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An Analysis of National Institutes of Health-Funded Dissemination and Implementation Research in Low- and Middle-Income Countries

Amina Chtourou[1] · Elise M. Garton[1] · Gila Neta[2]

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Abstract

Implementation science can inform healthcare delivery to improve outcomes in resource-constrained settings through tailored strategies. The National Institutes of Health funds implementation science largely through its Dissemination and Implementation Research in Health program. We analyzed the program's grants with collaborators in low- and middle-income countries to understand trends and gaps in National Institutes of Health-funded global implementation science research. Query-View-Report was used to identify grants awarded between fiscal years 2013–2022 with at least one collaborating institution in a low- and middle-income country. Two coders reviewed the abstract and specific aims to determine the intervention being studied, setting, implementer, implementation outcomes, strategies, frameworks, and study design. From fiscal years 2013–2022, 81 grants had collaborating institutions across 25 low- and middle-income countries in five World Bank-defined regions, funded by 11 National Institutes of Health institutes and centers. Most grants focused on cancer ($n=12$), other non-communicable diseases ($n=16$), and tuberculosis ($n=12$). Common implementation outcomes included costs ($n=43$), fidelity ($n=38$), maintenance ($n=36$), and adoption ($n=35$). Commonly studied implementation strategies included assess for readiness and identify barriers and facilitators ($n=18$), revise professional roles ($n=17$), and change service sites ($n=15$). Frequently reported frameworks were RE-AIM ($n=30$), CFIR ($n=22$), and EPIS ($n=8$). Most grants tested implementation strategies using experimental study designs ($n=52$) in healthcare settings ($n=56$). The National Institutes of Health funds a range of implementation science grants with collaborators in low- and middle-income countries. This analysis helps identify commonly utilized implementation outcomes, strategies, and frameworks and enables exploration of gaps and opportunities for further global research.

Keywords Global health · Implementation science · Implementation research · Dissemination research · Low-and middle-income countries (LMICs)

Abbreviations

NIH	National Institutes of Health
TMFs	Theories, models, and frameworks
LMICs	Low-and middle-income countries
RE-AIM	Reach, Effectiveness, Adoption, Implementation, and Maintenance
EPIS	Exploration, Preparation, Implementation, Sustainment
CFIR	Consolidated Framework for Implementation Research
ERIC	Expert Recommendations for Implementing Change

Through implementation science, researchers and practitioners in the U.S. and globally aim to build a knowledge base to help bridge the gap between research and healthcare practice and address health disparities (Kerkhoff et al., 2022). Implementation science seeks to develop and test strategies that can improve the efficiency and timeliness of delivering evidence-based interventions in real-world settings through a focus on increasing their adoption, integration, sustainment, and scale-up, in turn improving health outcomes. Further, implementation science can inform the feasible

✉ Amina Chtourou
amina.chtourou@nih.gov

[1] Center for Global Health, National Cancer Institute, Rockville, MD, USA

[2] Division of Cancer Control and Population Sciences, National Cancer Institute, Rockville, MD, USA

and sustainable use of healthcare resources in resource-constrained settings, which are particularly prevalent in low- and middle-income countries (LMICs) (Alonge et al., 2019; Theobald et al., 2018).

The National Institutes of Health (NIH) has supported implementation science through the Dissemination and Implementation Research in Health Program Announcements since 2006 (National Institutes of Health, 2022a, 2022b, 2022c). This program has served as a primary funding mechanism for implementation science and, as of April 2024, includes support from 23 NIH institutes, centers, and offices. This study catalogues and analyzes Dissemination and Implementation Research in Health-funded implementation science grants in LMICs. It builds upon previous analyses (Neta et al., 2021; Tinkle et al., 2013; Villalobos et al., 2023) of NIH-funded implementation science grants which are focused on specific health areas or topics within implementation science but lack a global focus. This portfolio analysis aims to assess trends and gaps in the NIH-funded implementation science portfolio across all participating institutes, centers, and offices by examining the use of theories, models, and frameworks (TMFs), implementation strategies, study designs, and implementation outcomes as well as contextual factors (e.g., setting and implementers) applied to research in LMICs. This analysis also explores differences in the use of implementation strategies between health areas and interventions. By examining implementation studies across the agency, we can identify opportunities for shared learning across disease states and interventions. This study can serve as a baseline for analyses of NIH-funded global implementation science (the Dissemination and Implementation Research in Health funding announcement has been re-issued and the program will continue in 2025 (National Institutes of Health, 2024b)) and can inform other funders' program development and evaluation efforts.

Methods

NIH's internal grant reporting database, Query-View-Report, was used to identify extramural awards based on the following criteria: funded by a Dissemination and Implementation Research in Health program Funding Opportunity Announcement, active in at least one year between fiscal years 2013 and 2022 (to include the last year of available data and most recent complete fiscal year in Query-View-Report at the time of data collection), and funded by any NIH institute, center, or office. If a project extended over multiple years, only the most recent award was included in the analysis. The initial search resulted in 281 Dissemination and Implementation Research in Health grants funded between fiscal years 2013 and 2022.

Of the 281 grants, 178 grants were excluded from this analysis because they did not have at least one foreign collaborating institution. Foreign collaborating institutions were defined as collaborating sites in any non-U.S. country documented in the Foreign Award and Component Tracking System used by NIH (National Institutes of Health, 2024a). Twenty-two additional grants were subsequently excluded since they did not have at least one foreign collaborating institution in an LMIC as defined by the World Bank (2023) (inclusive of low-income, lower-middle income, and upper-middle income countries). Grants with foreign collaborating institutions in high-income countries were included if they also had at least one foreign collaborating institution in an LMIC. Six supplements and amendments were identified as non-unique awards and excluded from the final portfolio. Figure 1 depicts exclusion criteria and the final number of grants for review. Collaborating institution names were edited for clarity and consistency using the Global Research Identifier Database and NIH Dimensions to produce standardized institution names when possible, using Microsoft Excel and Python.

A codebook was developed in the NIH internal platform, *iSearch*, to extract data on the following: evidence-based interventions, settings, implementers, implementation strategies tested, implementation outcomes, TMFs, and study designs. Table 1 shows the description, field type, field options, and data source for each variable in the codebook. Field options were based on previously published portfolio analyses and drew upon the implementation science literature. TMFs were derived from reviews of Tabak et al. (2012) and Nilsen (2015), strategies were based on the Expert Recommendations for Implementing Change (ERIC) strategies (Powell et al., 2015), and outcomes were based on a review from Proctor et al. (2011) and from Glasgow, Vogt, and Bole's RE-AIM framework (Glasgow et al., 1999).

Full-text abstract and specific aims of each grant were reviewed in *iSearch*. There were three total coders, and two coders per grant to extract information from the abstract and specific aims into the codebook. Grants could be coded to multiple implementation outcomes, strategies, TMFs, settings, and implementers. Strategies were coded only if they were tested, not only referenced, and were categorized into one of the ERIC strategies based on coder interpretation. Coding discrepancies were reconciled by the two initial coders in discrepancy discussions and finalized in *iSearch* once agreed upon. If the two coders could not reach a consensus, the third coder resolved the discrepancy during ad hoc discrepancy discussions. After interventions were coded using free text, interventions were categorized into ten overarching intervention categories which were further separated into 27 more specific focus areas. Categorization of interventions were original to this project and were not

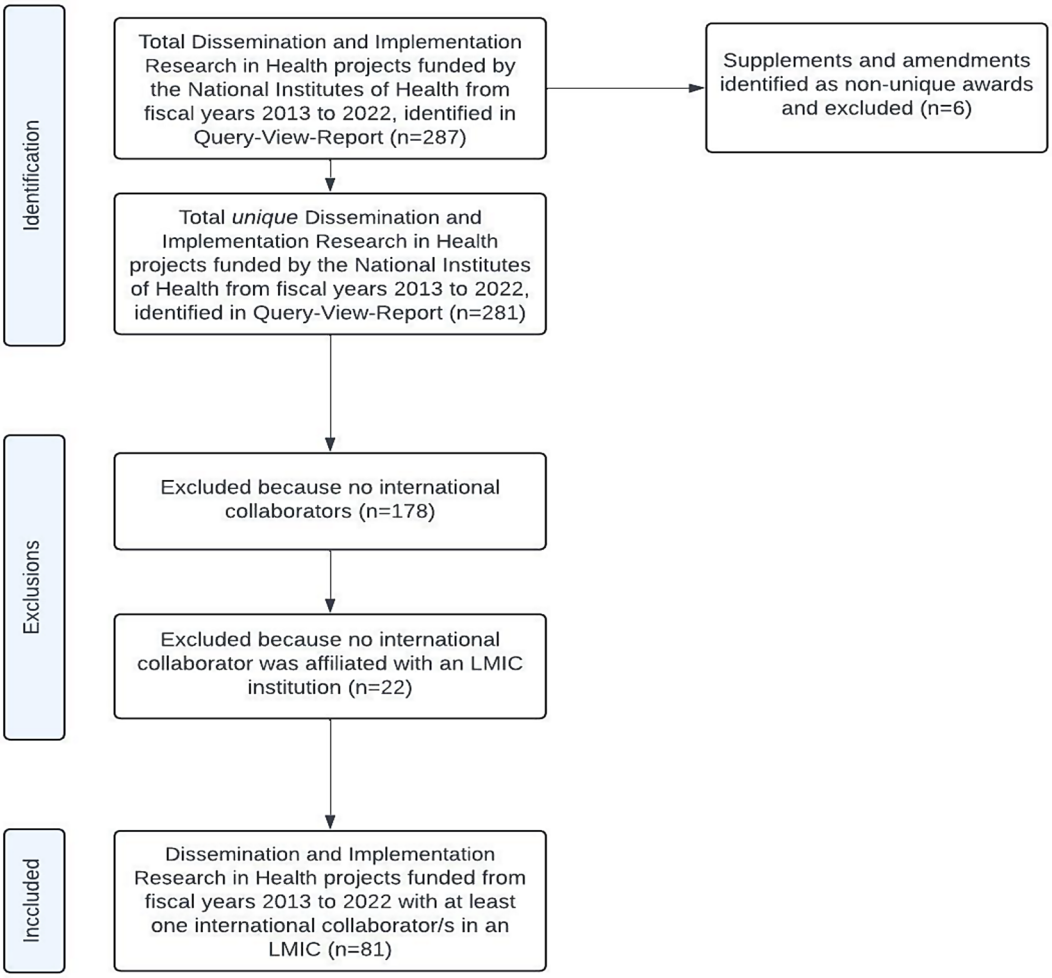


Fig. 1 Diagram of Dissemination and Implementation Research in Health portfolio analysis exclusions

based on a standardized implementation science approach, but rather disease categories, natural groupings, and discussions among coders. Intervention categories are mutually exclusive. Descriptive analyses were conducted in Microsoft Excel on the exported data from *iSearch*.

Results

The final Dissemination and Implementation Research in Health portfolio of grants active between fiscal years 2013 and 2022 with at least one collaborator in an LMIC consisted of 81 grants funded by 11 different NIH institutes, offices, or centers. Over half of the grants were active in the most recent three years, between fiscal years 2020 and 2022. Figure 2 shows the distribution of active grants over the ten-year period by funding mechanism. The 81 grants were initiated between fiscal year 2011 and fiscal year 2022 with all grants covering one grant activity category: "R" grants, or research projects. Fifty-seven of the research project grants were R01s (research projects), 19 were R21s (exploratory/developmental grants), and five were R03s (small research grants). Two R01s were follow-up grants to previously funded R21 grants.

Of the 81 grants in the portfolio, more than half received funding from three institutes: National Institute of Allergy and Infectious Disease ($n=20$), National Cancer Institute ($n=18$), and National Heart, Lung, and Blood Institute ($n=14$). Institutes fund implementation science for a variety of disease areas and types of interventions. Grants primarily examined interventions related to tuberculosis ($n=12$), HIV/AIDS ($n=11$), cancer ($n=12$), and other non-communicable diseases ($n=16$). The number of grants coded to each intervention category and intervention focus area is shown in Table 2.

Table 1 Codebook for analysis of Dissemination and Implementation Research in Health grants in LMICs, fiscal years 2013–2022

Study characteristic	Description	Field type	Field options	Data source
Intervention	Intervention being implemented or disseminated	Free text	N/A	N/A
Setting	Space in which the intervention is delivered	Multi-select	Healthcare, community-based organization, health department, recreation area, school, workplace, electronic, not specific, other	N/A
Implementer	Description of those delivering the intervention	Multi-select and free text	Clinic support staff, healthcare provider, lay health professional, not applicable, not stated, public health official, school personnel, or other	N/A
Implementation outcomes	Implementation outcomes measured in the study to evaluate the implementation and/or dissemination of the intervention	Multi-select	Acceptability, Acceptance, Adoption, Appropriateness, Awareness, Change in attitudes, Costs, Feasibility, Fidelity, Penetration, Reach, Receipt, Scale-up, Speed, Sustainability/Maintenance, None, Other	Proctor et al. (Proctor et al., 2011) and RE-AIM (Glasgow et al., 1999)
Strategies	Implementation strategies applied describing how an intervention is implemented	Free text	N/A	Expert Recommendations for Implementing Change (ERIC) Study (Powell et al., 2015)
Theories, models, or frameworks	Theories, models, or frameworks	Multi-select	ADAPT-ITT (Wingood & DiClemente, 2008), Conceptual Framework for Sustainability of Public Health Programs (Dearing) (Scheirer & Dearing, 2011), Consolidated Framework for Implementation Research (Damschroder et al., 2009), Diffusion of Innovations (Dearing & Cox, 2018), Diffusion of Innovations in Service Organizations (Greenhalgh) (Greenhalgh et al., 2004), Dynamic Sustainability Framework (Chambers et al., 2013), EPIS (Moullin et al., 2019), Framework by Shediac-Rizkallah and Bone (Shediac-Rizkallah & Bone, 1998), Framework of public health program capacity for sustainability (Schell, Luke) (Schell et al., 2013), Interactive Systems Framework (Wandersman et al., 2008), Organizational Theory of Innovation Implementation (Weiner et al., 2008), PARIHS (Kitson et al., 1998), PRECEDE/PROCEED (Crosby & Noar, 2011), PRISM (McCreight et al., 2019), Proctor's Implementation Outcomes Framework (Proctor et al., 2011), Program Sustainability Assessment Tool (Luke et al., 2014), RE-AIM (Glasgow et al., 1999), None, and Other	*See "Field Options" column*
Study design	Study design used to test the implementation strategy	Multi-select	Experimental, modeling, pre-post, design, quasi-experimental, case study, observational, or other	N/A

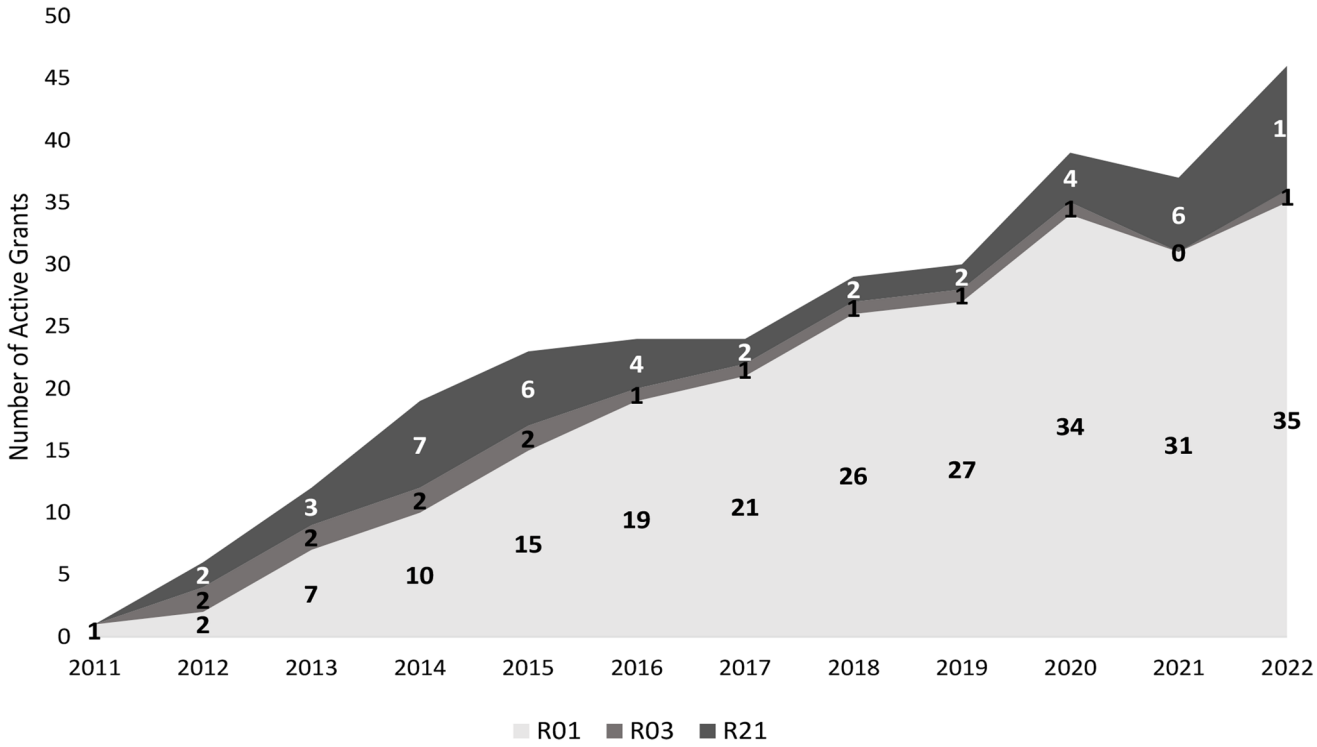


Fig. 2 Dissemination and Implementation Research in Health active grants by fiscal year and activity code

Principal Investigator and Collaborating Institutions in LMICs

Of the 81 grants, five were direct awards to principal investigators at foreign institutions and the remaining 76 were awards to U.S. institutions with foreign collaborating institutions. Direct awards funded institutions in Uganda ($n=2$), South Africa, Argentina, and Peru. Grants included collaborators at 238 institutions in 25 LMICs, and eight grants had collaborating institutions in multiple LMICs. Countries collaborating on the most grants were Kenya ($n=14$), South Africa ($n=11$), Uganda ($n=8$), India ($n=6$), and Mozambique ($n=5$); all collaborating institution countries are shown in Fig. 3.

Implementation Science Characteristics

Grants were coded for implementation strategies tested, TMFs used, and implementation outcomes assessed. Seventy-five grants tested a specific implementation strategy. Of these that referenced a specific strategy, 22 ERIC strategies were used in total. Studies most frequently used the following strategies: "assess for readiness and identify barriers and facilitators" ($n=18$; 22%), "revise professional roles" ($n=17$; 21%), and "change services sites" ($n=15$; 19%) (Fig. 4).

Implementation strategies are stratified by intervention category in Table 3, with thirteen strategies with three or more grants per intervention category shown. Different intervention categories exhibited varying uses of some strategies. For example, HIV/AIDS studies frequently tested "change physical structure and equipment" ($n=4$) and "change service sites" ($n=3$) strategies. Other infectious disease research, which included malaria treatment and STD testing, was the only disease area testing "alter incentive/allowance structure." Grants studying behavioral health ($n=5$), tobacco and alcohol control ($n=4$), cancer ($n=3$), and other non-communicable disease ($n=3$) interventions used "revise professional roles" ($n=15$) often. Additionally, tobacco and alcohol control and injury studies were the only disease areas that did not use "assess for barriers and facilitators" as an implementation strategy.

Fifty seven grants referenced a specific TMF (70%). Of those that referenced a specific TMF, 10 TMFs were mentioned, with RE-AIM being most frequently mentioned ($n=30$; 37%) followed by Consolidated Framework for Implementation Research (CFIR) ($n=22$; 27%), EPIS ($n=9$; 11%), and Proctor's Implementation Outcomes Framework ($n=5$; 16%). An additional nine grants (11%) used other TMFs, and 24 grants (30%) did not reference a specific TMF (Fig. 5).

Lastly, 75 grants referenced a specific implementation outcome (93%). Of those that referenced a specific

Table 2 Number of grants by intervention category and intervention focus

Intervention category	Intervention focus	Number of grants by focus	Number of grants by category
Tuberculosis	Tuberculosis screening and treatment	12	12
HIV/AIDS	HIV/AIDS prevention and treatment	10	11
	Clinical practice guidelines	1	
Other infectious diseases	Malaria treatment	3	5
	STD testing	1	
	Male circumcision device	1	
Cancer	Cancer screening	10	12
	Survivorship	1	
	Non-specified cancer prevention	1	
Other non-communicable diseases	Hypertension	7	16
	Heart disease	5	
	Diabetes	3	
	Sickle cell anemia	1	
Tobacco and alcohol control	Tobacco control	7	8
	Alcohol control	1	
Behavioral health	Mental health treatment	5	8
	Youth mental health prevention	2	
	Measure development	1	
Maternal and child health	Sexual and reproductive health	1	6
	Neonatal mortality	1	
	Group antenatal care	1	
	Partner violence	1	
	Pediatric surgical safety	1	
	Pediatric traumatic brain injury	1	
Air pollution	Indoor air pollution	1	2
	Plastic waste burning	1	
Injury	Snakebite	1	1

outcome, 15 implementation outcomes were evaluated. The most common implementation outcomes were costs ($n=43$; 53%), fidelity ($n=38$; 47%), sustainability ($n=36$; 56%;), adoption ($n=35$; 43%), feasibility ($n=27$; 33%), reach ($n=27$; 33%), and acceptability ($n=26$; 32%) (Fig. 6). Six grants (7%) did not specify an implementation outcome.

Table 4 shows study designs, settings, and implementers on each of the 81 grants. Proposed study designs included experimental designs ($n=52$; 64%), observational designs ($n=21$; 26%), pre-post ($n=7$; 9%), quasi-experimental ($n=5$; 6%), and systems modeling ($n=1$; 1%). Research was primarily conducted in healthcare settings ($n=56$; 69%) by healthcare providers ($n=48$; 59%) though six other settings were used. Interventions were implemented or disseminated by lay health professionals ($n=20$; 25%), "other" implementers not listed in the original codebook ($n=15$; 19%), public health officials ($n=6$; 7%), school personnel ($n=6$; 7%), and clinic support staff ($n=5$; 6%). Four grants (5%) were not coded to a specified implementation settings and nine grants (11%) were not coded to a specific implementer.

Discussion

This analysis revealed that NIH-funded Dissemination and Implementation Research in Health grants in LMICs cover a variety of health areas and interventions using a range of methodological approaches. Interventions were most often related to tuberculosis, HIV, cancer, and other non-communicable diseases, which aligns with the high burden of these diseases in LMICs (Institute for Health Metrics and Evaluation, 2024). Additionally, Dissemination and Implementation Research in Health-funded research in LMICs has been growing, as shown by the increase in active grants during each consecutive year between fiscal years 2011 and 2022. This increase follows the trends of NIH grants with collaborations in LMICs more broadly (National Institutes of Health Office of Portfolio Analysis, 2024).

This study highlights key trends in implementation strategies referenced in Dissemination and Implementation Research in Health grant proposals. Among the 81 grants in this analysis, 22 ERIC strategies were identified across 75 grants. Only 10% of grants did not plan to test an implementation strategy, indicating that Dissemination and Implementation Research in Health-funded studies may intentionally include testing of implementation strategies in their research proposals. The common use of the strategy "assess for readiness and identify barriers and facilitators" suggests that a significant portion of Dissemination and Implementation Research in Health studies in LMICs are in exploratory stages of implementation science. Lovero and colleagues (2023) found similar results in a systematic review examining the use of ERIC strategies in 60 publications that were published through March 2023 and covered implementation science across all health areas conducted in LMICs (Lovero et al., 2023). That study also found a high volume of named ERIC strategies related to using evaluative and iterative strategies including "assess for readiness." Other predominant strategies in this analysis of Dissemination and Implementation Research in Health grants were those related to task-shifting, which include two ERIC strategies: "change services sites" and "revise professional roles."

ERIC strategies are used across a variety of disease areas and interventions. "Assess for readiness and identify barriers and facilitators" was coded for in almost all disease

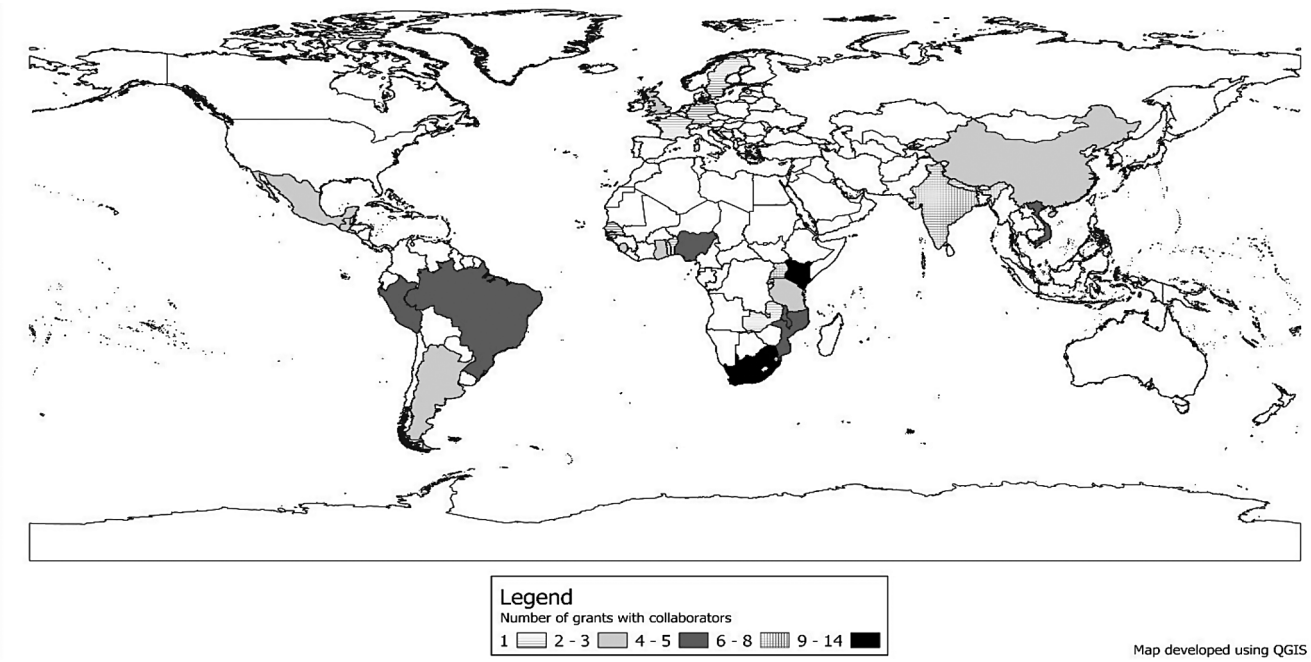
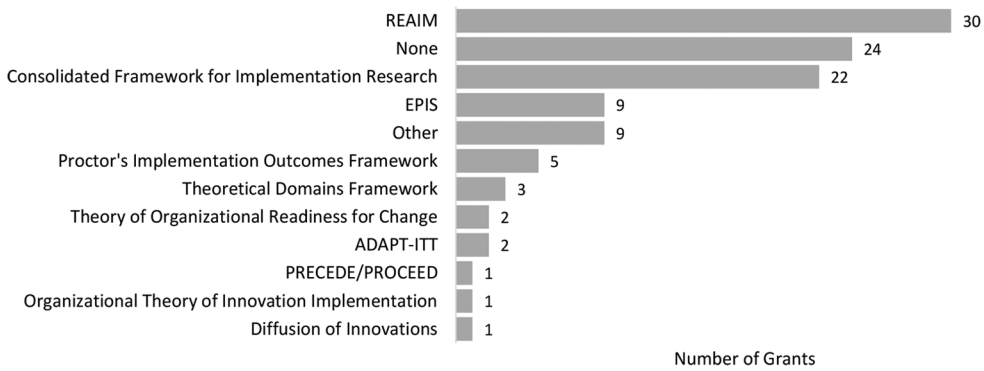


Fig. 3 Dissemination and Implementation Research in Health program grants with collaborating institutions in LMICs: collaborating site countries, fiscal years 2013-2022

Fig. 4 Implementation strategies of Dissemination and Implementation Research in Health grants with collaborators in LMICs, fiscal years 2013–2022



areas and interventions. However, compared to other disease areas, cancer, HIV/AIDS, and tobacco and alcohol control interventions infrequently used the strategy "assess for readiness and identify barriers and facilitators" indicating that perhaps the application of implementation science is more advanced in these interventions than in other disease areas. Task-shifting strategies are also prominent across most disease areas, with behavioral health and tobacco and alcohol control interventions relying heavily on the "revise professional roles" strategy. HIV/AIDS interventions more often employed "change service sites" and "change physical structure"; strategies that rely more on the physical movement of patients and medical supplies or changing infrastructure.

The prominence of task-shifting reflects the horizontal health system approach supported by policy guidance for health system strengthening in LMICs (World Health Organization, 2020). Task-shifting is often promoted to strengthen existing services and improve healthcare systems long-term by optimizing the use of already constrained resources (Mounier-Jack et al., 2017). United Nations guidance also promotes the integration of care (e.g. "change service sites" and "revise professional roles" strategies) for chronic diseases with primary healthcare services and with already existing healthcare programs such as HIV/AIDS, tuberculosis, and reproductive health (World Health Organization, 2020).

This portfolio analysis identifies primary strategies used in global implementation science, but further research is warranted to grow the knowledge base of existing implementation strategies, particularly in LMICs, and understand the implementation mechanisms of commonly used strategies. For example, future studies may explore how task-shifting may facilitate adaptation of an intervention and

Table 3 Number of grants that test specific implementation strategies by intervention category

Implementation strategy	Other non-communicable diseases	Tuberculosis	Cancer	HIV/AIDS	Behavioral health	Tobacco & alcohol control	Maternal & child health	Other infectious diseases	Air pollution	Injury
Assess for readiness and identify barriers and facilitators	5	3	1	1	3		2	2	1	
Revise professional roles	3	1	3	1	5	4				
Change service sites	2	3	3	3		2	1			1
Change physical structure and equipment		1	2	4			1			
None		2	2			1	1			
Facilitate relay of clinical data to providers	2	1		1	1					
Involve patients/consumers and family members	3							1	1	
Tailor strategies	2	1	1							
Create a learning collaborative			1		2				1	
Use train-the-trainer strategies	1				1	1			1	
Provide clinical supervision				1	2					
Conduct ongoing training	2				1					
Audit and provide feedback				1	1		1			
Alter incentive/allowance structures								3		

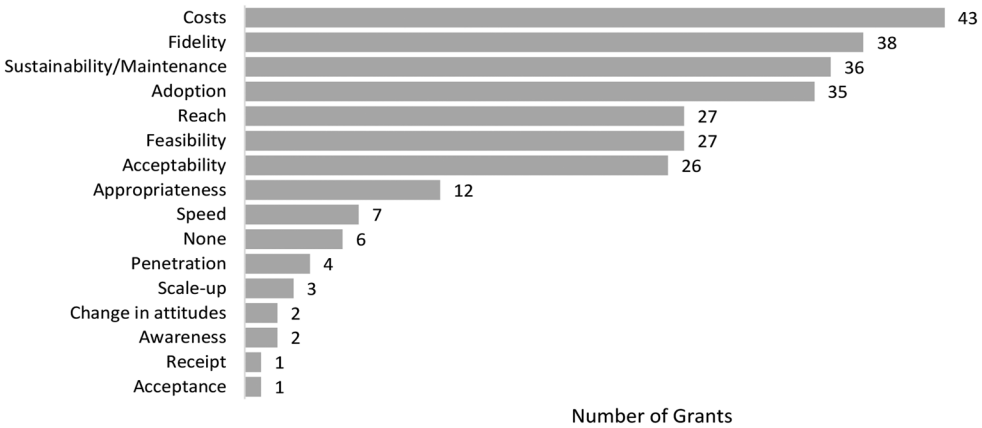


Fig. 5 Implementation science frameworks referenced in Dissemination and Implementation Research in Health grants with collaborators in LMICs, fiscal years 2013–2022

advance its implementation. Additional research should also seek to understand how these commonly identified strategies may be used to efficiently bundle care, integrate care into primary care settings, decentralize specialty care, and enhance patient retention across the continuum of care. Similar global implementation science research objectives were also identified in the National Cancer Institute's recently launched global implementation science initiative, Global Implementation Science for Equitable Cancer Control (National Institutes of Health, 2022).

Of the 73 ERIC strategies, 51 were not identified in any of the grants analyzed, suggesting these are underexplored in LMICs. Additional research is needed to further understand the use of implementation strategies and the suitability of the ERIC framework in LMICs. However, overall, very few funded grants did not test an ERIC strategy. Across disease areas and interventions within the portfolio, there was a broad distribution of ERIC strategies tested. These results highlight the great potential for cross-disciplinary collaboration and learning in the application of implementation strategies.

While an overwhelming majority of grants tested an implementation strategy, nearly 30% of grants did not specify a TMF, potentially illustrating either a gap in research

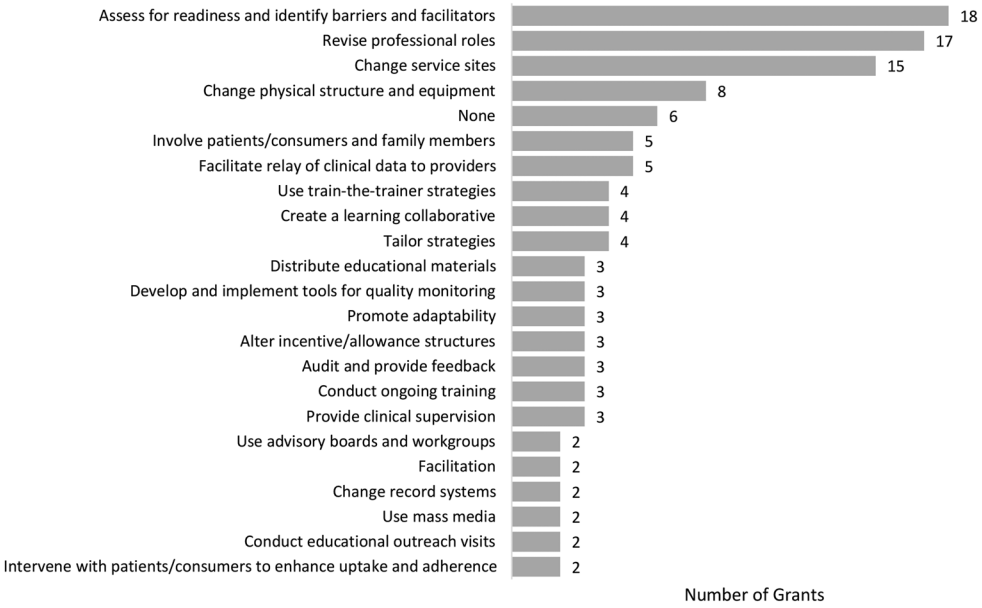


Fig. 6 Implementation outcomes of Dissemination and Implementation Research in Health grants with collaborators in LMICs, fiscal years 2013–2022

Table 4 Other characteristics of Dissemination and Implementation Research in Health grants with collaborators in LMICs, fiscal years 2013–2022

Implementation context	Number of grants (%)
Study design	
Experimental	52 (64)
Observational	21 (26)
Pre-post design	7 (9)
Quasi-experimental	5 (6)
Modeling	1 (1)
Setting	
Healthcare	56 (69)
Electronic	17 (21)
Other	15 (19)
Community-based organization	12 (15)
Health department	8 (10)
School	7 (9)
Not specified	4 (5)
Workplace	1 (1)
Implementer	
Healthcare provider	48 (59)
Lay health professional	20 (25)
Other	15 (19)
Not stated	9 (11)
Public health official	6 (7)
School personnel	6 (7)
Clinic support staff	5 (6)

methodology (e.g. a lack of knowledge on selection of an appropriate TMF), too many TMFs, or a lack of applicable TMFs in global implementation science. Although TMFs are proposed less often in grant applications compared to implementation strategies or outcomes, given that sixteen TMFs are identified in the codebook and 10 are identified across the grants, investigators are proposing to apply a range of TMFs. This indicates that TMFs are useful in LMIC settings. Additionally, nearly all grants included at least one implementation outcome. However, there is a clear gap in examining scale-up and receipt of interventions in implementation science. Future research may seek to prioritize the use of these implementation outcomes in their methodology.

Certain contextual factors across implementers and settings were more predominant than others across the grant portfolio. Interventions were implemented in healthcare settings by healthcare workers in over half the grants, resembling results from Lovero et al. (2023). Lay health professionals served as primary implementers of interventions, consistent with the substantial volume of interventions implemented in healthcare facilities and community-based organizations. System-level settings outside healthcare institutions and community-based organizations, such as schools, were often not identified as an implementation setting. The distribution of implementation settings suggests that there remain opportunities to explore implementation of evidence-based health interventions across a range of settings, as appropriate, and which can further enhance reach and inform scale up.

This study has several limitations. It includes only grants funded by the Dissemination and Implementation Research in Health program and does not cover implementation science funding through other NIH mechanisms or outside NIH. However, the Dissemination and Implementation Research in Health program is the predominant funding opportunity for NIH implementation science studies, so should capture a representative sample of investigator-initiated implementation science. Additionally, coders reviewed the abstracts and specific aims submitted in the grant proposal, which

may differ from the actual research conducted after investigators received funding. Another limitation is that due to lack of common terminology in the field of implementation science, there may have been misclassification of strategies and outcomes despite mitigation efforts described in the methods section. Furthermore, implementation characteristics and contexts may have been undercounted since coding was restricted to abstract and specific aims and did not include the research strategy.

Conclusions

This study shows that through the Dissemination and Implementation Research in Health program, NIH funds a variety of implementation science with collaborators in LMICs, and the number of grants has increased from fiscal years 2011 to 2022. There are a range of outcomes, strategies, and TMFs used in implementation science in LMICs. In particular, implementation strategies were tested in the majority of grants, with a range of strategies used across disease areas. Some strategies were more commonly explored than others across health foci, underscoring an opportunity to understand their broader generalizability, such as readiness and task-shifting, across a range of settings and disease areas. However, gaps remain highlighting an opportunity for new studies that seek to explore strategies for scale-up as well as studies to understand factors that influence implementation pace. This portfolio analysis provides a comprehensive summary of the Dissemination and Implementation Research in Health program in low- and middle-income countries and can inform future research priorities.

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Author Contributions AC: Conceptualization, Methodology, Formal analysis, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration. EMG: Conceptualization, Methodology, Software, Formal analysis, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration. GN: Conceptualization, Methodology, Formal analysis, Writing – original draft preparation, Writing – review and editing, Supervision.

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Data Availability Details of grants included in this analysis are available on NIH Reporter. Additional data requests can be directed to the corresponding author.

Declarations

Ethical Approval Ethical approval was not required for this study.

Consent to Participate There are no human participants in this article and informed consent is not required.

Consent for Publication Not applicable.

Competing Interests The Authors declare that there is no conflict of interest. Portions of these findings were presented as a poster at the 16th Annual Conference on the Science of Dissemination and Implementation in Health.

References

Alonge, O., Rodriguez, D. C., Brandes, N., Geng, E., Reveiz, L., & Peters, D. H. (2019). How is implementation research applied to advance health in low-income and middle-income countries? *BMJ Global Health*, *4*(2), e001257. https://doi.org/10.1136/bmjgh-2018-001257

Chambers, D. A., Glasgow, R. E., & Stange, K. C. (2013). The dynamic sustainability framework: Addressing the paradox of sustainment amid ongoing change. *Implementation Science*, *8*(1), 117. https://doi.org/10.1186/1748-5908-8-117

Crosby, R., & Noar, S. M. (2011). What is a planning model? An introduction to PRECEDE-PROCEED. *Journal of Public Health Dentistry*, *71*, s1. https://doi.org/10.1111/j.1752-7325.2011.00235.x

Damschroder, L. J., Aron, D. C., Keith, R. E., Kirsh, S. R., Alexander, J. A., & Lowery, J. C. (2009). Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. *Implementation Science*, *4*(1), 50. https://doi.org/10.1186/1748-5908-4-50

Dearing, J. W., & Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. *Health Affairs*, *37*(2), 183–190. https://doi.org/10.1377/hlthaff.2017.1104

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health*, *89*(9), 1322–1327. https://doi.org/10.2105/AJPH.89.9.1322

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of innovations in service organizations: Systematic review and recommendations. *The Milbank Quarterly*, *82*(4), 581–629. https://doi.org/10.1111/j.0887-378X.2004.00325.x

Institute for Health Metrics and Evaluation. (2024). *GBD compare*. IHME, University of Washington. https://vizhub.healthdata.org/gbd-compare/

Kerkhoff, A. D., Farrand, E., Marquez, C., Cattamanchi, A., & Handley, M. A. (2022). Addressing health disparities through implementation science—a need to integrate an equity lens from the outset. *Implementation Science*, *17*(1), 13. https://doi.org/10.1186/s13012-022-01189-5

Kitson, A., Harvey, G., & McCormack, B. (1998). Enabling the implementation of evidence based practice: A conceptual framework. *Quality and Safety in Health Care*, *7*(3), 149–158. https://doi.org/10.1136/qshc.7.3.149

Lovero, K. L., Kemp, C. G., Wagenaar, B. H., Giusto, A., Greene, M. C., Powell, B. J., & Proctor, E. K. (2023). Application of the Expert recommendations for Implementing Change (ERIC) compilation of strategies to health intervention implementation in low- and middle-income countries: A systematic review. *Implementation Science*, *18*(1), 56. https://doi.org/10.1186/s13012-023-01310-2

Luke, D. A., Calhoun, A., Robichaux, C. B., Elliott, M. B., & Moreland-Russell, S. (2014). The Program Sustainability Assessment Tool: A New Instrument for Public Health Programs. *Preventing Chronic Disease*, *11*, 130184. https://doi.org/10.5888/pcd11.130184

McCreight, M. S., Rabin, B. A., Glasgow, R. E., Ayele, R. A., Leonard, C. A., Gilmartin, H. M., Frank, J. W., Hess, P. L., Burke, R. E., & Battaglia, C. T. (2019). Using the practical, robust implementation and sustainability model (PRISM) to qualitatively assess multilevel contextual factors to help plan, implement, evaluate, and disseminate health services programs. *Translational Behavioral Medicine*, *9*(6), 1002–1011. https://doi.org/10.1093/tbm/ibz085

Moullin, J. C., Dickson, K. S., Stadnick, N. A., Rabin, B., & Aarons, G. A. (2019). Systematic review of the Exploration, Preparation, implementation, sustainment (EPIS) framework. *Implementation Science*, *14*(1), 1. https://doi.org/10.1186/s13012-018-0842-6

Mounier-Jack, S., Mayhew, S. H., & Mays, N. (2017). Integrated care: Learning between high-income, and low- and middle-income country health systems. *Health Policy and Planning*, *32*(suppl_4), iv6–iv12. https://doi.org/10.1093/heapol/czx039

National Institutes of Health (2024b). *Notice of Information: Reissuance of Notices of Funding Opportunity (NOFO) Dissemination and Implementation Research in Health*.https://grants.nih.gov/grants/guide/notice-files/NOT-CA-24-052.html

National Institutes of Health (2024a). *Foreign Award and Component Tracking System (FACTS) - Overview*. https://www.era.nih.gov/about-era/services-for-agency-staff/award-management/facts.htm

National Institutes of Health (2022). *RFA-CA-22-019 Global Implementation Science for Equitable Cancer Control*. https://grants.nih.gov/grants/guide/rfa-files/RFA-CA-22-019.html

National Institutes of Health (2022a). *DIRH Program PAR-22-105*. https://grants.nih.gov/grants/guide/pa-files/PAR-22-105.html

National Institutes of Health (2022b, May 9). *DIRH Program PAR-22-106*. https://grants.nih.gov/grants/guide/pa-files/PAR-22-106.html

National Institutes of Health (2022c, May 10). *DIRH Program PAR-22-109*. https://grants.nih.gov/grants/guide/pa-files/PAR-22-109.html

National Institutes of Health Office of Portfolio Analysis (2024). *World RePORT*. https://worldreport.nih.gov/wrapp/#/search?searchId=662698641a171a6207c29df2

Neta, G., Clyne, M., & Chambers, D. A. (2021). Dissemination and Implementation Research at the National Cancer Institute: A review of Funded studies (2006–2019) and opportunities to Advance the Field. *Cancer Epidemiology Biomarkers & Prevention*, *30*(2), 260–267. https://doi.org/10.1158/1055-9965.EPI-20-0795

Nilsen, P. (2015). Making sense of implementation theories, models and frameworks. *Implementation Science*, *10*(1), 53. https://doi.org/10.1186/s13012-015-0242-0

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., Proctor, E. K., & Kirchner, J. E. (2015). A refined compilation of implementation strategies: Results from the Expert recommendations for Implementing Change (ERIC) project. *Implementation Science*, *10*(1), 21. https://doi.org/10.1186/s13012-015-0209-1

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. *Administration and Policy in Mental Health*, *38*(2), 65–76. https://doi.org/10.1007/s10488-010-0319-7

Scheirer, M. A., & Dearing, J. W. (2011). An Agenda for Research on the Sustainability of Public Health Programs. *American Journal of Public Health*, *101*(11), 2059–2067. https://doi.org/10.2105/AJPH.2011.300193

Schell, S. F., Luke, D. A., Schooley, M. W., Elliott, M. B., Herbers, S. H., Mueller, N. B., & Bunger, A. C. (2013). Public health program capacity for sustainability: A new framework. *Implementation Science*, *8*(1), 15. https://doi.org/10.1186/1748-5908-8-15

Shediac-Rizkallah, M. C., & Bone, L. R. (1998). Planning for the sustainability of community-based health programs: Conceptual frameworks and future directions for research, practice and policy. *Health Education Research*, *13*(1), 87–108. https://doi.org/10.1093/her/13.1.87

Tabak, R. G., Khoong, E. C., Chambers, D. A., & Brownson, R. C. (2012). Bridging Research and Practice. *American Journal of Preventive Medicine*, *43*(3), 337–350. https://doi.org/10.1016/j.amepre.2012.05.024

Theobald, S., Brandes, N., Gyapong, M., El-Saharty, S., Proctor, E., Diaz, T., Wanji, S., Elloker, S., Raven, J., Elsey, H., Bharal, S., Pelletier, D., & Peters, D. H. (2018). Implementation research: New imperatives and opportunities in global health. *The Lancet (British Edition)*, *392*(10160), 2214–2228. https://doi.org/10.1016/S0140-6736(18)32205-0

Tinkle, M., Kimball, R., Haozous, E. A., Shuster, G., & Meize-Grochowski, R. (2013). Dissemination and implementation research funded by the US National Institutes of Health, 2005–2012. *Nursing Research and Practice*, *2013*, 1–15. https://doi.org/10.1155/2013/909606

Villalobos, A., Blachman-Demner, D., Percy-Laurry, A., Belis, D., & Bhattacharya, M. (2023). Community and partner engagement in dissemination and implementation research at the National Institutes of Health: An analysis of recently funded studies and opportunities to advance the field. *Implementation Science Communications*, *4*(1), 77. https://doi.org/10.1186/s43058-023-00462-y

Wandersman, A., Duffy, J., Flaspohler, P., Noonan, R., Lubell, K., Stillman, L., Blachman, M., Dunville, R., & Saul, J. (2008). Bridging the Gap between Prevention Research and Practice: The interactive systems Framework for dissemination and implementation. *American Journal of Community Psychology*, *41*(3–4), 171–181. https://doi.org/10.1007/s10464-008-9174-z

Weiner, B. J., Lewis, M. A., & Linnan, L. A. (2008). Using organization theory to understand the determinants of effective implementation of worksite health promotion programs. *Health Education Research*, *24*(2), 292–305. https://doi.org/10.1093/her/cyn019

Wingood, G. M., & DiClemente, R. J. (2008). The ADAPT-ITT model. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *47*(Supplement 1), S40–S46. https://doi.org/10.1097/QAI.0b013e3181605df1

World Bank (2023). *World Bank Country and Lending Groups*. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

World Health Organization (2020). *WHO package of essential noncommunicable (PEN) disease interventions for primary health care*. https://www.who.int/publications/i/item/who-package-of-essential-noncommunicable-(pen)-disease-interventions-for-primary-health-care