number of countries	%
World Bank income group classification	Low-income	10	30.3
	Lower-middle-income	8	24.2
	Upper-middle-income	5	15.1
	High-income	10	30.3

^a Four studies were conducted in more than one country and the percentage was adjusted accordingly.

Defining sustainability

Definitions

Over half of studies (n=53, 57.6%) explicitly referred to sustainability as part of the study aim. Only 27 studies (29.3%) defined sustainability, whether this was in reference to an established definition, a composite of established definitions, or authors' own definition (see Table 3). Thirty-two definitions were identified across the included studies. Nine pre-existing definitions were cited by multiple studies. In four of the studies, the authors provided their own definitions (Table 3). Collectively, the two most frequently cited definitions from Shediak-Rizkallah and Bone's[23] and Scheirer and Dearing's[24] were cited by 15 of the 27 studies (55.6%) that defined sustainability. There were 19 additional previously published definitions identified, each cited by single studies.

Terminology

The terminology used to describe sustainability varied greatly (Table 3). The most commonly used terms were a variation of “sustainability” or “sustained”, followed by “continuation”, “maintenance”, “follow-up” and “long-term”.

Table 3: Definitions of sustainability and terminology use

Defined sustainability	Number of studies	Percentage ^a
Yes	27	29.3
No	65	70.7
Definition	Number of studies ^b	Percentage ^{b,c}
Shediac-Rizkallah and Bone[23]	10	37.0
Scheirer and Dearing[24]	5	18.5
Pluye, Potvin, Denis, and Pelletier[37]	4	14.8
Scheirer[22]	3	11.1
Buchanen et al.[38]	2	7.4
Stirman et al.[21]	2	7.4
Slaghuis et al.[39]	2	7.4
Procter et al.[40]	2	7.4
Gruen et al.[41]	2	7.4
Other pre-existing definitions ^d	19	70.4
Authors’ own definition	4	14.8
Terminology	Number of studies ^b	Percentage ^{b,c}
Sustainability/sustainable/sustainably	70	76.1
Sustain/sustained/sustaining/ sustainment/sustainers	69	75.0
Continuation/continues/continued/ continuance/continue	47	51.1
Maintenance/maintained	46	50.0
Follow-up/followed-up	43	46.7
Long-term/longer term	42	45.7

Adoption/adopted/adopt/adopters	36	39.1
Post/after/following: trial/intervention/phase/program/training/ design/inception/project/initiation/establishment/ competition/assessment/test/funding/enrolment	31	33.7
Post-implementation/after implementation/ following implementation	25	27.2
Routine/routinisation/routinely	22	23.9
Institutionalised/institutional/ institutionalisation/institutionalizing	13	14.1
Discontinuation/discontinued/discontinuity/not continued	13	14.1
Durability/durable	3	3.3
Scalability/scale-up	2	2.2
Other	3	3.3

^a As a proportion of total studies

^b The number of studies and associated percentage exceeds the total number of included studies and 100%, respectively, as some studies referred to more than one definition or term

^c As a proportion of studies defining sustainability

^d Definitions each cited by single studies

Conceptualising sustainability

Sustainability focus

Over a third of studies (n=33, 35.9%) focused on the sustainability of a program, or its components. Thirty-seven studies (40.2%), looked at the continuation or improvement of healthcare systems outcomes such as length of stay, hospital costs, quality of care and hand hygiene compliance. Twenty-two studies (23.9%) examined both the sustainability of programs, and on systems outcomes.

Funding of programs

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

A quarter of studies (n=22, 23.9%) specified whether funding had ended (n=12, 13.0%) or was ongoing (n=10, 10.9%), and two studies (2.2%) indicated that funding was not applicable. Sixteen studies (17.4%) did not report funding. The remaining 52 studies (56.5%) referred to funding or specified funding organisation(s), however it was not clear what the length of funding was or whether funding had ended or was ongoing.

Time points at which sustainability was assessed

The majority of studies (n=80, 87.0%) provided a clear timeframe between the end of initial implementation, staff training or funding, and the final evaluation timepoint. An additional ten studies (10.9%) specified that evaluations occurred post-implementation, however, a final clear evaluation timepoint was not provided. Two programs (2.2%) were still in their implementation phase but were included in this review as stakeholders were interviewed about the future sustainability of the program. The evaluation periods from the 80 studies providing clear final evaluation timepoints ranged from several months to years, with the longest evaluations reported at 10,[42] 12,[43] and 16 years.[44] The mean evaluation period was 40.7 months. For most studies (n=34, 42.5%), the final evaluation time point was between 1-2 years post-implementation, -training or -funding. Nine studies (11.3%) used an evaluation time of less than a year.

Only eleven of the 92 studies (12.0%) reported that evaluation occurred after initial program funding had ended. Of these 11, nine studies (81.8%) evaluated program sustainability, one (9.1%) evaluated the continuation of systems-level outcomes, and one (9.1%) evaluated the sustainability of both program and outcomes. Eight of the 11 studies (72.7%) clearly specified the evaluation period after funding had ended, ranging from eight months to six years (mean=35 months). For the other three studies (27.3%), it was not clear when the funding ended in relation to the evaluation.[45-47]

Evolution of program

Thirty-four studies (34.0%) described evolution, adaptation or modification of programs, which included for example, flexibility of the program,[48] adjustments to suit local context,[49-51] incorporating feedback from front-line staff,[52, 53] evolution of the program over time,[54, 55] and establishing a dedicated team responsible for continuous monitoring and making adaptations to programs.[56]

Theoretical frameworks

Eighteen of the 92 included studies (19.6%) used a sustainability-related theoretical framework (Supplementary file 2). Fourteen of the 18 studies using a framework (77.8%) made explicit reference to sustainability in the study aims (Supplementary file 2). The other four studies (22.2%) reported on sustainability, despite not referring to the concept in the aims. Some frameworks were purpose-designed to evaluate sustainability (e.g., Gruen et al.'s *dynamic model of health program sustainability*.[41] Other frameworks were originally designed for other purposes and not for the assessment of sustainability, for example, the Consolidated Framework for Implementation Research,[57] Atun et al.'s conceptual framework for analysing integration of targeted health interventions into health systems,[58] or Greenhalgh et al.'s Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Service Delivery and Organization.[59] The *Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework*,[60] was designed to examine success across the lifecycle of a program, including its sustainability (maintenance), and was used by two studies (Supplementary file 2).

Reasons for using frameworks

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Seventeen of the 18 studies reported using a framework (94.4%) to underpin program evaluation, with three key purposes: 1. To assess quantitative data related to outcomes; 2. To frame interview guides; and 3. To inform, structure, map or verify qualitative findings. Six studies (33.3%) used frameworks for multiple purposes (Supplementary file 2).

Only one of the 18 studies (5.6%) used a framework to support implementation. Licskai et al. used the *Canadian Institutes of Health Research ‘knowledge-to-action’ framework* to implement an asthma guidelines program.[61] As part of this cycle, a key action phase was “sustained knowledge use”. No studies reported using frameworks to support the design of programs.

Measuring sustainability

Methods used

The most common research method used (n=46, 50.0%) to measure sustainability was the analysis of routinely collected data by healthcare organisations, (e.g., patient length of stay, admissions/readmission, financial data). Interviews were used in 41 studies (44.6%) and surveys in 28 (30.4%). Other methods included checklists, observations, cost-effectiveness evaluations, and focus group discussions. Forty-six of the studies (50.0%) used more than one method, including mixed methods approaches.

Tools used

A small proportion of studies (n=6, 6.5%) used purpose-designed tools to evaluate sustainability. Three studies[62-64] used the NHS Sustainability Model and associated index.[65] Despite using the same tool, the three studies reported different names: the British National Health Service Sustainability Index, the NHS Sustainability Survey and the NHS Institute for Innovation and Improvement Sustainability Model self assessment tool. Two

1
2
3 studies[66, 67] used the Routinization Instrument developed by Slaghuis et al.[39] and one
4
5 study[68] used Goodman's Level of Institutionalization Scales.[69]
6
7
8
9

10 11 **DISCUSSION** 12 13

14 We need health systems and programs that are built to last, but studies purporting to assess
15 such systems and programs lack definitional consistency and rigour. Our study provides a
16 unique summary of the current application of theoretical concepts and frameworks to assess
17 the sustainability of implemented healthcare programs. Surprisingly, over 40% of studies
18 describing programs that referred to sustainability or related concepts in the title, abstract or
19 keywords had to be excluded at full-text review because they did not assess or report on
20 program sustainability. Just over 57% of studies explicitly referred to sustainability in their
21 aims, whilst only 29% of studies provided an operational definition of program sustainability.
22 This is even lower than the 35% of studies included in Stirman's review published in
23 2012,[21] but higher than Moore et al.'s 2017 review on definitions of sustainability, where
24 only 11.5% of included articles provided a definition.[25] Unlike Stirman and colleagues,[21]
25 the majority of the studies in our review that provided a definition of sustainability cited a
26 pre-existing definition in the literature suggesting that evaluators are increasingly looking to
27 the literature for definitions of program sustainability.
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45

46 The lack of a unified definition of sustainability across the literature, manifested in our
47 review through a 16-year variation in time points at which the authors assessed the
48 sustainability of their programs or program outcomes. Of the 80 studies reporting a clear final
49 evaluation timepoint, the majority (n=34, 42.5%) measured sustainability of a program or
50 continuation of outcomes 1-2 years after initial implementation, staff training, or funding
51 ended. This was similar to the 64% reported by Stirman et al.[21] Just over 11% (n=9) of the
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

80 studies used an evaluation time of less than a year which is higher than the 6% reported by Stirman et al.[21] Furthermore, some studies assessed program sustainability only a few months after the end of initial implementation or program funding.[48, 70, 71] Whilst programs and approaches to implementation may differ, time is an important construct of sustainability, and it must be clearly articulated and justified as part of an operational definition of sustainability before undertaking an evaluation.[25] The timing of a sustainability evaluation is dependent on the individual program, outcomes of interest, and whether sustainability is viewed as an outcome or as a process.[25, 26] Lennox et al.’s systematic review, investigating approaches to healthcare sustainability evaluation, found that the measurement over time approach was used in the majority of studies.[26] Although we attempted to identify studies that assessed sustainability at multiple time points, this was methodologically impossible as the timepoints reported were varied and often ambiguous. Formative evaluation feedback loops are thought to be essential to support successful program implementation processes,[72] however, only about a third of our included studies reported on some aspects of program evolution, adaptation or modification, with ongoing monitoring and evaluation running along-side the implementation.

Stirman et al. argued that researchers should be guided by appropriate theoretical frameworks in order to advance healthcare program sustainability research.[21] Many theoretical frameworks have been published to support the implementation, monitoring and assessment of healthcare program sustainability.[26] Our review suggests that in recent years, there has been little improvement in the use of theoretical frameworks to underpin assessment of the sustainability of healthcare programs implemented in the healthcare delivery system. Stirman et al. reported that 16% of studies included in their review used a theoretical framework[21] and approximately 20% of our included studies did so.[21] Furthermore, studies that applied frameworks, mostly reported doing so at the evaluation stage rather than at the inception of

program design or implementation. This post-hoc approach limits the rigour and validity of evaluation results for these programs.[73] Robust comparisons across studies were difficult because only 6.5% of studies used published tools to assess sustainability. Although three studies used the same tool (The National Health Service [NHS] Institute for Innovation and Improvement Sustainability Model), they published different names for this tool, further challenging the ability to compare across studies.

Study Implications

Our review revealed a lack of consistency in the way sustainability is defined, conceptualised, assessed, and reported on. Furthermore, we found little improvement since Stirman's review in 2012, with ongoing limited use of sustainability-related theoretical frameworks and assessment tools. We recommend that future evaluations of programs mobilise operational definitions of sustainability, theoretically rigorous frameworks, clear and appropriate timepoints and validated assessment tools such as the Routinization Instrument[39] to evaluate sustainability of healthcare programs. This will build a needed evidence base to support policy and investment decisions about scaling-up and spreading healthcare programs, and for them ultimately to be longer-lasting.

A concerted effort is needed to move theory into practice and to support ongoing engagement between the healthcare sector and implementation science and healthcare services researchers.[74] Embedding healthcare services researchers with skills in implementation science and systems science expertise in the healthcare system is one potential solution.[75] Closer links at organisational level between academic and research institutes and organisations at the front-lines of the healthcare system may also be helpful.

Healthcare delivery improvement programs are considered among the essential building blocks of sustainable healthcare systems.[76] The current lack of evidence consistency about

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

the sustainability of implemented improvement programs, will inevitably limit the understanding of broader concepts such as social, economic and environmental benefits, increasingly expected from sustainable healthcare systems.[77] Although artificial intelligence (AI) is also increasingly proposed as one of the solutions to support healthcare system sustainability, our review did not pick up publications in AI, possibly because this is an emerging field. We expect that future reviews will build on currently emerging work in AI,[78, 79] to incorporate evaluations of implemented AI solutions and their contribution to health system sustainability.

Strengths and limitations

The search strategy was designed in collaboration with a medical librarian to enable us to capture the diversity of healthcare programs and the disparate nature of the study methodologies and settings. We ensured our methods were rigorous through team discussions and a double blinded sample review to ensure consistency of study inclusion and interpretation. Regular team meetings were necessary to resolve queries and divergence of opinions about which healthcare programs to include and what constitutes sustainability. Our review is limited to English-language studies published in the peer review literature, however, we know that many healthcare program evaluations are not published in the public domain, or are published in the grey literature. The literature search was conducted in March 2018, and therefore, this review does not include articles published in the last two years. We intend to review this topic again in two years’ time in order to assess the progression of research on health systems sustainability. We used a systems sustainability lens for our review and programs that assessed patient and community outcomes only were excluded; we acknowledge that positive system outcomes do not necessarily translate to positive patient or community outcomes. Additional analyses are needed to describe the complex inter-

relationships among patient, community and system aspects of healthcare program sustainability.

CONCLUSIONS

Our review uncovered lack of conceptual clarity, poor consistency of purpose, and inconsistencies in defining and assessing the sustainability of programs implemented in healthcare systems. Many studies discussed the sustainability of healthcare programs but failed to adequately define or measure program sustainability. Furthermore, few studies reported using sustainability-related frameworks to support program evaluations. There is a need therefore to upskill and build capacity in teams that design, implement and evaluate healthcare programs to ensure conceptual clarity and rigorous methodology. Consistent and unified definitions of program sustainability are needed to enable comparisons among evaluation studies and to generate a systematic evidence base on which to make decisions about program sustainability. The effectiveness of embedding implementation science and healthcare services researchers into the healthcare system to form collaborative teams with decision-makers and clinicians should be trialled.

STATEMENTS

Acknowledgements

The authors would like to thank Ms Mary Simons, clinical librarian, Macquarie University, who assisted with the development of the search strategy, and Ms Johanna Holt for helping to refine the selection criteria. They would also like to thank Ms Hsuen P. Ting, biostatistician at the Australian Institute of Health Innovation, Macquarie University, for calculating the kappa coefficient for the blinded 5% sample abstract review and Dr Margie Campbell,

1
2
3 Research Fellow, Centre for Health Economics Research and Evaluation, University of
4
5 Technology Sydney, for identifying additional articles to include in the review via
6
7 snowballing techniques.
8
9

10
11
12
13 **Competing interests**
14

15
16 There are no competing interests.
17
18

19
20
21 **Funding**
22

23
24 This work was supported by the NHMRC Partnership Centre in Health System Sustainability
25
26 (Grant ID 9100002) and NHMRC Investigator Grant APP1176620.
27
28

29
30
31 **Authors' Contributions**
32

33
34 JB conceptualised the study and lead the team's work. KL, LT, JHe and EM developed the
35
36 search strategy. KL, LT, JHe, HA, GL and EM conducted the abstract review, full-text
37
38 review and data extraction, with JB and YZ acting as arbitrators. The quality assessment of
39
40 included articles was conducted by KL, LT, JHe, HA and GL. KL and LT undertook the
41
42 synthesis of data. KL, LT and YZ wrote the draft manuscript, with all authors providing
43
44 feedback and approving the final version.
45
46
47
48
49
50

51
52 **Data sharing**
53

54
55 No additional data available.
56
57
58
59
60

REFERENCES

1. Organisation for Economic Cooperation and Development. Tackling wasteful spending on health. Paris, France: OECD; 2017. Available from: <https://www.oecd.org/health/tackling-wasteful-spending-on-health-9789264266414-en.htm>
2. Braithwaite J, Mannion R, Matsuyama Y, et al., editors. Healthcare Systems: Future Predictions for Global Care. Boca Raton, FL: Taylor & Francis 2018.
3. World Economic Forum. Sustainable health systems. Visions, strategies, critical uncertainties and scenarios. Geneva, Switzerland: WEF; 2013. Available from: <https://www.weforum.org/reports/sustainable-health-systems-visions-strategies-critical-uncertainties-and-scenarios>
4. World Health Organization. Everybody's business. Strengthening health systems to improve health outcomes. WHO's framework for action. Geneva, Switzerland: WHO; 2007. Available from: https://www.who.int/healthsystems/strategy/everybodys_business.pdf
5. Braithwaite J, Vincent C, Nicklin W, et al. Coping with more people with more illness. Part 2: New generation of standards for enabling healthcare system transformation and sustainability. *IJQHC*. 2018;31(2):159-63. doi: 10.1093/intqhc/mzy236.
6. World Health Organization. World report on ageing and health 2015. Geneva, Switzerland: WHO; 2015. Available from: <https://www.who.int/ageing/events/world-report-2015-launch/en/>
7. Australian Institute of Health and Welfare. Australia's health 2018: In brief. Canberra, Australia: AIHW; 2018. Available from: <https://www.aihw.gov.au/reports/australias-health/australias-health-2018-in-brief/contents/about>
8. Saini V, Brownlee S, Elshaug AG, et al. Addressing overuse and underuse around the world. *Lancet*. 2017;390(10090):105-7. doi: 10.1016/s0140-6736(16)32573-9.
9. Institute of Medicine (US) Roundtable on Evidence-Based Medicine, Yong PL, Saunders RS, et al. Consumers-directed policies. In: Institute of Medicine (US) Roundtable on Evidence-Based Medicine, Yong PL, Saunders RS, Olsen LA, eds. The Healthcare Imperative: Lowering Costs and Improving Outcomes: Workshop Series Summary. Washington, DC: Institute of Medicine (US); 2010.
10. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: Assessing the appropriateness of health care delivery in Australia. *Med J Aust*. 2012;197(2):100-5. doi: 10.5694/mja12.10510.

11. Braithwaite J. Changing how we think about healthcare improvement. *BMJ*. 2018;361:k2014. doi: 10.1136/bmj.k2014.

12. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348(26):2635-45. doi: 10.1056/NEJMsa022615.

13. Mangione-Smith R, DeCristofaro AH, Setodji CM, et al. The quality of ambulatory care delivered to children in the United States. *N Engl J Med*. 2007;357(15):1515-23. doi: 10.1056/NEJMsa064637.

14. Braithwaite J, Hibbert PD, Jaffe A, et al. Quality of health care for children in Australia, 2012-2013. *JAMA*. 2018;319(11):1113-24. doi: 10.1001/jama.2018.0162.

15. Ferlie E, Montgomery K, Reff A, et al. Patient safety and quality. In: Ferlie E, Montgomery K, Reff A, eds. *The Oxford Handbook of Health Care Management*. Oxford, UK: Oxford University Press; 2016:325-51.

16. Lipsitz LA. Understanding health care as a complex system: The foundation for unintended consequences. *JAMA*. 2012;308(3):243-4. doi: 10.1001/jama.2012.7551.

17. World Economic Forum. Misaligned stakeholders and health system underperformance. Cologny, Switzerland: WEF; 2016. Available from: <https://www.weforum.org/whitepapers/misaligned-stakeholders-and-health-system-underperformance>

18. Toth F. Integration vs separation in the provision of health care: 24 OECD countries compared. *Health Econ Policy Law*. 2018;1-13. doi: 10.1017/S1744133118000476.

19. Organisation for Economic Cooperation and Development. Caring for quality in health: Lessons learnt from 15 reviews of health care quality. Paris, France: OECD; 2017. Available from: <https://www.oecd.org/health/caring-for-quality-in-health-9789264267787-en.htm>

20. Shelton RC, Cooper BR, Stirman SW. The sustainability of evidence-based interventions and practices in public health and health care. *Annu Rev Public Health*. 2018;39:55-76. doi: 10.1146/annurev-publhealth-040617-014731.

21. Stirman SW, Kimberly J, Cook N, et al. The sustainability of new programs and innovations: A review of the empirical literature and recommendations for future research. *Implement Sci*. 2012;7:17. doi: 10.1186/1748-5908-7-17.

22. Scheirer MA. Is Sustainability possible? a review and commentary on empirical studies of program sustainability. *Am J Eval*. 2005;26(3):320-47. doi: 10.1177/1098214005278752.

23. Shediach-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: Conceptual frameworks and future directions for research, practice and policy. *Health Educ Res.* 1998;13(1):87-108. doi: 10.1093/her/13.1.87.
24. Scheirer M, A., Dearing JW. An agenda for research on the sustainability of public health programs. *Am J Public Health.* 2011;101(11):2059-67. doi: 10.2105/AJPH.2011.300193.
25. Moore JE, Mascarenhas A, Bain J, et al. Developing a comprehensive definition of sustainability. *Implement Sci.* 2017;12(1):110. doi: 10.1186/s13012-017-0637-1.
26. Lennox L, Maher L, Reed J. Navigating the sustainability landscape: A systematic review of sustainability approaches in healthcare. *Implement Sci.* 2018;13(1):27. doi: 10.1186/s13012-017-0707-4.
27. Braithwaite J, Testa L, Lamprell G, et al. Built to last? The sustainability of health system improvements, interventions and change strategies: A study protocol for a systematic review. *BMJ Open.* 2017;7(11):e018568. doi: 10.1136/bmjopen-2017-018568.
28. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ.* 2009;339:b2535. doi: 10.1136/bmj.b2535.
29. Ouzzani M, Hammady H, Fedorowicz Z, et al. Rayyan — A web and mobile app for systematic reviews. *Syst Rev.* 2016;5:210. doi: 10.1186/s13643-016-0384-4.
30. Miles MB, Huberman AM. *Qualitative Data Analysis.* Thousand Oaks, CA: Sage Publications; 1994.
31. Whittemore R, Knafl K. The integrative review: Updated methodology. *J Adv Nurs.* 2005;52(5):546-53. doi: 10.1111/j.1365-2648.2005.03621.x.
32. Hawker S, Payne S, Kerr C, et al. Appraising the evidence: Reviewing disparate data systematically. *Qual Health Res.* 2002;12(9):1284-99. doi: 10.1177/1049732302238251.
33. Lorenc T, Petticrew M, Whitehead M, et al. Crime, fear of crime and mental health: Synthesis of theory and systematic reviews of interventions and qualitative evidence. *PHR.* 2014;2(2):1-398. doi: 10.3310/phr02020.
34. Feinstein AR, Cicchetti DV. High agreement but low kappa: I. The problems of two paradoxes. *J Clin Epidemiol.* 1990;43(6):543-9. doi: 10.1016/0895-4356(90)90158-1.
35. Gwet KL, editor. *Handbook of Inter-Rater Reliability: The Definitive Guide to Measuring the Extent of Agreement Among Raters 4th Edition.* Gaithersburg, MD: Advanced Analytics, LLC; 2010.
36. World Bank. *World Bank Country and Lending Groups* Washington, DC: World Bank; 2019. Available from:

<https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.

37. Pluye P, Potvin L, Denis J-L. Making public health programs last: Conceptualizing sustainability. *Eval Program Plann*. 2004;27(2):121-33. doi: 10.1016/j.evalprogplan.2004.01.001.
38. Buchanan D, Fitzgerald L, Ketley D, et al. No going back: A review of the literature on sustaining organizational change. *Int J Manag Rev*. 2005;7(3):189-205. doi: 10.1111/j.1468-2370.2005.00111.x.
39. Slaghuis SS, Strating MMH, Bal RA, et al. A framework and a measurement instrument for sustainability of work practices in long-term care. *BMC Health Serv Res*. 2011;11(1):314. doi: 10.1186/1472-6963-11-314.
40. Proctor E, Luke D, Calhoun A, et al. Sustainability of evidence-based healthcare: research agenda, methodological advances, and infrastructure support. *Implement Sci*. 2015;10:88. doi: 10.1186/s13012-015-0274-5.
41. Gruen RL, Elliott JH, Nolan ML, et al. Sustainability science: An integrated approach for health-programme planning. *Lancet*. 2008;372(9649):1579-89. doi: 10.1016/s0140-6736(08)61659-1.
42. Paul DL, McDaniel RR. Facilitating telemedicine project sustainability in medically underserved areas: A healthcare provider participant perspective. *BMC Health Serv Res*. 2016;16(1):148. doi: 10.1186/s12913-016-1401-y.
43. Oliveira SRA, Medina MG, Figueiro AC, et al. Strategic factors for the sustainability of a health intervention at municipal level of Brazil. *Cad Saude Publica*. 2017;33(7):e00063516. doi: 10.1590/0102-311x00063516.
44. Sorensen TD, Pestka D, Sorge LA, et al. A qualitative evaluation of medication management services in six Minnesota health systems. *Am J Health Syst Pharm*. 2016;73(5):307-14. doi: 10.2146/ajhp150212.
45. Druss BG, von Esenwein SA, Compton MT, et al. Budget impact and sustainability of medical care management for persons with serious mental illnesses. *The American Journal of Psychiatry*. 2011;168(11):1171-8. doi: 10.1176/appi.ajp.2011.11010071.
46. MacLean S, Berends L, Mugavin J. Factors contributing to the sustainability of alcohol and other drug interventions in Australian community health settings. *Aust J Prim Health*. 2013;19(1):53-8. doi: 10.1071/py11136.

47. Seppey M, Ridde V, Touré L, et al. Donor-funded project's sustainability assessment: A qualitative case study of a results-based financing pilot in Koulikoro region, Mali. *Global Health*. 2017;13(1):86. doi: 10.1186/s12992-017-0307-8.
48. Bridges J, May C, Fuller A, et al. Optimising impact and sustainability: a qualitative process evaluation of a complex intervention targeted at compassionate care. *BMJ Qual Saf*. 2017;26(12):970-7. doi: 10.1136/bmjqs-2017-006702.
49. Rubin FH, Neal K, Fenlon K, et al. Sustainability and scalability of the hospital elder life program at a community hospital. *J Am Geriatr Soc*. 2011;59(2):359-65. doi: 10.1111/j.1532-5415.2010.03243.x.
50. Brewster AL, Curry LA, Cherlin EJ, et al. Integrating new practices: A qualitative study of how hospital innovations become routine. *Implement Sci*. 2015;10(1):168. doi: 10.1186/s13012-015-0357-3.
51. Singh M, Gmyrek A, Hernandez A, et al. Sustaining Screening, Brief Intervention and Referral to Treatment (SBIRT) services in health-care settings. *Addiction*. 2017;112(S2):92-100. doi: 10.1111/add.13654.
52. Hovlid E, Bukve O, Haug K, et al. Sustainability of healthcare improvement: What can we learn from learning theory? *BMC Health Serv Res*. 2012;12(1):235. doi: 10.1186/1472-6963-12-235.
53. Rask K, Gitomer R, Spell N, et al. A two-pronged quality improvement training program for leaders and frontline staff. *Jt Comm J Qual Saf*. 2011;37(4):147-53.
54. Regagnin DA, da Silva Alves DS, Maria Cavaleiro A, et al. Sustainability of a program for continuous reduction of catheter-associated urinary tract infection. *Am J Infect Control*. 2016;44(6):642-6. doi: 10.1016/j.ajic.2015.11.037.
55. King K, Christo J, Fletcher J, et al. The sustainability of an Australian initiative designed to improve interdisciplinary collaboration in mental health care. *Int J Ment Health Syst*. 2013;7(1):10. doi: 10.1186/1752-4458-7-10.
56. Agarwal H, Saville B, Slayton J, et al. Standardized postoperative handover process improves outcomes in the intensive care unit: A model for operational sustainability and improved team performance. *Crit Care Med*. 2012;40(7):2109-15.
57. Ament SMC, Gillissen F, Maessen JMC, et al. Sustainability of short stay after breast cancer surgery in early adopter hospitals. *Breast*. 2014;23(4):429-34. doi: 10.1016/j.breast.2014.02.010.

58. Atun R, de Jongh T, Secci F, et al. Integration of targeted health interventions into health systems: A conceptual framework for analysis. *Health Policy Plan*. 2010;25(2):104-11. doi: 10.1093/heapol/czp055.
59. Greenhalgh T, Robert G, Macfarlane F, et al. Diffusion of innovations in service organizations: Systematic review and recommendations. *Milbank Q*. 2004;82(4):581-629. doi: 10.1111/j.0887-378X.2004.00325.x.
60. Glasgow RE, McKay HG, Piette JD, et al. The RE-AIM framework for evaluating interventions: What can it tell us about approaches to chronic illness management? *Patient Educ Couns*. 2001;44(2):119-27.
61. Licskai C, Sands T, Ong M, et al. Using a knowledge translation framework to implement asthma clinical practice guidelines in primary care. *Int J Qual Health Care*. 2012;24(5):538-46. doi: 10.1093/intqhc/mzs043.
62. Ford JH, 2nd, Krahn D, Wise M, et al. Measuring sustainability within the Veterans Administration Mental Health System Redesign initiative. *Qual Manag Health Care*. 2011;20(4):263-79. doi: 10.1097/QMH.0b013e3182314b20.
63. Kastner M, Sayal R, Oliver D, et al. Sustainability and scalability of a volunteer-based primary care intervention (Health TAPESTRY): A mixed-methods analysis. *BMC Health Serv Res*. 2017;17(1):514. doi: 10.1186/s12913-017-2468-9.
64. Mahomed OH, Asmall S, Voce A. Sustainability of the integrated chronic disease management model at primary care clinics in South Africa. *African journal of primary health care & family medicine*. 2016;8(1):e1-e7. doi: 10.4102/phcfm.v8i1.1248.
65. Maher L, Gustafson D, Evans A. NHS Sustainability Model and Guide London, UK: NHS Improvement; 2017. Available from: <https://improvement.nhs.uk/resources/Sustainability-model-and-guide/>.
66. Cramm JM, Nieboer AP. Short and long term improvements in quality of chronic care delivery predict program sustainability. *Soc Sci Med*. 2014;101:148-54. doi: 10.1016/j.socscimed.2013.11.035.
67. Makai P, Cramm JM, van Grotel M, et al. Labor productivity, perceived effectiveness, and sustainability of innovative projects. *J Healthc Qual*. 2014;36(2):14-24. doi: 10.1111/j.1945-1474.2012.00209.x.
68. Zakumumpa H, Bennett S, Ssengooba F. Accounting for variations in ART program sustainability outcomes in health facilities in Uganda: A comparative case study analysis. *BMC Health Serv Res*. 2016;16(1):584. doi: 10.1186/s12913-016-1833-4.

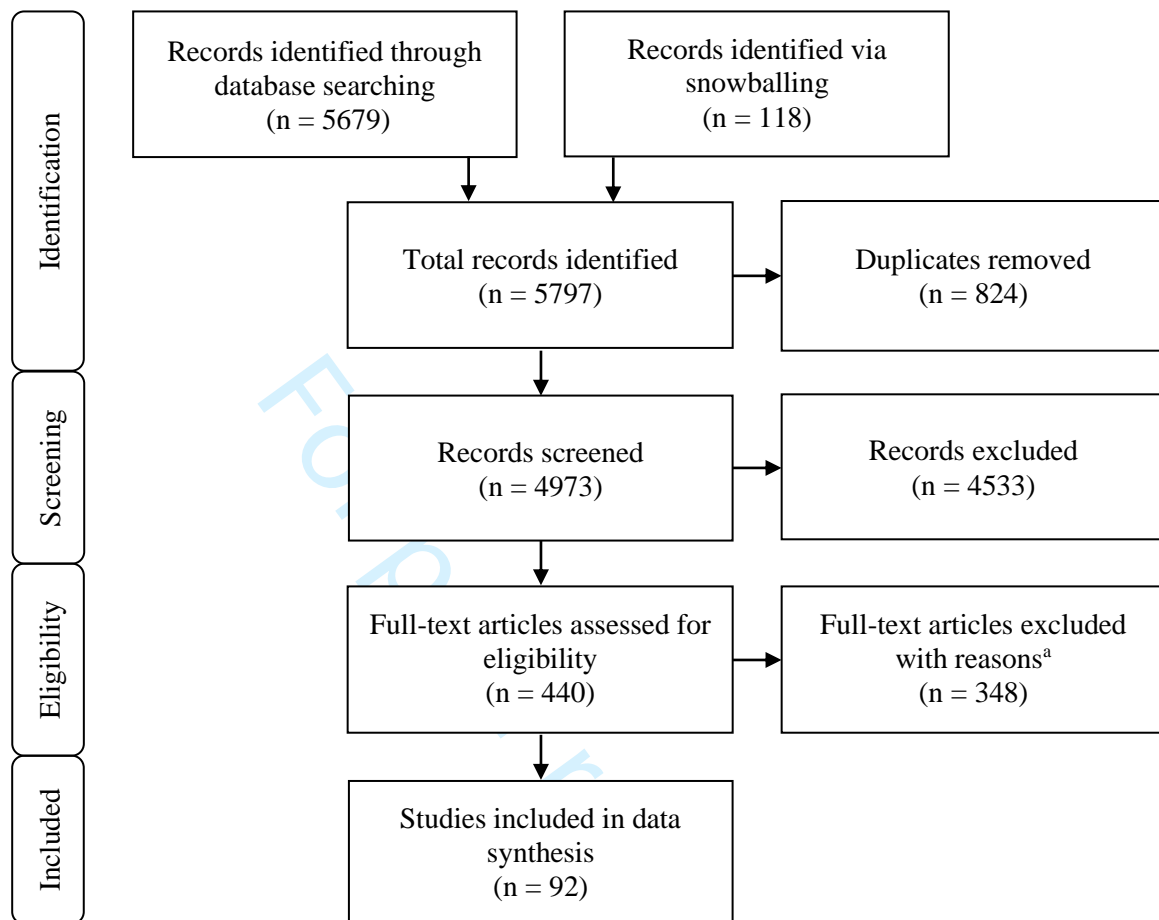
69. Goodman RM, McLeroy KR, Steckler AB, et al. Development of level of institutionalization scales for health promotion programs. *Health Educ Q*. 2003;20(2):161-78.
70. Khanal S, Ibrahim MI, Shankar PR, et al. Evaluation of academic detailing programme on childhood diarrhoea management by primary healthcare providers in Banke district of Nepal. *J Health Popul Nutr*. 2013;31(2):231-42. doi: 10.3329/jhpn.v31i2.16388.
71. Lean M, Leavey G, Killaspy H, et al. Barriers to the sustainability of an intervention designed to improve patient engagement within NHS mental health rehabilitation units: A qualitative study nested within a randomised controlled trial. *BMC Psychiatry*. 2015;15(1):209. doi: 10.1186/s12888-015-0592-9.
72. Braithwaite J, Westbrook M, Nugus P, et al. A four-year, systems-wide intervention promoting interprofessional collaboration. *BMC Health Serv Res*. 2012;12(1):99. doi: 10.1186/1472-6963-12-99.
73. Dixon-Woods M. How to improve healthcare improvement—An essay by Mary Dixon-Woods. *BMJ*. 2019;367:l5514. doi: 10.1136/bmj.l5514.
74. Brownson RC, Colditz GA, Proctor EK, editors. Dissemination and Implementation Research in Health – Translating Science to Practice. Oxford, UK: Oxford University Press; 2012.
75. Churrua K, Ludlow K, Taylor N, et al. The time has come: Embedded implementation research for health care improvement. *J Eval Clin Pract*. 2019;25(3):373-80. doi: 10.1111/jep.13100.
76. Manyazewal T. Using the World Health Organization health system building blocks through survey of healthcare professionals to determine the performance of public healthcare facilities. *Arch Public Health*. 2017;75:50-. doi: 10.1186/s13690-017-0221-9.
77. Pencheon D. Developing a sustainable health care system: The United Kingdom experience. *Med J Aust*. 2018;208(7):284-5. doi: 10.5694/mja17.01134.
78. Tran BX, Nghiem S, Sahin O, et al. Modeling research topics for artificial intelligence applications in medicine: Latent dirichlet allocation application study. *J Med Internet Res*. 2019;21(11):e15511. doi: 10.2196/15511.
79. Tran BX, Vu GT, Ha GH, et al. Global evolution of research in artificial intelligence in health and medicine: A bibliometric study. *J Clin Med*. 2019;8(3). doi: 10.3390/jcm8030360.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

FIGURE LEGEND

Figure 1: PRISMA flow diagram[28] summarising the review process and reasons for article exclusion.

For peer review only

^aExclusion criteriaNumber of studies^b

1 Full-text not available	0
2 Not English language	0
3 Not published in a peer-reviewed journal article	3
4 Not empirical or primary research	41
5 Published before July 2011	13
6 Not healthcare setting	4
7 Does not evaluate programs, interventions or change strategies	85
8 Focus is not on changes or improvements to the healthcare system	67
9 Does not assess sustainability (or discontinuation) of a program, intervention or change strategy	148

^b The number of studies in this column exceeds the total number of articles excluded at the full-text stage as some studies meet one or more of the exclusion criteria.

Supplementary file 1: Included publications

Reference	Method	Study design	Measurements	Country	Country income classification	Quality score (max. 36)	Quality rating
Agarwal et al., 2012	Quantitative	Longitudinal	Survey & Organisation/system data	USA	High income	29	Medium
Agarwal et al., 2016	Quantitative	Longitudinal	Survey	USA	High income	27	Medium
Allegranzi et al., 2013	Quantitative	Longitudinal	Observation	Costa Rica, Italy, Mali, Pakistan, and Saudi Arabia	Low income - High income	29	Medium
Ament et al., 2014	Quantitative	Case study	Organisation/system data	The Netherlands	High income	35	High
Ament et al., 2017	Qualitative	Case study	Interview	The Netherlands	High income	33	High
Assuncao et al., 2014	Quantitative	Case study	Organisation/system data & Cost-effectiveness evaluation	Brazil	Upper-middle income	30	High
Balfour et al., 2017	Quantitative	Quasi-experimental	Organisation/system data	USA	High income	27	Medium
Barfar et al., 2017	Quantitative	RCT	Survey & Cost-effectiveness evaluation	Iran	Upper-middle income	34	High
Barsky et al., 2013	Quantitative	RCT	Survey & Interview	USA	High income	32	High

Benn et al., 2012	Quantitative	Longitudinal	Survey	UK	High income	33	High
Benzer et al., 2014	Quantitative	Longitudinal	Organisation/system data	USA	High income	31	High
Blanchet & James, 2014	Quantitative and qualitative components	Case study	Interview & Organisation/system data	Ghana	Lower-middle income	33	High
Block et al., 2018	Quantitative	Longitudinal	Survey & Observation	USA	High income	33	High
Bond et al., 2014	Qualitative	Longitudinal	Interviews	USA	High income	33	High
Breckenridge-Sproat et al., 2017	Quantitative and qualitative components	Longitudinal	Survey, Interview, Checklist & Organisation/system data	USA	High income	32	High
Brewster et al., 2015	Qualitative	Cross-sectional	Interview	USA	High income	29	Medium
Bridges et al., 2017	Qualitative	Longitudinal	Survey & Interview	UK	High income	27	Medium
Burlew et al., 2014	Quantitative and qualitative components	Case study	Survey & Interview	Nigeria	Lower-middle income	27	Medium
Casati & Bjugn, 2012	Quantitative	Longitudinal	Organisation/system data	Norway	High income	33	High
Chandani et al., 2017	Mixed methods	Longitudinal	Survey	Malawi and Rwanda	Low income	32	High
Cramm & Nieboer, 2014	Quantitative	Longitudinal	Survey	The Netherlands	High income	29	Medium
Cresswell et al., 2012	Qualitative	Longitudinal	Interview & Focus group	UK	High income	34	High

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

De Neve et al., 2017	Qualitative	Case study	Interview & Organisation/system data	Lesotho, Mozambique, South Africa, and Swaziland	Low-income - upper-middle income	34	High
Deri Armstrong et al., 2016	Quantitative	RCT	Organisation/system data	Canada	High income	35	High
Druss et al., 2011	Quantitative	Longitudinal	Interview & Organisation/system data	USA	High income	30	High
Eichler et al., 2014	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	Switzerland	High income	31	High
Fieldston et al., 2016	Quantitative and qualitative components	Longitudinal		USA	High income	21	Low
Fleiszer et al., 2016	Qualitative	Case study	Interview	Canada	High income	35	High
Ford et al., 2011	Mixed methods	Cross-sectional	Survey & Interview	USA	High income	29	Medium
Gillissen et al., 2015	Quantitative	Longitudinal	Organisation/system data	The Netherlands	High income	33	High
Greenhalgh et al., 2012	Mixed methods	Case study	Interview, Organisation/system data & Observation	UK	High income	34	High
Hernández et al., 2015	Quantitative	RCT	Organisation/system data	Spain	High income	35	High

6/bmjopen-2019-036488
http://bmjopen.bmj.com/ by guest, Protected by copyright.
Downloaded from
June 2020
April 10, 2024

Hoque et al., 2014	Quantitative	Longitudinal	Survey & Observation	Bangladesh	Lower-middle income	32	High
Hovlid et al., 2012	Qualitative	Case study	Interview	Norway	High income	34	High
Ilott et al., 2016	Qualitative	Case study	Interview & Organisation/system data	UK	High income	33	High
Jansink et al., 2013	Quantitative	RCT	Checklist & Video and audio recordings	The Netherlands	High income	27	Medium
Jonasson et al., 2014	Qualitative	Cross-sectional	Interview	Sweden	High income	28	Medium
Kanamori et al., 2015	Qualitative	Longitudinal	Survey & Interview	Senegal	Low income	33	High
Kastner et al., 2017	Mixed methods	Cross-sectional	Survey & Interview	Canada	High income	32	High
Khanal et al., 2013	Quantitative	RCT	Survey	Nepal	Low income	33	High
King et al., 2013	Qualitative	Cross-sectional	Focus group	Australia	High income	36	High
Kirchner et al., 2014	Quantitative	Quasi-experimental	Organisation/system data	USA	High income	35	High
Lean et al., 2015	Qualitative	RCT	Focus group	UK	High income	33	High
Levchenko et al., 2014	Quantitative	Case study	Electronic monitoring technologies	Canada	High income	29	Medium
Licskai et al., 2012	Quantitative	Case study	Interview, Organisation/system data & Cost-effectiveness evaluation	Canada	High income	32	High

1									
2									
3	Long et al., 2014	Quantitative	Longitudinal	Organisation/system data	USA	High income	32		High
4									
5	MacLean et al., 2013	Qualitative	Cross-sectional	Interview & Organisation/system data	Australia	High income	31		High
6									
7									
8									
9									
10	Magadzire et al., 2015	Quantitative and qualitative components	Case study	Interview & Focus group	South Africa	Upper-middle income	31		High
11									
12									
13									
14	Mahomed et al., 2016	Quantitative	Cross-sectional	Observation, self-assessment tool	South Africa	Upper-middle income	32		High
15									
16									
17									
18	Makai et al., 2014	Quantitative	Longitudinal	Survey	The Netherlands	High income	32		High
19									
20	Marten, 2017	Qualitative	Cross-sectional	Interview	Tanzania and USA	Low income & high income	23		Low
21									
22									
23									
24									
25	Martin et al., 2016	Quantitative	Longitudinal	Organisation/system data	Switzerland	High income	30		High
26									
27									
28	Mayer et al., 2011	Quantitative and qualitative components	Quasi-experimental	Survey & Observation	USA	High income	28		Medium
29									
30									
31									
32	McKinnon, 2013	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	USA	High income	35		High
33									
34									
35									
36									
37	Morris et al., 2012	Quantitative	Longitudinal	Survey & Organisation/system data	UK	High income	31		High
38									
39									
40									
41									
42									
43									
44									
45									
46									

Mottes et al., 2013	Quantitative	Longitudinal	Organisation/system data	USA	High income	29	Medium
Najafizada et al., 2017	Qualitative	Cross-sectional	Interview & Focus group	Afghanistan	Low income	32	High
Neufeld & Case, 2013	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	USA	High income	31	High
Ohinmaa et al., 2016	Quantitative	Longitudinal	Organisation/system data & Cost-effectiveness evaluation	Canada	High income	35	High
Oliveira et al., 2017	Qualitative	Case study	Interview	Brazil	Upper-middle income	28	Medium
Ostermann et al., 2012	Quantitative	Longitudinal	Organisation/system data	Austria	High income	33	High
Palinkas et al., 2011	Qualitative	Cross-sectional	Interview & Focus group	USA	High income	32	High
Parchman et al., 2013	Quantitative	Longitudinal	Survey	USA	High income	34	High
Paul & McDaniel, 2016	Quantitative and qualitative components	Case study	Interview	USA	High income	33	High
Pearson et al., 2017	Quantitative	Quasi-experimental	Organisation/system data	UK	High income	34	High

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Peterson et al., 2014	Quantitative and qualitative components	Longitudinal	Interview & On-site fidelity assessment	USA	High income	31	High
Pomey et al., 2017	Qualitative	Case study	Interview & Organisation/system data	Canada	High income	32	High
Prashanth et al., 2014	Quantitative and qualitative components	Case study	Survey & Interview	India	Lower-middle income	32	High
Qian et al., 2011	Quantitative	Longitudinal	Organisation/system data	USA	High income	32	High
Rakha et al., 2013	Quantitative	Longitudinal	Survey & Organisation/system data	Egypt	Lower-middle income	30	High
Rask et al., 2011	Quantitative and qualitative components	Case study	Interview	USA	High income	30	High
Regagnin et al., 2016	Quantitative	Quasi-experimental	Checklist & Organisation/system data	Brazil	Upper-middle income	29	Medium
Rubin et al., 2011	Quantitative	Longitudinal	Organisation/system data	USA	High income	26	Medium
Schaffzin et al., 2013	Quantitative	Case study	Organisation/system data	USA	High income	22	Low
Schuller et al., 2015	Qualitative	Case study	Interview	USA	High income	33	High
Scullin et al., 2012	Quantitative	Natural experiment	Organisation/system data	UK	High income	35	High

Seppey et al., 2017	Qualitative	Case study	Interview	Mali	Low income	32	High
Singh et al., 2017	Quantitative and qualitative components	Cross-sectional	Survey & Interview	USA	High income	33	High
Sorensen et al., 2016	Qualitative	Case study	Interview	USA	High income	32	High
Stirman et al., 2015	Qualitative	Longitudinal	Interview & Organisation/system data	USA	High income	31	High
Storm-Versloot et al., 2012	Mixed methods	Longitudinal	Survey, Organisation/system data & Focus group	The Netherlands	High income	30	High
Sullivan et al., 2014	Quantitative and qualitative components	Longitudinal	Interview & Organisation/system data	Australia	High income	34	High
Tanguturi et al., 2016	Quantitative	Longitudinal	Organisation/system	USA	High income	30	High
Tjia et al., 2015	Quantitative and qualitative components	RCT	Organisation/system & Observation	USA	High income	33	High
Tomioaka & Braun, 2015	Qualitative	Case study	Interview	USA	High income	27	Medium
van Rossum et al., 2016	Quantitative	Cross-sectional	Survey	The Netherlands	High income	31	High
Weir et al., 2016	Quantitative	Longitudinal	Organisation/system	USA	High income	29	Medium
Weobong et al., 2017	Quantitative	RCT	Organisation/system data & Cost-	India	Lower-middle income	36	High

				effectiveness evaluation					
	Wysham et al., 2014	Quantitative	Quasi- experimental	Survey & Checklist	USA	High income	29		Medium
	Zakumumpa et al., 2016(a)	Quantitative and qualitative components	Case study	Survey & Interview	Uganda	Low income	35		High
	Zakumumpa et al., 2016(b)	Mixed methods	Longitudinal	Survey & Interview	Uganda	Low income	35		High
	Zakumumpa et al., 2017	Mixed methods	Case study	Survey & Interview	Uganda	Low income	35		High

Supplementary file 2: Theoretical frameworks

Publication	Explicit reference to sustainability in the study aims (yes/no)	Framework	Details	Use in study	Stage of use
Ament et al.[76]	Yes	Consolidated Framework for Implementation Research (CFIR)[77]	Thirty-nine constructs organised into five domains related to the effective implementation of programs	a) Framing interview guide b) Categorising factors related to sustainability (study findings) under the five domains of the framework	Evaluation
Bridges et al.[48]	Yes	Normalisation Process Theory (NPT)[78]	Four dynamic processes involved in implementing and integrating new innovations	a) Guiding interview schedule b) Comparing emerging theories of implementation processes (study findings) with NTP framework	Evaluation
Burlew et al.[79]	Yes	In-Service Training (IST) Improvement Framework	Forty recommendations for improving the effectiveness, efficiency and sustainability of IST	a) Developing the survey tool	Evaluation
Cresswell et al.[80]	No	Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Service	Not specified by authors	a) Guiding the interpretation of results	Evaluation

6/bmjopen-2019-036453 on 1 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 10, 2024 by guest. Protected by copyright.

		Delivery and Organization[59]; Rogers' work on the diffusion of innovation[81]			
De Neve et al.[82]	Yes	Conceptual framework for analyzing the harmonization of CHW programs	Five components based on Atun et al.'s[58] framework for analysing integration of targeted health interventions into health systems	a) Inform the design of semi-structured questionnaires b) Mapping mediators of harmonisation of programs (study findings) to the framework components	Evaluation
Ford et al.[62]	Yes	National Health Service (NHS) Institute for Innovation and Improvement Sustainability Model ^a [65]	Ten factors, organised into three domains, identified to increase the likelihood of sustainability and continuous improvement of projects	a) Assessing participants' perceptions of sustainability via sustainability scores	Evaluation
Greenhalgh et al.[83]	Yes	Framework developed by Øvretveit[84]; Conceptual framework for sustainability of public health programs[24]; Modified Dynamic model of health program sustainability[41]; Actor-Network Theory[85]	Adapted from Øvretveit[84]; Scheirer and Dearing[24]; Gruen et al.[41]; and Bisset and Potvin[85]	a) Informing the synthesis of qualitative and quantitative findings	Evaluation
Kastner et al.[63]	Yes	National Health Service (NHS) Institute for Innovation and	Ten factors, organised into three domains, identified	a) Assessing participants' perceptions of sustainability via sustainability scores	Evaluation

			Improvement Sustainability Model ^a [65]	to increase the likelihood of sustainability and continuous improvement of projects		
	Kirchner et al.[86]	No	Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework[60]	Five domains related to health behaviour interventions	a) Evaluating outcomes. Outcomes for effectiveness, adoption and implementation measured at the late implementation phase. Each measure was measured again at the maintenance phase measure the degree to which the intervention outcomes were sustained	Evaluation
	Licskai et al.[61]	No	Canadian Institute of Health Research 'knowledge-to-action' framework[87]	Knowledge-to-action' cycle comprising process elements common to planned-action models. 'Sustained knowledge use' was an action phase of implementation	a) Implementing asthma guidelines.	Implementation
	Mahomed et al.[64]	Yes	National Health Service (NHS) Institute for Innovation and Improvement Sustainability Model ^a [65]	Ten factors, organised into three domains, identified to increase the likelihood of sustainability and	a) Assessing participants' perceptions of sustainability via sustainability scores	Evaluation

6/bmjopen-2019-036453 on 1 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 10, 2024 by guest. Protected by copyright.

			continuous improvement of projects		
Palinkas et al.[88]	Yes	Author developed model of collaborative care sustainability	Eight themes mapping to three categories	a) Mapping study findings	Evaluation
Pomey et al.[89]	Yes	A conceptual framework [unnamed]; Integrated model of unintended consequences within healthcare organizations[81]	Four dimensions adapted from Parsons[90]; four consequences adapted from Bloomrosen et al.[91]; Rogers[81].	a) Guiding analysis of transcripts b) Categorizing consequences (study findings)	Evaluation
Seppey et al.[92]	Yes	Author developed sustainability framework	Adapted from Johnson et al.[93]; Chambers et al.[94]; Pluye, Potvin and Denis[37]; Moullin et al.[95]	a) Guiding open-ended questions b) Informing thematic analysis	Evaluation
Sorensen et al.[44]	Yes	Kotter’s 8-Steps Change Model[96]	An eight step process mapping to three stages of change. The third change is ‘Implementing and sustaining change’	a) Framing the question guide b) Structuring themes (study findings)	Evaluation
Tjia et al.[97]	No	Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework[60]	Five domains related to health behaviour interventions	a) Evaluating outcomes. Maintenance (i.e. sustainability) evaluated by	Evaluation

					measuring outcome 12 months after the intervention	
	Tomiooka & Braun[98]	Yes	Modified sustainability framework[22]	Modified from Scheirer. [22] Five sustainability factors, with the addition a sixth factor identified from a literature search	a) Developing the interview guide	Evaluation
	Zakumumpa et al.[68]	Yes	Framework for conceptualizing program sustainability[23]	Three levels that influence that influence health program sustainability	a) Structuring study findings	Evaluation

^a Three studies presented different names for the same tool. The “National Health Service (NHS) Institute for Innovation and Improvement Sustainability Model” has been adopted for consistency.



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Table 1 (p. 9)
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Box 1 (pp. 7-8)
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	11
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Box 2 (11)
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12-13
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	12

1136/bmjopen-2019-036453 on 1 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 19, 2024 by guest. Protected by copyright.



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICO, follow-up period) and provide the citations.	14-15
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	n/a
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	15-20
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	21-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	23-24
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	24
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data; role of funders for the systematic review).	25

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

The PRISMA for Abstracts Checklist

TITLE	CHECKLIST ITEM	REPORTED ON PAGE #
1. Title:	Identify the report as a systematic review, meta-analysis, or both.	2
BACKGROUND		
2. Objectives:	The research question including components such as participants, interventions, comparators, and outcomes.	2
METHODS		2
3. Eligibility criteria:	Study and report characteristics used as criteria for inclusion.	2
4. Information sources:	Key databases searched and search dates.	2
5. Risk of bias:	Methods of assessing risk of bias.	2
RESULTS		
6. Included studies:	Number and type of included studies and participants and relevant characteristics of studies.	2
7. Synthesis of results:	Results for main outcomes (benefits and harms), preferably indicating the number of studies and participants for each. If meta-analysis was done, include summary measures and confidence intervals.	2
8. Description of the effect:	Direction of the effect (i.e. which group is favoured) and size of the effect in terms meaningful to clinicians and patients.	n/a
DISCUSSION		
9. Strengths and Limitations of evidence:	Brief summary of strengths and limitations of evidence (e.g. inconsistency, imprecision, indirectness, or risk of bias, other supporting or conflicting evidence)	3
10. Interpretation:	General interpretation of the results and important implications	3
OTHER		
11. Funding:	Primary source of funding for the review.	3
12. Registration:	Registration number and registry name.	n/a