

RESEARCH PAPER



Application of quality improvement approaches in health-care settings to reduce missed opportunities for childhood vaccination: a scoping review

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ABSTRACT

Missed opportunities for vaccination (MOV) is a poor reflection of the quality of care for children attending health facilities. It also contributes to a reduction in overall immunization coverage. Although there is a growing interest in the use of quality improvement (QI) in complex health systems to improve health outcomes, the degree to which this approach has been used to address MOV is poorly understood. We conducted a scoping review using Arksey and O'Malley's framework to investigate the extent to which QI has been used in health facilities to reduce MOV. The review followed five stages as follows: (1) identifying the research question; (2) identifying the relevant studies; (3) selecting the studies; (4) charting data; and (5) collating, summarizing, and reporting results. The search strategy included electronic databases and gray literature. A total of 12 literatures on QI projects focused on addressing MOV were identified. Eleven were published manuscripts, and one was a conference presentation. All the QI projects published were conducted in the United States and majority were between 2014 and 2018. In these projects, 45 change ideas targeting providers, clients, and health system were used. This study generated important evidence on the use of QI in health facilities to reduce MOV. In addition, the result suggests that there is a growing interest in the use of this approach to address MOV in recent years. However, no literature was found in low- and middle-income countries especially sub-Saharan Africa.

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Introduction

Immunization is one of the most effective and cost-effective public health interventions for preventing morbidity and mortality from common childhood infectious diseases.^{1–3} In addition to averting deaths, immunization also improves long-term productivity and has positive ecological externalities.⁴ As a result childhood immunization is considered a priority child health service in health facilities.⁵ Despite this, many children who are eligible for vaccination often make contact with health services and are still missed by the immunization sub-system thus resulting in missed opportunities for vaccination (MOV).⁶ This MOV can occur during health care visits for curative or preventive services.^{6,7} Its prevalence in low- and middle-income (LMIC) countries is estimated to be 32.2%.⁶ A recent review on MOV among African children from 14 countries found a pooled prevalence of 27.26%.⁸ In the same study, the complexity of MOV was highlighted.⁸ Using complex adaptive systems lens, it was shown that interrelated and interdependent factors which originate from multiple stakeholders including caregivers, health workers as well as health systems managers are responsible for MOV.⁸ According to the World Health Organization,

MOV contributes to a further reduction in childhood immunization coverage level at district and national level.⁹ Its impact on this important public health indicator has reinvigorate WHO's interest in address it across health systems.⁹

Quality improvement (QI), which originated from industrial manufacturing, has emerged as one of the main approaches for improving health outcomes within complex health systems.^{10–13} This is because QI methodologies enable the use of multicomponent interventions concurrently to institute change at multiple levels and allows experiential learning.^{12,14,15} Within the context of immunization programs, QI would differ from general implementation activities designed to improve uptake of immunization. This is because QI process would involve specific activities like baseline data collection, testing iterative cycles of intervention packages to improve immunization uptake, brainstorming on progress, and periodic reflections on the change packages supported by continuous data collection on the outcome of interest which can then be used to inform modifications. Several QI models exist; however, the most commonly used are Model for Improvement (MFI), lean, and six sigma.^{16–20} MFI is a hybrid of two frameworks: total quality management

(TQM) and rapid cycle improvement (RCI).²¹ It uses plan-do-study-act (PDSA) cycles to test change ideas.²¹ Lean and six sigma are somewhat similar; however, lean is concerned with reducing wastage, while six sigma focuses on reducing process variation.²² Lean six sigma is an integration of the two models which focuses on defect prevention and is usually used when wastage and process variation coexists.²³

At core, QI entails process change with resultant variation in outcomes.^{10,11} It has been used in health facilities in high-income countries to improve neonatal and child health outcomes.²⁴⁻²⁶ Similarly, there is also evidence of its use to strengthen health systems in LMIC.²⁷ Studies conducted in Rwanda, Ghana, and Nigeria have demonstrated the impact of QI on maternal health outcomes.²⁸⁻³⁰ However, there is scarcity of information on how QI has been applied within the immunization system to reduce MOV.

Therefore, in this study, we explored the extent to which QI has been used to address MOV using a scoping review methodology.³¹ We adopted Arksey and O'Malley's framework for conducting scoping review.³¹ The review followed five stages as follows:¹ identifying the research question²; identifying the relevant studies³; selecting the studies⁴; charting data; and⁵ collating, summarizing, and reporting results.³¹ For this study, we defined a scoping review as a research synthesis technique for mapping literature on a particular field of study or topic to identify key concepts and gaps so as to inform further research, as well as policy and practice.³²

We chose to use a scoping review method as we intend to explore the degree to which QI has been applied in health-care setting to reduce MOV, rather than sum up available evidence on the effect of QI on MOV.³³ This review methodology is as transparent as a systematic review as it employs rigorous approaches to identify literature that are relevant to a research question.³³ It is suitable for broad questions that would likely combine diverse literature.³³ Using a scoping review will enable us to identify different types of change ideas for reducing MOV that have been used to broadly target stakeholders such as caregivers, health workers and health systems.³³ Our study filled existing knowledge gap by presenting a broad descriptive overview of the application of QI in health-care setting to reduce MOV. This study is relevant for researchers as it highlighted the nature and characteristics of available literature on the topic. It is also relevant for health practitioners and policy makers that are planning to use QI approach within their setting to address this problem. This scoping review was conducted before embarking on a QI project in primary health-care facilities in a resource constrained setting.

The objectives of this study were as follows:

- a. To map and describe existing literature on QI projects to reduce MOV within the context of routine childhood immunization.
- b. To identify the QI models, change ideas, and study designs used in QI projects to reduce MOV within the context of routine childhood immunization.

Results

A total of 12 publications met the eligibility criteria for this review. The total number of publications that were assessed for eligibility is 19, and 7 were excluded as shown in Figure 1. In two of the excluded studies, the focus was on general pediatric care.^{34,35} Others focused on immunization coverage.³⁶⁻⁴⁰ The electronic databases search yielded nine publications. Manual search of the reference list of eligible publication yielded an additional two publications. While the gray literature search yielded one conference presentation. No publication was obtained from the organizations that were contacted.

Description of the characteristics of included publications

The country affiliation of all the first authors included in this review was the United States of America (USA). Their type of institutional affiliation varies with 50% affiliated with a university. Majority of included literature were published in the last 5 y (2014–2018). Other bibliometric characteristics of the publications are shown on Table 1.

QI interventions

Most of the QI projects that were conducted covered routine childhood immunization, while four focused solely on human papillomavirus (HPV) vaccine. In one of the projects, the age group of the target population for HPV vaccine extended till 26 y. This extension to 26 y of age is a function of United States recommendations for catch-up immunization for women who did not receive HPV vaccine as adolescents. In one of the projects, a QI intervention was instituted in a primary care clinic in Denver to reduce MOV among children up to 25 months of age.⁴¹ This clinic is in an inner-city teaching hospital that serves low-income families.⁴¹ Three difference change ideas chart prompts, provider education, and provider reminders were implemented.⁴¹ The change ideas targeted nurses and clinicians.⁴¹ Details of each literature with the vaccines and target population are presented on Table 2. Although all the QI projects were implemented within a health facility the level of health care vary across studies.⁴¹⁻⁵¹ The context within which these QI projects were implemented also varies from one another.⁴¹⁻⁵¹ One of the QI practices was implemented within a health center in an urban public university.⁴² In another study, the QI practice was implemented in a clinic that serves mainly low-income families.⁴¹

In all the QI projects conducted, QI teams implemented multiple change ideas (interventions) targeting various levels of stakeholders.⁴¹⁻⁵¹ The change ideas were about evenly divided between provider- and patient-focused strategies with few cross-cutting strategies. In Table 3, all the compiled change ideas are classified according to their level of influence.

QI models, methods, and study designs

In three of the reviewed publications, continuous quality improvement (CQI) model was used.^{44,48,49} Only one publication reported

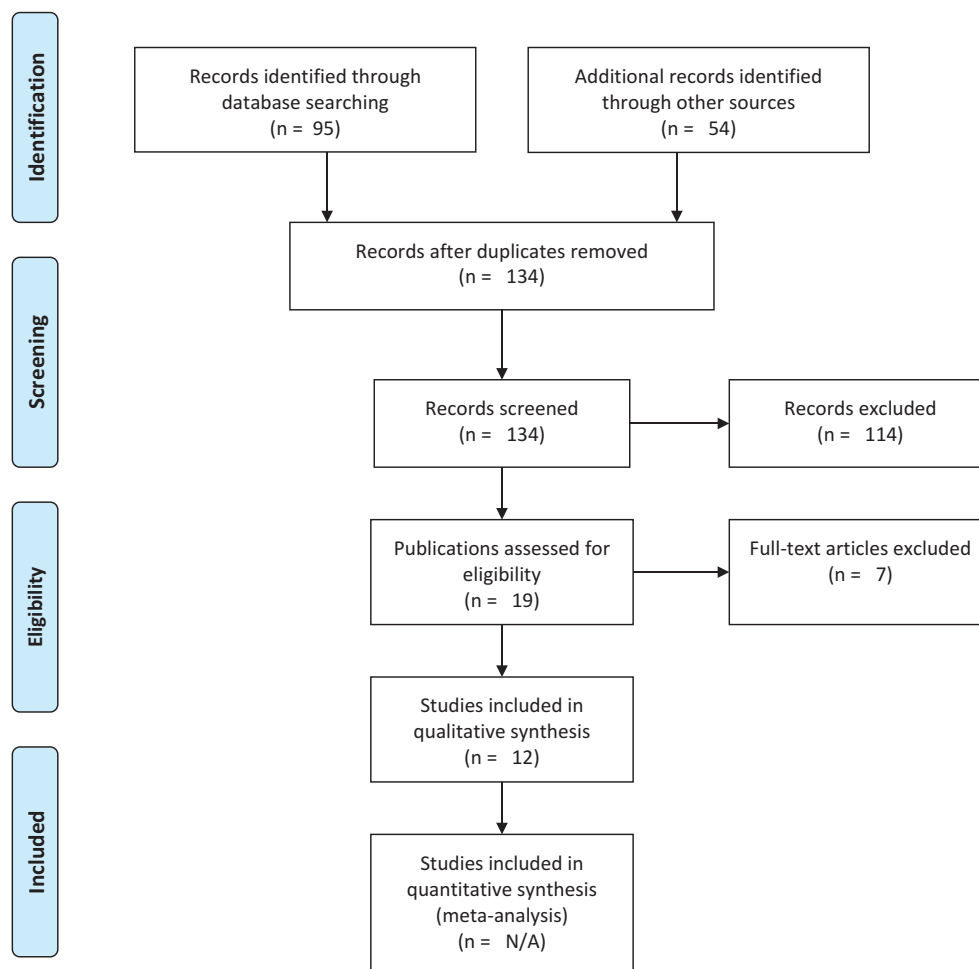


Figure 1. Adapted PRISMA flow chart.

Table 1. General features of publications on use of quality improvement to address missed opportunities for childhood vaccination.

Characteristics	Frequency	Percentage
Year of publication		
1999–2003	2	16.67
2004–2008	1	8.33
2009–2013	0	
2014–2018	9	75.00
Country affiliation		
United States of America	12	100
Others	0	
Publication type		
Published literature	11	91.67
Conference proceedings	1	8.33
Type of institutional affiliation of first author		
University	5	41.67
Hospital	4	33.33
Government agency	3	25.00

the use of collaborative QI model.⁴⁷ The use of PDSA as the method for QI was reported in four studies.^{43,44,47,48} In all the publications QI practice was implemented by QI teams.^{41–51} In the QI projects identified, quasi experimental designs like pre-post design, before and after studies, and time series designs were used to evaluate the effect of the interventions.^{41,44–49}

Discussion

Summary of results

We embarked on this scoping review to explore the extent to which QI has been used to address MOV within the context of routine childhood immunization. Our objective was to map and describe existing literature, and identify the QI models, change ideas, and study designs used in QI projects. Our search for published and gray literature yielded 12 publications (11 published literature, and 1 conference presentation). Based on the charted information from these publications, we found that all the QI projects were implemented in the United States and majority of them were conducted between 2014 and 2018. In the QI projects implemented, multicomponent change ideas were used. We identified 45 change ideas across all the projects and classified them into three namely interventions for providers, interventions for clients, and cross-cutting interventions. It was beyond the ambit of this scoping review to conduct an evaluation of the methodological quality of individual studies included.

Table 2. Target population and vaccine(s) targeted in quality improvement practices to address missed opportunities for vaccination.

Authors	Study title	Target population	Vaccine(s)
Published literature			
Daley, M. F., et al.	Quality improvement in immunization delivery following an unsuccessful immunization recall ⁴¹	Children aged 3–35 months	All routine immunization
Daly, K. L., et al.	A University Health Initiative to Increase Human Papillomavirus Vaccination Rates ⁴²	Young adults aged 18–26 y	Human papillomavirus (HPV) vaccine
Fiks, A. G., et al.	Improving HPV Vaccination Rates Using Maintenance-of-Certification Requirements ⁴³	Adolescents aged 11–17 y	Human papillomavirus (HPV) vaccine
Jones, K. B., et al.	Improving Immunizations in Children: A Clinical Break-even Analysis ⁴⁴	Children aged 3 y and below	All routine immunization
Krantz, L., et al.	Increasing HPV Vaccination Coverage Through Provider-Based Interventions ⁴⁵	Adolescents aged 13–17 y	Human papillomavirus (HPV) vaccine
Moore, K. L., et al.	Tennessee's 3-Star Report: Using Available Data Systems to Reduce Missed Opportunities to Vaccinate Preteens ⁴⁶	Adolescents aged 11–13 y	Tetanus-diphtheria-pertussis vaccine (Tdap), Quadrivalent meningococcal vaccine (Men-ACWY), and Human papillomavirus (HPV) vaccine
Rand, C. M., et al.	A Learning Collaborative Model to Improve Human Papillomavirus Vaccination Rates in Primary Care ⁴⁷	Adolescents aged 11–17 y	Human papillomavirus (HPV) vaccine
Jones, K. B., et al.	Improving pediatric immunization rates: description of a resident-led clinical continuous quality improvement project ⁴⁸	Children aged 3 y and below	All routine immunization
Sinn, J. S., et al.	Improving immunization rates in private pediatric practices through physician leadership ⁴⁹	Children aged 9–30 months	All routine immunization
Melinkovich, P., et al.	Improving pediatric immunization rates in a safety-net delivery system ⁵⁰	Children aged 3 y and below	All routine immunization
Carlin, E., et al.	Using Continuous Quality Improvement Tools to Improve Pediatric Immunization Rates ⁵¹	Children aged 2 y and below	All routine immunization
Conference presentation			
Gurov, Heidi	Assessment-Feedback-Incentive-Exchange (AFIX) Overview(73)	Children below 35 months of age, and adolescents aged 13–17 y	All routine immunization

Strengths and limitations of the study

A key strength of this review is that we employed a rigorous and transparent search strategy to identify existing literature on the use of QI to address MOV. In addition, we did not restrict our search to any language, date of publication or document type. Some limitations of this review should also be considered. Despite the comprehensiveness of our search strategy, we cannot conclude that we found all the publications due to the broad nature of QI as a field of practice. It is still possible that we missed some papers. We were also unable to obtain publications and reports from organizations engaged in QI projects for immunization, as such, it is possible that other non-public literature exist that have not been included in this review.

QI and MOV

Our study confirms the emerging interest in QI as majority of identified literature were published between 2014 and 2018. As practitioners increasingly understand and begin to view MOV from the complexity lens, a further rise in the use of QI to address it might occur. However, the overall volume of QI projects to address MOV, which is a health-care quality issue with substantial population health implications, was low. Furthermore, all the identified publications were for projects conducted in the United States. Although global organizations such as the WHO recognize the role of QI in health systems, its use in immunization systems in LMIC to reduce MOV seems low.⁵² Many factors including paucity of skills to conduct and report QI interventions or failure to publish QI projects might be contributing to this.

Authors of the publications included in this review reported the use of multiple change ideas which is

consistent with the science of improvement.¹⁰ While some of these change ideas are targeted at providers, others focus on clients and the system, thus enabling a multipronged approach. However, the process of selection of these change ideas were rarely described enough to enable replication in other settings. In a resident-led clinical QI project to improve immunization rate, third year residents engage immunization stakeholders to implement a set of activities.⁴⁸ These activities include printing daily immunization reports, distributing them to health-care providers and discussion about immunization with parents and guardians.⁴⁸ However, it is unclear how the residents arrived at these choice of change ideas.⁴⁸

Most of the QI projects reviewed reported only the QI outcome measure and this practice is inconsistent with current guidance on QI in health care.⁵³ It is essential to include and report on process and balancing measures as well.⁵³ Process measures will enable QI practitioners to track whether the system is performing as planned.⁵³ While balancing measure will allow tracking of the influence of the QI project on other parts of the system.⁵³ Balancing measures are particularly important as it will provide information on whether the change ideas causing improvement in one unit, is decreasing a desirable outcome in others. In addition to these measures, more recent improvement models have also included implementation outcomes.⁵⁴

Due to the “real world” context within which QI are implemented, quasi experimental designs are sometimes more feasible.⁵⁵ As expected, most of the publications reported the use of these study designs. However, it is important to consider additional design features to these quasi-experimental designs or conduct pragmatic or hybrid trials to improve confidence in the effect measure attributed to QI interventions.⁵⁶⁻⁵⁹

Table 3. Classification of quality improvement interventions (change ideas) used in quality improvement projects to address missed opportunities for vaccination.

Interventions for providers	Interventions for clients	Cross-cutting interventions
Place registry-generated copy of child's immunization data on front of chart at every visit ⁴¹	Providing a strong recommendation for vaccination at every visit ⁴²	Improve record keeping by keeping immunization history current ⁴⁹
Make notation on clinician encounter form whenever child is due to visit ⁴¹	Using patient reminder systems ⁴²	Record keeping ⁵¹
Educate providers regarding methods for reducing missed opportunities ⁴¹	Implementing campus-based marketing strategies ⁴²	Developing an immunization registry to track patients ⁵⁰
Place reminder posters prominently in clinic ⁴¹	Use of consistent language to recommend HPV vaccine ⁴³	
Prevent missed opportunities to vaccinate by increasing provider acknowledgement of vaccine history ⁴²	Provider emphasizing the vaccine as a tool for cancer prevention ⁴³	
Distributing immunization records for all scheduled pediatric patients to provider medical-assistants teamlets ⁴⁴	Provider emphasizing the vaccines at acute visits ⁴³	
Educational seminar on HPV for physicians, residents, nurses, and medical assistants ⁴⁵	Mailing letters to caregivers of children under 3 years of age providing information on reasons for immunization and encourage them to make appointment to obtain missing immunizations ⁴⁴	
Weekly individualized audit to providers who missed an opportunity to vaccinate a patient against HPV ⁴⁵	Administering all recommended vaccines at the same visit ⁴⁶	
Allowing staffs to schedule their HPV visits ⁴⁵	Making strong recommendations for vaccines ⁴⁶	
Support staffs indicating to providers when client is HPV vaccine eligible ⁴⁵	Discussing the need for immunizations with caregivers at that day's visit ⁴⁸	
"Best practice alert" for HPV in EMR ⁴⁵	Use all clinical encounter to screening at every visit ⁴⁹	
Electronic reminders using Huddle ⁴⁵	Administer immunization at some sick visits ⁴⁹	
Auditing and feedback ⁴⁶	Administer immunization at any opportunity ⁴⁹	
Providers were trained on offering a strong recommendation for HPV vaccination ⁴⁷	Using only true contraindication to immunization ⁴⁹	
Practices implemented provider prompts and/or standing orders and/or reminder/recall if desired ⁴⁷	Simultaneous administration of multiple vaccines ⁴⁹	
Provide monthly feedback on missed opportunities for vaccination to assess their progress ⁴⁷	Administering DTP at 12 or 15 months instead of 18 months ⁴⁹	
Teach residents about the principles of FOCUS-PDSA through didactic lecture ⁴⁸	Recommendations pertained to missed opportunities ⁵¹	
Printing daily report with the immunization record for that day's pediatric patients ⁴⁸	Encourage parents to bring immunization record to all clinic visits ⁴⁹	
Algorithms for catch-up of patients not on schedule or with incomplete immunizations ⁵¹	Educating parents even when refusal occur ⁷³	
Conducting regular assessment of immunization levels with provision of clinic-specific feedback ⁵⁰		
Holding team-based quality improvement meetings ⁵⁰		
Use of standing orders on immunization in clinics ⁷³		
Training of health care providers ⁷³		

HPV: human papilloma virus; EMR: Electronic Medical Record; FOCUS-PDSA: Find Organize Clarify Understand Select-Plan Do Study Act.

Implications for research

In view of our findings, we recommend more research. Our research recommendations, which follow the EPICOT+ format, are presented in Box 1.⁶⁰

We recommend the use of standardized guidance such as Standards for Quality Improvement Reporting Excellence – SQUIRE 2.0 to report future studies.⁶¹ This would greatly enhance the sharing of best practices. Also, researcher and practitioners can place related gray literature on repositories that are accessible to wide range of audience.

Methodology

A review team was established comprising of the principal investigator and three supervisors with expertise in research synthesis, epidemiology, and vaccinology.⁶² The team deliberated upon and agreed on the broad research question to be addressed as well as the review protocol.

Stage 1: identify the research question

The scoping review question was, "What is the nature and extent of use of QI approaches in health facilities to reduce missed opportunities for vaccination within the context of routine childhood immunization?" Due to the broad nature of this review question, with its main focus on mapping existing literature, a systematic review would not be appropriate.⁶³ Since emerging consensus on knowledge synthesis methodologies have made clearer the applicability of a broad range of other methods, we used this to inform our choice of scoping review methodology to answer this question.^{64,65}

Since routine childhood immunization for children extend to those in the adolescent age group, they were included as part of the population of interest.⁶⁶ The detailed population intervention comparator and outcome (PICO) elements for the review question are shown in Box 2.

For this study, we adopted the Cochrane Effectiveness Practice and Organization of Care (EPOC) group's definition of QI as "an iterative process to review and improve

Box 1. Use of EPICOT+ to highlight research recommendations based on gaps identified in a scoping review on the use of quality improvement to address missed opportunities for vaccination.

Element	Recommendation(s) Core elements
Evidence (State of evidence)	Existing quality improvement projects for addressing missed opportunities for vaccination among children were conducted in the United States.
Population (Population of interest)	Quality improvement projects addressing missed opportunities for vaccination targeting; <ol style="list-style-type: none"> Children in low- and middle-income countries especially in sub-Saharan Africa HIV exposed infants Children in internally displaced persons camps Children in hard to reach areas Children in urban areas (slums and non-slums) Adolescents including those in LMICs
Interventions	<ol style="list-style-type: none"> Quality improvement projects with multiple change ideas targeted at different stakeholders that are systematically selected from evidence-based innovation or generated de-novo by health-care workers in quality improvement teams. Collaborative quality improvement projects encompassing the attributes of (a) above.
Comparisons outcomes	Control (non-intervention) health facilities <ol style="list-style-type: none"> Proportion of missed opportunities for vaccination disaggregated by vaccines and vaccine doses. Process outcomes to measure how the quality improvement interventions were delivered Balancing outcome to assess the effect of quality improvement on other program areas Implementation outcomes such as acceptability, adoption, appropriateness, fidelity, feasibility, cost, penetration and sustainability
Time stamp	July 2018
Study type	Optional element Quasi experimental design (Interrupted time series design with non-equivalent control groups), pragmatic trials and implementation-effectiveness hybrid trials.

care that includes the involvement of health-care teams, analysis of a process or system, a structured process improvement method or problem-solving approach, and use of data analysis to assess change”.⁶⁷ Since our interest is in routine childhood immunization, the following antigens were considered: Bacillus Calmette-Guerin (BCG), hepatitis B, Polio, Diphtheria-Tetanus-Pertussis containing vaccine, *Haemophilus influenzae type b*, pneumococcal (conjugate), rotavirus, measles, rubella, and HPV.⁶⁶ Other antigens such as yellow fever, Japanese encephalitis, tick-borne

Box 2. PICO elements for scoping review question.

Population	Children and adolescents
Intervention	Quality improvement
Comparator	Usual practice
Outcome	Proportion, frequency or percentage of missed opportunities for vaccination
Study setting	Health facilities

encephalitis, typhoid, cholera, meningococcal, hepatitis A, rabies, dengue, mumps, seasonal influenza, and varicella that are indicated for children under certain conditions like place of residence, type of population, and immunization program were also considered.⁶⁶

Stage 2: identifying relevant studies

To identify literature (published and unpublished) appropriate for answering the research question, we employed a search strategy involving:

- (1) Three³ electronic databases and manual search of reference lists of relevant studies
- (2) Google search
- (3) Contacting networks and organizations involved in QI

Electronic databases

Three³ electronic databases: PubMed, Scopus, and Web of Science were searched on 4th July 2018 on the Internet. These databases were selected to ensure a comprehensive inclusion of all published literature. To ensure that all possible publications were found, date, language, or document type restrictions were not specified during database search. Using the research question, we developed the following search terms: “quality improvement”, “implementation strategy”, “implementation process”, “Plan do study act”, “define measure analyze improve control”, “define measure analyze improve control”, “define measure analyze design verify”, “define measure analyze design verify”, “lean six sigma”, “immunization”, “missed opportunities”, “infant”, “childhood”, “teenager”, and “adolescent” among others. These search terms are keywords that combine QI with missed opportunities for vaccination in children and adolescent. The search terms were tailored to each database. Detailed search strategy developed with input from an information specialist is attached as Appendix. All citations exported from databases were imported to Endnote X7.7.1. While on the reference manager, duplicate of citations were removed. The reference list of the selected manuscripts was also manually searched to identify any relevant paper that reported the use of QI approach to address missed opportunities for vaccination.

Grey literature

Advanced Google search using the following URL: https://www.google.com/advanced_search was implemented to identify gray literatures that are relevant to the review question.⁶⁸ The keywords that were used for electronic database search were also applied. The search filters were left at their default setting so as to include results in any language, from any geographical region, and without data limits among others. Since Google search has the tendency to produce high search volume, we limited our search to the first 50⁴⁷ results.⁶⁹

Networks and organizations

Experts at the American Academy of Pediatrics were contacted by email with a request for any published or

unpublished report on the use of QI approaches to address missed opportunities for vaccination among children. The use of QI practices is part of the academy's mission of ensuring high standards of health for children.⁷⁰

Stage 3: study selection

A set of eligibility criteria with inclusion and exclusion criteria were developed while preparing the protocol to help in removing studies that did not answer the review question. It was agreed that these eligibility criteria can be modified post hoc as the authors become more familiar with the studies.

Inclusion criteria were as follows:

- a. All literature reporting a QI approach aimed at reducing missed opportunities for vaccination for children and adolescents.
- b. Vaccines that are used for routine immunization
- c. QI approaches implemented in a health facility setting

Exclusion criteria were as follows:

- a. QI aimed at improving immunization rate in high-risk children with deficient immune system
- b. QI approaches implemented within a community setting

After identifying relevant literature, two authors independently screened the titles and abstracts of all publications obtained from the electronic databases. If the studies broadly described the use of QI in a health facility setting to reduce missed opportunities for vaccination, its full text was retrieved. There was no masking of reviewers involved in the screening to author name or journal. It was agreed *a priori* that the full text of publications without abstracts will automatically be considered. The prespecified inclusion and exclusion criteria were applied to the full text of the publications to identify the "best fit". The assistance of librarians at the medicine and health sciences library of Stellenbosch University, South Africa, was sought to help retrieve articles that were published in journals that the university did not subscribe to. It was also agreed that if full text could not be retrieved, then abstract can be used. During the study selection, the two reviewers resolved any disagreements through discussion. Figure 1 is a four-phased flow diagram from identification through inclusion.⁷¹ The Google search results were also screened by the two authors.

Stage 4: charting the data

Two authors independently charted key information from the included publications. An Excel spreadsheet was used for this purpose. The charting approach used was similar to that of a narrative review as we obtained information about the QI projects.⁷² The recorded information is presented in Table 4.

Table 4. Key information charted and their description.

Information	Description
<i>General characteristics</i>	
ID	Identifier of the publication
Year of publication	Year of publication of the document
Country	Location of institution of the first author
Type of publication	Type of document
Language	Language of publication
<i>Setting and target population</i>	
Level of health-care	Category of health facility where the quality improvement project was implemented
Context	Setting in which the quality improvement project was conducted
Target population	Individuals whom the quality improvement was meant to have an impact on
Age group of target population	Age category of the individuals targeted in the quality improvement project
<i>Quality improvement process</i>	
Quality Improvement (QI) strategy	The strategies that were used during the quality improvement project
Quality Improvement (QI) team	People responsible for implementing the quality improvement project
Quality Improvement (QI) model	Theoretical framework or model of the quality improvement project
Quality Improvement (QI) method	Process of iterative implementation of the quality improvement activities
Vaccines	Antigens that were targeted

Stage 5: collating, summarizing, and reporting the results

Charted information was collated using Microsoft Excel 2016. Same software was used for coding the data. Analysis was done using Microsoft Excel as well. Number of published literatures over the study periods were calculated. Descriptive statistics (frequency and percentage) of country affiliation, language of publication, publication type, and institutional affiliation of authors was also calculated. Vaccines targeted in each QI interventions were presented.

Conclusion

This scoping review identified and described the extent of current publications on use of QI approach to address MOV. There is a growing interest in the use of QI to improve health outcomes, and this was also observed for MOV. Given that only few publications were found, all of which were conducted in the United States, buttresses the need for this systematic appraisal of currently available literature. No published or gray literature was found in LMIC especially sub-Saharan Africa.

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Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the authors.

Contributors

AAA conceptualized the study, drafted the review protocol, conducted the literature search, screened publications and charted data, conducted

the data analysis and interpretation, and wrote the first draft of the manuscript. CSW, OAU, MAG reviewed and approved the protocol, contributed to data analysis and interpretation, manuscript development and approved the final manuscript. EOW screened publication and charted of data and contributed to manuscript development.

Ethics approval

Not applicable

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APPENDIX

PUBMED

(infant[mh] OR infant[tiab] OR infants[tiab] OR infancy[tiab] OR toddler* [tiab] OR preterm*[tiab] OR prematur*[tiab] OR postmatur*[tiab] OR baby[tiab] OR babies[tiab] OR neonat*[tiab] OR newborn[tiab] OR pre-school*[tiab] OR pre-school*[tiab] OR child[mh] OR child*[tiab] OR kindergar*[tiab] OR pupil*[tiab] OR schoolchild*[tiab] OR teen*[tiab] OR youth[tiab] OR youths[tiab] OR youngster*[tiab] OR young person*[tiab] OR young people[tiab] OR minors[mh] OR minors[tiab] OR puberty[mh] OR puberty[tiab] OR pubescen*[tiab] OR prepubescen*[tiab] OR paediatric*[tiab] OR pediatric*[tiab] OR peadiatric*[tiab] OR schools[mh:noexp] OR school*[tiab] OR kid[tiab] OR kids[tiab] OR boy*[tiab] OR girl*[tiab] OR creche*[tiab] OR highschool*[tiab] OR "secondary school"[tiab] OR juvenil*[tiab] OR adolescent[mh] OR adolescen*[tiab])

AND

quality improvement[mh] OR (quality[tiab] AND (system*[tiab] OR process*[tiab] OR improvement*[tiab] OR enhancement*[tiab] OR strateg*[tiab] OR intervention*[tiab] OR management[tiab])) OR implementation strateg*[tiab] OR implementation process*[tiab]

OR

Plan do study act[tiab] OR plan do check act[tiab] OR define measure analyze improve control[tiab] OR define measure analyse improve control[tiab] OR define measure analyse design verify[tiab] OR define measure analyze design verify[tiab] OR lean six sigma[tiab]

AND

Immunization[mh] OR immuni*[tiab] OR vaccin*[tiab] OR revaccin*[tiab] OR innoculat*[tiab] OR inoculat*[tiab]

AND

Missed[tiab] AND opportunit*[tiab]

WEB OF Science (1970–2018)

ts = (infant OR toddler* OR preterm* OR prematur* OR baby OR babies OR neonat* OR newborn OR preschool* OR pre-school* OR child OR child*OR kindergar* OR pupil* OR schoolchild* OR teen* OR youth OR youths OR youngster* OR young person* OR young people OR minors OR minors OR puberty OR pubescen* OR prepubescen* OR paediatric*) OR pediatric* OR peadiatric* OR kid OR boy* OR girl* OR creche* OR highschool* OR "secondary school" OR juvenil* OR adolescent OR adolescen*)

AND

ts = ("quality improvement" OR "quality system*" OR "quality network*" OR "quality process*" OR "quality improvement*" OR "quality enhancement*" OR "quality strateg*" OR "quality intervention*" OR "quality management" OR "implementation strategy*" OR "implementation process*")

OR

ts = ("Plan do study act" OR "plan do check act" OR "define measure analyze improve control" OR "define measure analyse improve control" OR "define measure analyse design verify" OR "define measure analyze design verify" OR lean OR "six sigma")

AND

ts = (Immunization OR immuni* OR vaccin* OR revaccin* OR innoculat* OR inoculat*)

AND

ts = ("missed opportunities for vaccination" OR "missed opportunities for immunization" OR Missed near/3 opportunit*)

SCOPUS

TITLE-ABS-KEY ("quality improvement" OR "quality system*" OR "quality network*" OR "quality process*" OR "quality improvement*" OR "quality enhancement*" OR "quality strateg*" OR "quality intervention*" OR "quality management" OR "implementation strategy*" OR "implementation process*" OR "Plan do study act" OR "plan do check act" OR "define measure analyze improve control" OR "define measure analyse improve control" OR "define measure analyse design verify" OR "define measure analyze design verify" OR lean OR "six sigma")

TITLE-ABS-KEY (infant OR toddler* OR preterm* OR prematur* OR baby OR babies OR neonat* OR newborn OR preschool* OR pre-school* OR child OR child*OR kindergar* OR pupil* OR schoolchild* OR teen* OR youth OR youths OR youngster* OR young person* OR young people OR minors OR minors OR puberty OR pubescen* OR prepubescen* OR paediatric*) OR pediatric* OR peadiatric* OR kid OR boy* OR girl* OR creche* OR highschool* OR "secondary school" OR juvenil* OR adolescent OR adolescen*)

TITLE-ABS-KEY (Immunization OR immuni* OR vaccin* OR revaccin* OR innoculat* OR inoculat*)