



ELSEVIER

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Review Article

Identifying opportunities to develop the science of implementation for community-based non-communicable disease prevention: A review of implementation trials



Luke Wolfenden^{a,b,c,d}, Kathryn Reilly^{a,b,c,d,*}, Melanie Kingsland^{a,b,c,d}, Alice Grady^{a,b,c,d}, Christopher M. Williams^{a,b,c,d,g}, Nicole Nathan^{a,b,c,d}, Rachel Sutherland^{a,b,c,d}, John Wiggers^{a,b,c,d}, Jannah Jones^{a,b,c,d}, Rebecca Hodder^{a,b,c,d}, Meghan Finch^{a,b,c,d}, Tameka McFadyen^{a,b,c,d}, Adrian Bauman^{e,h}, Chris Rissel^h, Andrew Milat^f, Taren Swindleⁱ, Sze Lin Yoong^{a,b,c,d}

^a School of Medicine and Public Health, University of Newcastle, Callaghan, New South Wales 2308, Australia

^b Hunter Medical Research Institute, Newcastle, New South Wales 2300, Australia

^c Priority Research Centre for Health Behaviour, University of Newcastle, New South Wales 2308, Australia

^d Hunter New England Population Health, Wallsend, New South Wales 2287, Australia

^e School of Public Health, The University of Sydney, Sydney, Australia

^f Centre for Epidemiology and Evidence, NSW Ministry of Health, North Sydney, Australia

^g Musculoskeletal Division, The George Institute for Global Health, Sydney, Australia

^h Prevention Research Collaboration, Sydney School of Public Health, Faculty of Medicine University of Sydney, NSW, Australia

ⁱ College of Medicine, Department of Family and Preventive Medicine, University of Arkansas for Medical Sciences, Little Rock, AR, United States

ARTICLE INFO

Keywords:

Implementation
Non-communicable diseases
Prevention
Community settings

ABSTRACT

Implementation of interventions in community organisations such as schools, childcare centres, and sporting clubs are recommended to target a range of modifiable risks of non-communicable diseases. Poor implementation, however, is common and has contributed to the failure of non-communicable disease interventions globally. This study aimed to characterise experimental research regarding strategies to improve implementation of chronic disease prevention programs in community settings.

The review used data collected in three comprehensive systematic reviews undertaken between August 2015 and July 2017. Randomised controlled trials, including cluster design, and non-randomised trials with a parallel control group were included. The data were extracted to describe trial characteristics, implementation strategies employed, implementation outcomes and study quality.

Of the 40 implementation trials included in the study, unhealthy diet was the most common risk factor targeted ($n = 20$). The most commonly reported implementation strategies were educational meetings ($n = 38$, 95%), educational materials ($n = 36$, 90%) and educational outreach visits ($n = 29$, 73%). Few trials were conducted 'at-scale' ($n = 8$, 20%) or reported adverse effects ($n = 5$, 13%). The reporting of implementation related outcomes; intervention adoption ($n = 13$, 33%); appropriateness ($n = 11$, 28%); acceptability ($n = 8$, 20%); feasibility ($n = 8$, 20%); cost ($n = 3$, 8%); and sustainability ($n = 2$, 5%); was limited. For the majority of trials, risk of bias was high for blinding of study personnel/participants and outcome assessors.

Testing of strategies to improve implementation of non-communicable disease prevention strategies in community settings, delivered 'at-scale', utilising implementation frameworks, including a comprehensive range of implementation outcomes should be priority areas for future research in implementation science.

* Corresponding author at: Hunter New England Population Health, Locked Bag 10, Wallsend, New South Wales 2287, Australia.

E-mail addresses: luke.wolfenden@hnehealth.nsw.gov.au (L. Wolfenden), kathryn.reilly@hnehealth.nsw.gov.au (K. Reilly), melanie.kingsland@hnehealth.nsw.gov.au (M. Kingsland), alice.grady@hnehealth.nsw.gov.au (A. Grady), christopher.m.williams@hnehealth.nsw.gov.au (C.M. Williams), nicole.nathan@hnehealth.nsw.gov.au (N. Nathan), rachel.sutherland@hnehealth.nsw.gov.au (R. Sutherland), john.wiggers@hnehealth.nsw.gov.au (J. Wiggers), jannah.jones@hnehealth.nsw.gov.au (J. Jones), rebecca.hodder@hnehealth.nsw.gov.au (R. Hodder), meghan.finch@hnehealth.nsw.gov.au (M. Finch), tameka-rae.small@hnehealth.nsw.gov.au (T. McFadyen), adrian.bauman@sydney.edu.au (A. Bauman), Chris.Rissel@health.nsw.gov.au (C. Rissel), amila@doh.health.nsw.gov.au (A. Milat), TSwindle@uams.edu (T. Swindle), serene.yoong@hnehealth.nsw.gov.au (S.L. Yoong).

<https://doi.org/10.1016/j.ypmed.2018.11.014>

Received 10 January 2018; Received in revised form 4 November 2018; Accepted 19 November 2018

Available online 20 November 2018

0091-7435/ © 2018 Published by Elsevier Inc.

1. Introduction

Non-communicable diseases are the leading cause of morbidity and mortality globally (Lim et al., 2013). As diet, physical activity, weight status, tobacco and alcohol use are among the primary modifiable risks for a range of non-communicable diseases (Lim et al., 2013), global initiatives including the World Health Organization (WHO) Global action plan for the prevention and control of non-communicable disease, prioritise the implementation of evidence-based interventions to address these risks (WHO, 2013). In particular, the implementation of interventions in community (non-clinical ‘settings’) organisations such as schools, childcare, sporting clubs and workplaces are recommended given their existing infrastructure and capacity to access a large proportion of the population (Mendis, 2014).

Implementation science is the study of methods to promote the adoption and integration of evidence-based initiatives into routine health care and public health settings (Nilsen, 2015). Poor implementation, however, is common and has contributed to the failure of many large non-communicable disease (NCD) interventions globally (Matheson et al., 2013). While the effects of NCD interventions may be enhanced with improved implementation (WHO, 2013), little evidence is available to guide decisions regarding the strategies to achieve this outcome (Wolfenden et al., 2016a; Milat et al., 2011). Relative to implementation research undertaken in clinical settings, where hundreds of randomised trials have been undertaken assessing the efficacy of specific implementation strategies, previous reviews have identified few such trials in community settings targeting NCD risks (McFayden et al., 2018; Wolfenden et al., 2016b; Wolfenden et al., 2017a). Further, such reviews have suggested that the evidence base in the field of community base implementation is heterogeneous, is of poor methodological quality, and provides few examples of effective implementation approaches (McFayden et al., 2018; Wolfenden et al., 2016b; Wolfenden et al., 2017a).

A number of developments in implementation science have sought to facilitate improvements in the quality of implementation research. For example, a range of implementation frameworks exist to support researchers to identify relevant implementation barriers and select appropriate implementation strategies (Birken et al., 2017). Taxonomies have been published to facilitate the standardised description, classification and reporting of implementation strategies, and outcomes (Proctor et al., 2011). There have also been calls to improve the efficiency of evidence generation and reduce research waste through prioritisation of implementation research to ensure high quality research trials are undertaken that address important knowledge gaps in the field (Ivers and Grimshaw, 2016).

Given the considerable investment by governments in the implementation of community-based NCD interventions (Nilsen, 2015), co-ordinated research efforts to improve the implementation evidence base in the field would be particularly worthwhile. A necessary first step toward achieving this outcome is to characterise the existing evidence base, and to identify opportunities for improvement and future research priorities. To this end, the aim of this study was to describe the study characteristics, implementation strategies, outcomes and methodological quality of trials that have investigated the effects of NCD implementation strategies in community settings.

2. Methods

2.1. Systematic search

The review utilises studies identified by searches undertaken in three comprehensive systematic reviews (McFayden et al., 2018; Wolfenden et al., 2016b; Wolfenden et al., 2017a) undertaken between August 2015 and July 2017. The systematic reviews to examine the effects of strategies to improve implementation of non-communicable disease prevention interventions in school, childcare centre and

sporting club settings (McFayden et al., 2018; Wolfenden et al., 2016b; Wolfenden et al., 2017a). Across the three reviews, 32,173 manuscripts were screened, 532 full text articles were assessed for eligibility, of which 40 studies (101 articles) were deemed eligible for inclusion (McFayden et al., 2018; Wolfenden et al., 2016b; Wolfenden et al., 2017a). Full details of the reviews can be found elsewhere (McFayden et al., 2018; Wolfenden et al., 2016b; Wolfenden et al., 2017a) and are described briefly in the Supplementary material.

2.2. Inclusion criteria

Randomised controlled trials (RCTs), including those with a cluster design, and non-randomised trials with a parallel control group were included. Eligible studies were those undertaken in the school, childcare centre or sporting club setting. Studies that assessed a strategy to improve the implementation of policies, practices or programs compared to either another implementation strategy, no strategy or ‘usual’ practice were included. Studies targeted one (or multiple) of the following risk factors: unhealthy diet, physical inactivity, obesity, tobacco use and risky alcohol consumption. Implementation of targeted policies or practices needed to occur by usual staff or personnel within these community organisations (as opposed to paid research staff). Trials that did not report the effects on a measure of the fidelity of implementation of a targeted policy, practice or program implementation for both intervention and control groups were excluded. Fidelity was defined as the degree to which an intervention was implemented as it was prescribed in the original protocol or as it was intended by the program developers (Proctor et al., 2011).

2.3. Data extraction

For all reviews, screening and data extraction occurred independently by pairs of review authors in accordance with the Cochrane Handbook (Higgins and Green, 2011). A comprehensive search for both published and unpublished research studies across a broad range of information sources was undertaken to reflect the cross-disciplinary nature of the topic. Articles published in any language were eligible and there were no restrictions regarding article publication dates or country of origin. Discrepancies in trial inclusion or data extraction were resolved via consensus between review pairs or via adjudication by a third reviewer where consensus could not be reached. We expanded the data extracted as part of the published reviews and consolidated the findings across all community settings. A description of the number of citations screened and full texts included in the reviews is described in Fig. 1.

2.4. Measures

2.4.1. Study characteristics

We extracted data to describe the trial research design (e.g. randomised trial), country where the research was undertaken, targeted health risks, and setting and the use of an effectiveness-implementation hybrid design - defined as those trials assessing both the impact of the intervention on a measures of the targeted health risk, and the impact of the implementation strategy on implementation outcomes (Curran et al., 2012). The use of an implementation specific theoretical framework was extracted. Rather than develop an operational definition we recorded the use of any framework included in a recent comprehensive systematic review of implementation frameworks (Birken et al., 2017). The period from baseline to follow-up, the implementation of policies, practices and programs ‘at-scale’ (defined as 50 or more sites), and any adverse effects reported by included studies was also recorded. Finally, to assess whether the intervention subject to implementation was ‘evidence based’ we recorded information from included studies which indicated that the intervention had been previously tested and found to be effective in improving one or more of the targeted health behaviours

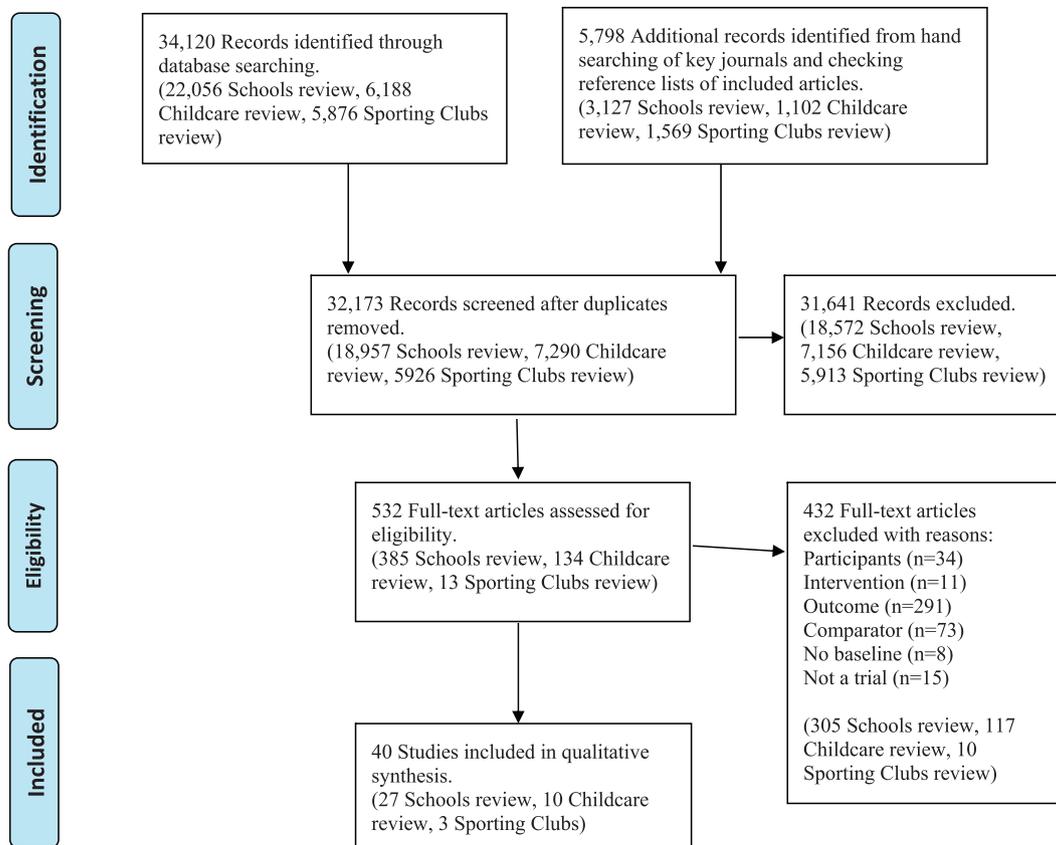


Fig. 1. Combined CONSORT diagram.

or was supported more broadly by evidence suggesting its efficacy (for example systematic review evidence had found similar interventions or interventions based on the same principles were effective).

2.4.2. Implementation strategy characteristics

The Cochrane Effective Practice and Organisation of Care (EPOC) taxonomy descriptors (Table 1) were used to classify implementation strategies employed by included trials based on strategy descriptions provided in the manuscript (*Effective Practice and Organisation of Care (EPOC), 2015*). The EPOC criteria is the most widely used taxonomy for describing implementation and practice change strategies (Proctor et al., 2013).

2.4.3. Implementation outcomes reported

In addition to measures of fidelity which was an inclusion criteria (the extent of implementation of the targeted policy or practice), the ‘Taxonomy of Implementation Outcomes’ (Proctor et al., 2011) was used to classify other implementation outcomes (acceptability, adoption, appropriateness, costs, feasibility, penetration and sustainability) reported in included trials (Proctor et al., 2011).

2.4.4. Study quality

We used the Cochrane risk of bias tool to assess the quality of included trials as having ‘low’, ‘high’, or ‘unclear’ risk of bias in accordance with the Cochrane Handbook (Higgins and Green, 2011). For cluster-RCTs, ‘recruitment to cluster’, ‘baseline imbalance’, ‘loss of clusters’, ‘incorrect analysis’, ‘contamination’ and ‘compatibility with individually RCTs’ was also assessed in addition to the standard risk of bias criteria. For non-randomised trials, the additional criterion ‘potential confounding’ was also included. Consistent with suggestions from the Cochrane handbook to assess potential confounding, reviewers considered whether authors of trials; (i) restricted participant selection

so that trial groups had the same value for the confounder; (ii) demonstrated balance between groups for the confounder; (iii) matched on the confounder; or (iv) adjusted for the confounder in statistical analyses.

2.5. Synthesis

Simple descriptive statistics including counts and percentages were used to describe the study characteristics, implementation strategy characteristics and outcomes reported in included studies.

3. Results

3.1. Study characteristics

As reported in Table 2, of the 40 included trials, most were conducted in the United States (n = 23) or Australia (n = 11). The most common risk factor targeted was unhealthy diet (n = 20, 50%). Most trials were conducted in schools (n = 27, 68%), used randomised/cluster RCT designs (n = 29, 73%) and conducted follow-up more than twelve months post baseline (n = 23, 57%). Few studies sought to improve the implementation of policies, practices and programs ‘at-scale’ (n = 8, 20%). Only five (n = 5, 13%) studies reported measures of adverse effects. Of the 40 included studies, 17 (43%) were hybrid in nature, that is, they included implementation and individual level health behaviour outcomes, and the majority of studies reported implementation of an evidence-based intervention (n = 34, 85%).

3.2. Implementation strategy characteristics

As reported in Table 2, 35 different implementation strategies were used across the three settings. The most commonly used strategies

Table 1
Intervention Implementation Strategy definitions according to the [Effective Practice and Organisation of Care \(EPOC\), \(2015\)](#) (Curran et al., 2012).

Implementation strategy	Definition
Educational meetings	Courses, workshops, conferences or other educational meetings
Educational materials	Distribution to individuals, or groups, of educational materials to support clinical care, i.e., any intervention in which knowledge is distributed. For example this may be facilitated by the internet, learning critical appraisal skills; skills for electronic retrieval of information, diagnostic formulation; question formulation
Educational outreach visits	Personal visits by a trained person to health workers in their own settings, to provide information with the aim of changing practice.
Local consensus processes	Formal or informal local consensus processes, for example agreeing a clinical protocol to manage a patient group, adapting a guideline for a local health system or promoting the implementation of guidelines
Local opinion leaders	The identification and use of identifiable local opinion leaders to promote good clinical practice.
Audit and feedback	A summary of health workers' performance over a specified period of time, given to them in a written, electronic or verbal format. The summary may include recommendations for clinical action.
Tailored interventions	Interventions to change practice that are selected based on an assessment of barriers to change, for example through interviews or surveys.
Incentives	Targeted financial incentives.
External funding	Financial contributions such as donations, loans, etc. from public or private entities from outside the national or local health financing system
Clinical practice guidelines	Clinical guidelines are systematically developed statements to assist healthcare providers and patients to decide on appropriate health care for specific clinical circumstances ^{(US IOM)^a} .
Monitoring performance of the delivery of healthcare	Monitoring of health services by individuals or healthcare organisations, for example by comparing with an external standard.
Continuous quality improvement	An iterative process to review and improve care that includes involvement of healthcare teams, analysis of a process or system, a structured process improvement method or problem solving approach, and use of data analysis to assess changes
Educational games	The use of games as an educational strategy to improve standards of care.
Pay for performance	Transfer of money or material goods to healthcare providers conditional on taking a measurable action or achieving a predetermined performance target, for example incentives for lay health workers.
The use of information/communication technology	Technology based methods to transfer healthcare information and support the delivery of care.
Inter-professional education	Continuing education for health professionals that involves more than one profession in joint, interactive learning
Managerial supervision	Routine supervision visits by health staff.
Length of consultation	Changes in the length of consultations
Procurement/distribution of supplies	Systems for procuring and distributing drugs or other supplies

^a United States Institute of Medicine.

across the studies were educational meetings ($n = 38$, 95%), educational materials ($n = 36$, 90%) and educational outreach visits ($n = 29$, 73%). Further implementation strategies included in the studies were local consensus processes ($n = 18$, 45%), local opinion leaders ($n = 15$, 38%) and audit and feedback ($n = 13$ (33%)).

3.3. Implementation outcomes reported

As reported in [Table 2](#), the most frequently reported implementation outcomes were fidelity ($n = 40$, 100%), penetration ($n = 19$, 48%) and adoption ($n = 13$, 33%). Reporting of the remaining five implementation outcomes was limited across included studies (appropriateness ($n = 11$, 28%), acceptability ($n = 8$, 20%), feasibility ($n = 8$, 20%), costs ($n = 3$, 8%) and sustainability ($n = 2$, 5%). Overall, studies addressing unhealthy diet and physical activity had a greater frequency of reporting implementation outcomes.

3.4. Study quality

Ninety-five percent ($n = 38$) of studies were considered to have high risk of performance bias, due to participants and research personnel not being blind to group allocation. Additionally, 60% ($n = 24$) of studies were considered to have high risk of detection bias, primarily due to the use of self-report measures ([Fig. 2](#)). For all other criteria such as selection bias, attrition bias and reporting bias, risk of bias was low or unclear for most trials.

4. Discussion

This review identified 40 trials, most of which were RCTs, conducted in schools, targeted dietary risks, and were not undertaken 'at-scale'. While a diverse range of implementation strategies were tested, the strategies were dominated by those that seek to improve the knowledge and skills of community organisational staff such as

educational meeting (i.e training) and resources, rather than strategies that seek to address organisational or environmental or outer setting impediments to implementation. As organisational and environmental barriers are frequently reported as impediments to the implementation of NCD prevention policies and interventions in community settings ([Seward et al., 2017](#); [Nathan et al., 2017](#)), greater testing of implementation strategies that seek to address such barriers is warranted.

Limited reporting of research methods within included manuscripts was a consistent challenge. A lack of detail regarding implementation strategies made classification difficult. Similarly, for many criteria information to assess risk of bias was reported insufficiently to enable a judgement and so was classified as unclear. Clear and transparent reporting of key methodological detail is critical for trial evidence to be accurately synthesised in systematic reviews and contribute to the collective evidence-base. Enhanced adherence to a recently published 'Standards for Reporting Implementation Studies statement' ([Pinnock et al., 2017](#)) may improve the reporting of future trials to address these limitations.

Interestingly, most trials reported outcomes related to both the impact of the implementation strategy on implementation outcomes, and health outcomes of the intervention (e.g. physical activity or dietary behaviours). The use of such 'hybrid' designs has been recommended as a means of better understanding implementation processes and effects, and of advance progression of the field ([Wolfenden et al., 2016c](#)). However, consistent with reviews of implementation trials in other settings ([Lau et al., 2015](#)), the findings of the study also suggest trials used a narrow range of potential implementation outcomes. Measures of acceptability, feasibility, costs, and sustainability were rarely reported. Similarly, little consideration was given to the potential for un-intended harms. These outcomes are important to health policy and practice deliberations regarding investment in NCD prevention interventions and provide a more comprehensive understanding of strategy impacts and opportunities for improvement ([Durlak and DuPre, 2008](#)). More frequent use of these measures,

Table 2
Characteristics of included studies from systematic reviews undertaken between August 2015 and July 2017.

		Unhealthy diet (n = 20)	PA ^a (n = 7)	Tobacco use (n = 3)	Risky alcohol intake (n = 1)	Unhealthy diet and PA ^a (n = 8)	Unhealthy diet, PA ^a and tobacco use (n = 1)	Total (n = 40) n (%)
Characteristic								
Setting	Schools	16	5	3	0	2	1	27 (68)
	Childcare centres	2	2	0	0	6	0	10 (25)
	Sporting clubs	2	0	0	1	0	0	3 (7)
Trial research design	RCT ^b /cluster RCT ^b	13	5	2	1	7	1	29 (73)
	Non-randomised	7	2	1	0	1	0	11 (27)
Hybrid design		8	3	0	1	4	1	17 (43)
Evidence-based intervention		17	6	3	1	7	0	34 (85)
Theory/framework	Implementation specific framework	5	0	0	0	0	0	5 (13)
	Other	8	5	2	1	5	0	21 (53)
Outcome measures to assess implementation fidelity	Questionnaire/log book	13	4	3	3	4	1	28 (70)
	Observation	5	3	0	0	3	1	12 (30)
	Administrative	7	0	0	0	0	0	7 (18)
Length to f/up ^c	6 months or less	0	1	0	0	1	0	2 (5)
	6–12 months	6	2	1	0	5	1	15 (38)
	> 12 months	14	4	2	1	2	0	23 (57)
Programs delivered at-scale i.e. > 50 units		5	1	1	0	1	0	8 (20)
Adverse effects reported		3	1	0	1	0	0	5 (13)
Strategy								
Educational meetings		18	7	3	1	8	1	38 (95)
Educational materials		17	7	2	1	8	1	36 (90)
Educational outreach visits		16	5	1	1	6	0	29 (73)
Local consensus processes		10	3	3	0	1	1	18 (45)
Local opinion leaders		7	5	1	1	0	1	15 (38)
Other strategy not covered by EPOC		8	4	0	0	2	1	15 (38)
Audit and feedback		5	3	1	0	4	0	13 (33)
Tailored interventions		8	1	0	0	0	1	10 (25)
Small incentives and grants		3	2	1	0	2	0	8 (20)
External funding		5	0	1	1	0	0	7 (18)
Clinical practice guidelines		5	0	0	0	0	0	5 (13)
Monitoring performance of the delivery		3	0	1	0	0	0	4 (10)
Continuous quality improvement		3	0	1	0	0	0	4 (10)
Educational games		1	0	0	0	0	1	2 (5)
Pay for performance		1	0	0	0	1	0	2 (5)
The use of information/communication technology		1	0	0	0	1	0	2 (5)
Inter-professional education		0	1	0	0	0	0	1 (3)
Managerial supervision		1	0	0	0	0	0	1 (3)
Length of consultation		0	1	0	0	0	0	1 (3) >
Procurement/distribution of supplies		1	0	0	0	0	0	1 (3)
Implementation outcomes								
Fidelity ^d		20	7	3	1	8	1	40 (100)
Penetration ^e		10	5	1	0	3	0	19 (48)
Adoption ^f		3	2	3	1	3	1	13 (33)
Appropriateness ^g		4	5	0	1	1	0	11 (28)
Acceptability ^h		2	4	0	0	2	0	8 (20)
Feasibility ⁱ		2	3	0	1	2	0	8 (20)
Costs ^j		2	0	0	1	0	0	3 (8)
Sustainability ^k		1	0	1	0	0	0	2 (5)

^a Physical activity.

^b Randomised control trial.

^c Follow-up.

^d Fidelity = delivered as intended.

^e Penetration = included any measure of intervention exposure (did not include study participation rates).

^f Adoption = the existence of a policy related to the targeted practice.

^g Appropriateness = perceived compatibility, suitability, usefulness.

^h Acceptability = satisfaction with the implementation strategy.

ⁱ Feasibility = utility, practicality.

^j Costs = implementation costs.

^k Sustainability = sustained use, maintenance or institutionalization of the practice/policy.

therefore, would strengthen the evidence base and its utility for policy and practice decision making.

To maximise the benefit of evidence based interventions, interventions need to be implemented with sufficient fidelity to retain their effectiveness and reach a large proportion of the population. Both small and large scale implementation trials provide useful evidence to develop the field of community based implementation. Achieving

implementation ‘at-scale’, however, presents unique challenges given resources, workforces and capacity constraints and may require the use of different implementation strategies (Centre for Epidemiology and Evidence et al., 2014). While implementation ‘at-scale’ is the intended goal of many large-scale NCD initiatives to improve population health (World Health Organization, 2014), interestingly, evaluation of implementation efforts ‘at-scale’ were not prevalent in the literature. Only

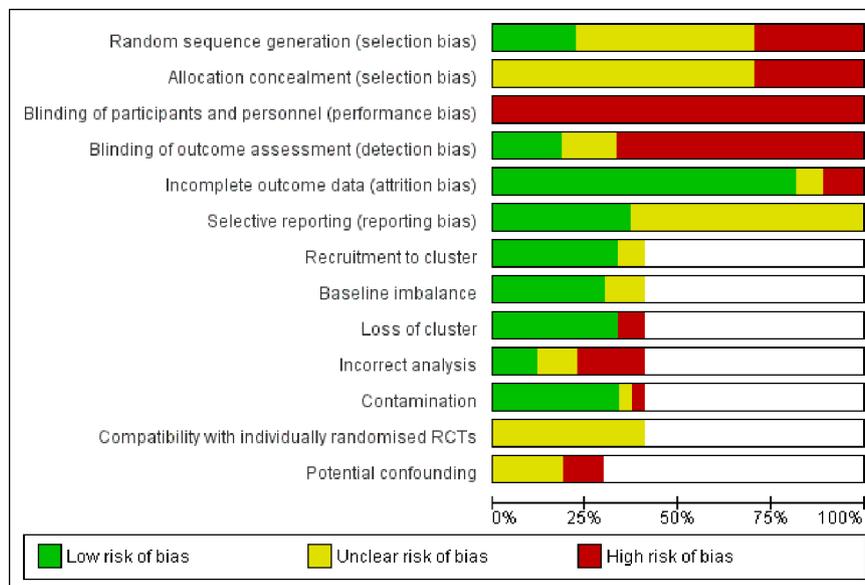


Fig. 2. Risk of bias summary of included studies (n = 40).

one in five trials identified in this study evaluated implementation of interventions conducted in > 50 community organisations. As the findings of small-scale implementation trials may not generalise to larger scale studies (Proctor et al., 2011) building the evidence base ‘at-scale’ should represent a future research priority. Developing research-practice partnerships to evaluate large scale implementation initiatives may represent one way of achieving this (Wolfenden et al., 2017b).

A number of limitations of the study require consideration when interpreting the findings. While the study was intended to provide an overview of research in the field, such broad characterisations can overlook important study details. For example, while the most frequently employed strategies were those related to educational meetings and materials, there was considerable heterogeneity between trials in the content, componentry and delivery of these strategies and the behaviour change strategies employed within. Such information could elucidate important gaps in the execution of past implementation strategies. The research was also restricted to selected community settings. The generalisability of the findings to other community settings is unknown.

5. Conclusion

Population health improvements are contingent upon evidence-based interventions being implemented ‘at-scale’ across entire populations. An evidence-base regarding how to best do so needs to be urgently developed. The findings of this study identify a range of opportunities to improve the implementation evidence base for community NCD prevention.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpmed.2018.11.014>.

Conflict of interest

All authors declare no financial relationships with any organizations that might have an interest in the submitted work in the previous five years; no other relationships or activities that could appear to have influenced the submitted work.

Financial disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

- Birken, S.A., Powell, B.J., Shea, C.M., Haines, E.R., Kirk, M.A., Leeman, J., Rohweder, C., Damschroder, L., Presseau, J., 2017. Criteria for selecting implementation science theories and frameworks: results from an international survey. *Implement. Sci.* 12 (1), 124 (Dec).
- Centre for Epidemiology and Evidence, Milat, A.J., Newson, R., King, L., 2014. Increasing the scale of population health interventions: a guide. In: *Evidence and Evaluation Guidance Series, Population and Public Health Division*. NSW Ministry of Health, Sydney.
- Curran, G.M., Bauer, M., Mittman, B., Pyne, J.M., Stetler, C., 2012. Effectiveness-implementation hybrid designs: combining elements of clinical effectiveness and implementation research to enhance public health impact. *Med. Care* 50 (3), 217 (Mar).
- Durlak, J.A., DuPre, E.P., 2008. Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. *Am. J. Community Psychol.* 41 (3–4), 327–350 (Jun 1).
- Effective Practice and Organisation of Care (EPOC), 2015. EPOC Taxonomy. Available from: <https://epoc.cochrane.org/epoc-taxonomy>.
- Higgins, J.P.T., Green, S. (Eds.), 2011. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0*. The Cochrane Collaboration [updated March 2011]. www.cochrane-handbook.org.
- Ivers, N.M., Grimshaw, J.M., 2016. Reducing research waste with implementation laboratories. *Lancet* 388 (10044), 547–548 (Aug 6).
- Lau, R., Stevenson, F., Ong, B.N., Dziedzic, K., Treweek, S., Eldridge, S., Everitt, H., Kennedy, A., Qureshi, N., Rogers, A., Peacock, R., 2015. Achieving change in primary care—effectiveness of strategies for improving implementation of complex interventions: systematic review of reviews. *BMJ Open* 5 (12), e009993 (Dec 1).
- Lim, S.S., Vos, T., Flaxman, A.D., et al., 2013. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380 (9859), 2224–2260 (Jan 4).
- Matheson, G.O., Klügl, M., Engebretsen, L., et al., 2013. Prevention and management of non-communicable disease: the IOC consensus statement, Lausanne 2013. *Br. J. Sports Med.* 47 (16), 1003–1011 (Nov 1).
- McFayden, T., Kheng Chai, L., Wyse, R., et al., 2018. Strategies to improve the implementation of policies, practices or programs in sporting organisations targeting poor diet, physical inactivity, obesity, risky alcohol use or tobacco use – a systematic review. *BMJ Open*, 8e019151. <https://doi.org/10.1136/bmjopen-2017-019141>.
- Mendis, S., 2014. *Global Status Report on Noncommunicable Diseases*. World Health Organization, Geneva.
- Milat, A.J., Bauman, A.E., Redman, S., Curac, N., 2011. Public health research outputs from efficacy to dissemination: a bibliometric analysis. *BMC Public Health* 11 (1), 934 (Dec 1).
- Nathan, N., Elton, B., Babic, M., McCarthy, N., Sutherland, R., Presseau, J., Seward, K., Hodder, R., Booth, D., Yoong, S., Wolfenden, L., 2017. Barriers and facilitators to the implementation of physical activity policies in schools: a systematic review. *Prev. Med.* 107 <https://doi.org/10.1016/j.jpmed.2017.11.012>. 11.
- Nilsen, P., 2015. Making sense of implementation theories, models and frameworks. *Implement. Sci.* 10, 53.
- Pinnock, H., Barwick, M., Carpenter CR for the StaRI Group, et al., 2017. Standards for Reporting Implementation Studies (StaRI): explanation and elaboration document. *BMJ Open* 7, e013318. <https://doi.org/10.1136/bmjopen-2016-013318>.
- Proctor, E., Silmere, H., Raghavan, R., Hovmand, P., Aarons, G., Bunger, A., Griffey, R., Hensley, M., 2011. Outcomes for implementation research: conceptual distinctions,

- measurement challenges, and research agenda. *Adm. Policy Ment. Health Ment. Health Serv. Res.* 38 (2), 65–76 (Mar 1).
- Proctor, E.K., Powell, B.J., McMillen, J.C., 2013. Implementation strategies: recommendations for specifying and reporting. *Implement. Sci.* 8 (1), 139 (Dec).
- Seward, K., Finch, M., Yoong, S.L., Wyse, R., Jones, J., Grady, A., Wiggers, J., Nathan, N., Conte, K., Wolfenden, L., 2017. Factors that influence the implementation of dietary guidelines regarding food provision in centre based childcare services: a systematic review. *Prev. Med.*
- WHO, 2013. *Global Action Plan for Non Communicable Diseases 2013–2020*. World Health Organization, Geneva.
- Wolfenden, L., Milat, A.J., Lecathelinais, C., et al., 2016a. A bibliographic review of public health dissemination and implementation research output and citation rates. *Prev. Med. Rep.* 4, 441–443 (Dec 31).
- Wolfenden, L., Jones, J., Williams, C.M., et al., 2016b. Strategies to improve the implementation of healthy eating, physical activity and obesity prevention policies, practices or programmes within childcare services. *Cochrane Database Syst. Rev.* 10, CD011779.
- Wolfenden, L., Williams, C.M., Wiggers, J., Nathan, N., Yoong, S.L., 2016c. Improving the translation of health promotion interventions using effectiveness–implementation hybrid designs in program evaluations. *Health Promot. J. Austr.* 27 (3), 204–207 (Dec).
- Wolfenden, L., Nathan, N., Sutherland, R., et al., 2017a. Strategies for enhancing the implementation of school-based policies or practices targeting risk factors for chronic disease. *Cochrane Database Syst. Rev.*(11), CD011677.
- Wolfenden, L., Yoong, S.L., Williams, C.M., et al., 2017b. Embedding researchers in health service organizations improves research translation and health service performance: the Australian Hunter New England Population Health example. *J. Clin. Epidemiol.* 85, 3–11.
- World Health Organization, 2014. *Global Status Report on Noncommunicable Diseases*. Geneva. .