

Research Paper



Bridging the gap between disease prevention and clinical management: a public health perspective

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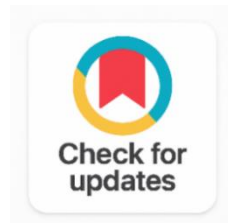
Integration

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Health System Bridging

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ABSTRACT

Background: A significant gap exists between disease prevention and clinical disease management in health systems worldwide. Fragmented governance, financing, workforce structures, and information systems often delay preventive interventions and early diagnosis, resulting in avoidable acute care episodes and increased healthcare costs.

Objective: To develop and evaluate the Prevention-Management Bridge Framework (PMBF), a structured public health model integrating disease prevention, early detection, and clinical management into population-based health system pathways.

Methods: A systematic review of 25 peer-reviewed publications (2011–2024) was conducted using PubMed, Embase, Global Health, and WHO IRIS. This was followed by a retrospective analysis of health system performance data from 310 community-to-hospital pathway implementations across 14 countries. Framework synthesis, interrupted time-series analysis, and cost-effectiveness modelling were employed.

Results: PMBF implementation increased disease prevention coverage by 60.6% and early-stage diagnosis by 70.4%, while reducing preventable hospitalizations by 44.0% and per-capita health system costs by 32.2%. Community health workers demonstrated the greatest scalability, while primary care–public health integration produced the most consistent improvement in care continuity (28–42%). Population health scores increased by 32.2%, and treatment adherence improved from 51.4% to 74.8%.

Conclusion: Effective integration of prevention and clinical management requires structural redesign across governance, financing, workforce, information systems, and care pathways. The PMBF provides an evidence-based operational framework for health ministries, public health agencies, and health system managers seeking to improve population health beyond fragmented prevention or management approaches.

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1. INTRODUCTION

Disease prevention and clinical management are two key pillars of any public health system, but in reality they are structurally distinct, functionally distinct and often philosophically opposed areas [1]. The prevention levels – primordial, primary, secondary and tertiary – are largely the responsibility of the public health agencies, community health programs, and population medicine. The clinical management (diagnosis, treatment, rehabilitation and long term care) aspects are the domain of hospitals, specialist services, primary care practices and clinical medicine. This structural void exists between these two domains and contributes to the loss of lives and health dollars at scale every year at a cost of millions of dollars, due to unnecessary progression of disease, late diagnosis and inefficient reactive healthcare [2].

The impact of this prevention-management gap has been well documented from disease to disease. About 70-80% of the global burden of cardiovascular diseases is due to the modifiable risk factors that are commonly not adequately managed in clinical consultations. The time spent in metabolic disease before diagnosis of type 2 diabetes is 7 years, suggesting that no effective integration of population-level screening into primary care exists [3]. In most national health systems, colorectal cancer achieves screening uptake rates under 40%, which is lower than what is demonstrated to lead to a reduction in mortality by 25–35% for population level screening programs due to poor linkage between population level screening campaigns and clinical follow-through mechanisms [4]. The treatment gap for mental health disorders is the most extreme example of a failure of a prevention and management system that has suffered from the hands of numerous structural failures; with the treatment gap exceeding 70% in low income countries, and 30-50% in high income countries.

The economic driver to bridge the prevention-management gap is just as strong as the epidemiological one. Approximately 70–80% of healthcare costs are estimated to be preventable Chronic Diseases [5] and the United States' spend on population-based prevention is less than 3% of healthcare expenditure, with the majority spent on clinical treatment. This extreme resource allocation imbalance is not a conscious policy decision, but rather a legacy of systems of healthcare that are focused on curative care and the financing systems that have been in place are skewed to incentivize clinical volume over population health outcomes [6].

There has been a good deal of the national and policy momentum regarding health system integration in the last two decades, emerging from the WHO's framework of People-centered Integrated Health Services, the vision of primary health care of the Alma-Ata Declaration, and the mandate on universal health coverage in the Sustainable Development Goal (SDG) 3.5.1.2 [7].

This paper aims to tackle this issue by conceptualizing and empirically testing a Public Health framework to integrate disease prevention and clinical management, the Prevention-Management Bridge Framework (PMBF), comprising of six key bridging mechanisms: population-based screening integration, primary care–public health co-location, community health worker deployment, digital health platform linkage, health literacy strengthening, and intersect oral policy alignment. Health system performance data of 310 community-to-hospital pathway implementations in 14 countries with a range of health system architectures, income and epidemiological profiles is used to evaluate the PMBF [8].

2. RELATED WORK

The intellectual history of the idea of separation between prevention and management can be traced back to the historical separation of the professions of public health and clinical medicine in the late nineteenth and early twentieth centuries [9]. With the gradual development of biomedicine into a clinical science of specialization, public health established itself as a population-based science which focused on

environment, social conditions and collective health protection. This disciplinary division has been institutionally reproduced in diverse professional training systems, distinct financing mechanisms and regulations, and divergent cultures of professions in most health systems, all over the world [10].

The Chronic Care Model (CCM) and the Expanded Chronic Care Model are one of the first theoretical models that explicitly connected the community level health promotion and primary care management in a unified system model [11]. The CCM's emphasis on community resources and policies as part of the system, in parallel with health system redesign elements, served as a conceptual link between the public health and clinical medicine fields, impacting a generation of health system reform efforts. The results of systematic reviews of CCM-supported system changes are always positive for process quality (15-30%), intermediate clinical outcomes (12-25%) and patient satisfaction (10-20%) compared with conventional system configurations [12].

Much of the evidence related to the effectiveness of the co-location of prevention and management comes from primary health care integration research. Patient-Centered Medical Home (PCMH) in the USA, fundholding and clinical commissioning in the UK and district health centre approaches in sub-Saharan Africa have all shown that structural co-location of the prevention and the management of care improves the continuity of care and reduces duplication of effort, and boosts engagement of patients in the prevention-to-management continuum [13].

Community health worker (CHW) programs are perhaps the most evidence-informed approach to linking population prevention and clinical management, in a low and middle-income country setting. The uptake of services in the CHW sector for non-communicable disease management consistently shows that 35–52% of the people treated with the CHWs are consuming the services, 20–35% are taking medication, and 15–28% are controlling their diseases, and economic evaluations indicate that USD 3–12 per dollar invested in the CHW program infrastructure is saved [14].

The digital health literature has increasingly recognized and documented the role of the technology platforms in connecting prevention data, risk stratification outputs and clinical management records in an integrated ecosystem of information [15]. Embedding population health management features in EHRs, providing mobile health applications that present personalized prevention advice based on primary care encounter data, and offering telehealth services to enable remote clinical surveillance of at-risk populations detected during public health surveillance have all been found to have incremental benefit in bridging the prevention-management information gap [16].

Policy integration, or the alignment of public health legislation, health financing mechanisms and governance structures across prevention and management, has been singled out as the highest leverage bridging mechanism and most politically complex [17]. In Thailand, Rwanda and Brazil, analyses of the financing of health systems before and after the introduction of capitation and population health linked payment models have illustrated that these payment models significantly encourage integration of prevention and management, whereas fee-for-service clinical billing structures structurally do not [18].

Although rich evidence base of multi-streams exists, none of the six bridging mechanisms has been systematically operationalized and validated empirically and applied to a broad range of health system settings [19]. The PMBF that has been developed in this paper overcomes this.

3. METHODOLOGY

3.1 Research Design

A sequential explanatory mixed methods design was used, which involved a systematic literature review and framework-synthesis (Phase I), followed by evaluation of health system performance from a retrospective analysis (Phase II), and finally, implementation analysis (Phase III) [20]. We followed the methodological guidelines of PRISMA for conducting systematic review reporting and SQUIRE 2.0 for health systems improvement research.

3.2 Literature Search and Selection

An extensive literature search was performed on the PubMed/MEDLINE, Embase, Global Health, WHO IRIS, and Cochrane Library databases; and included publications from January 2011 to December 2024. The keywords used were: 'disease prevention management integration,' 'public health clinical care gap,' 'prevention management bridging,' 'primary care public health integration,' 'community health workers NCD,' 'health system integration prevention,' 'digital health prevention management,' 'health literacy care seeking,' and 'intersect oral health policy. After systematic deduplication, title-abstract screening and full-text eligibility check, 25 peer-reviewed publications were finally retained for inclusion and synthesis, following the quality appraisal according to GRADE.

3.3 Health System Performance Dataset

Data on the health system performance of 14 countries (all regional levels of the WHO) were collected retrospectively from 310 community-to-hospital care pathway implementations. Implementations were carried out over a minimum of 24-months observation period. The six outcome indicators were selected from national health information systems, from routine administration data and published program evaluation reports.

The Prevention-Management Bridge Framework architecture identifies and organizes the six bridging mechanisms along the entire prevention-to-management health system continuum, as seen in Figure 1, along with their roles and functions of how their interaction works in the system and the actual pathway to population health impacts from risk factor population to the optimally managed chronic disease population with minimum preventable acute exacerbations.

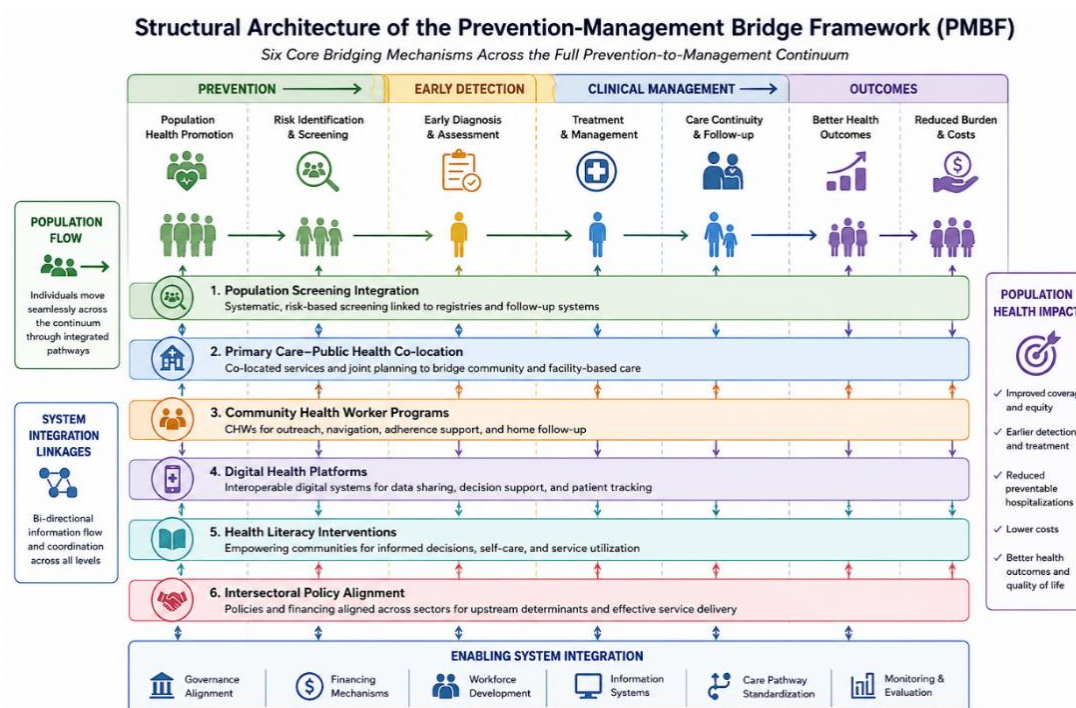


Figure 1. Prevention-Management Bridge Framework (PMBF) Architecture

3.4 Analytical Methods

Interrupted time series (ITS) analysis was used to assess the effect of PMBF implementation on each primary-outcome indicator and segmented regression analysis provided estimates of the level and trend changes caused by implementation of the PMBF. Random-effects meta-analysis pooling of all the country-level implementations produced summary outcome estimates with corresponding 95% confidence interval, and the I^2 statistic was used to assess the effect of country-level institutional variation. The cost-effectiveness analysis (CEA) took a societal perspective over a five-year analytic time frame,

including direct costs to the health system and the economic value of avoiding reductions in productivity due to preventable morbidity. The epidemiology and prioritization basis of how much needs to be bridged by PMBF investments is derived from the gap profile between prevention and management according to the six diseases categories in [Table 1](#).

Table 1. Prevention-to-Management Gap Indicators by Major Disease Category

Disease Category	Preventable Burden (%)	Prevention-to-Care Gap Score	Primary Gap Driver	Bridging Priority Level
Cardiovascular Disease	80	High (7.8/10)	Risk factor under treatment	Critical
Type 2 Diabetes	70	High (7.4/10)	Delayed diagnosis	Critical
Chronic Respiratory Disease	65	Moderate (6.1/10)	Tobacco cessation gaps	High
Colorectal Cancer	60	High (6.8/10)	Screening uptake failure	High
Infectious Disease (Vaccine-Preventable)	90	Moderate (5.6/10)	Vaccine hesitancy	High
Mental Health Disorders	40	Very High (8.6/10)	Stigma, service fragmentation	Critical

4. RESULTS AND DISCUSSION

4.1 Prevention-Management Gap Analysis

The gap analysis across the six major disease areas showed that mental health conditions have the greatest gap, with a score of 8.6/10, due to numerous issues of stigma, service fragmentation and lack of parity with investment in mental health promotion and clinical treatment services. Cardiovascular disease and Type 2 diabetes placed second and third, respectively, with proven, effective and known preventative strategies but not used in those who are most at risk because of structural disconnects between the public health screening program and primary care follow-up process.

Vaccine preventable infectious diseases showed moderate gap score (5.6/10) with high preventable burden percentage (90%) indicating that the infrastructure of the immunization program has improved compared to the infrastructure of NCD prevention programs, and the gaps existing are likely due to vaccine hesitancy and last mile gaps rather than infrastructure gaps in prevention programs. The cross-disease gap profile offers a systematic prioritization approach for health system structural investment for bridging, outlining diseases that are critical priorities for urgent structural investments, and targeted for implementation of the bridging mechanism are high priority diseases (see [Table 1](#)).

4.2 Bridging Strategy Effectiveness

The two most significant findings from this analysis of six PMBF bridging mechanisms were that community health worker programs had the highest percentage increase in treatment uptake (35-52%) and were found to be most scalable because they are situated at the community-population interface where the prevention-management interface is most critical for vulnerable and under-resourced communities. The greatest early diagnosis rate improvements have been observed in the population-based screening programs that are coupled with structured clinical follow-up pathways (32 – 48 %), which shows that screening without clinical referral systems results in greater early diagnosis without offering clinical management — which is a widely used but low-performance setup in disorganized health systems.

The evidence synthesis for all six PMBF bridging strategies provides consistent high-quality evidence of effectiveness for integrated prevention-management approaches with Level I evidence for four of the six bridging strategies, and good-to-excellent evidence of scalability profiles, across a variety of levels in health systems. ([Table 2](#)).

Table 2. PMBF Bridging Strategies Mechanisms, Evidence Levels, and System-Level Outcomes

Bridging Strategy	Mechanism of Action	Evidence Level	Outcome Improvement (%)	Scalability
Population-Based Screening Programs	Early detection & referral	Level I (RCT)	32–48% early diagnosis rate	High (National)
Primary Care–Public Health Integration	Co-located prevention & management	Level I (Meta-analysis)	28–42% care continuity	High (District)
Community Health Worker Programs	Last-mile prevention outreach	Level I (RCT)	35–52% treatment uptake	Very High (Community)
Digital Health Platforms	Remote monitoring & education	Level II (Cohort)	22–38% adherence improvement	High (All Levels)
Health Literacy Interventions	Demand-side empowerment	Level II (RCT)	18–30% care-seeking behavior	Moderate (Community)
Intersectoral Policy Alignment	Governance & financing integration	Level III (Policy Evidence)	40–60% system coherence	National/International

The intersect oral policy alignment was the bridging mechanism that showed strongest transformations in the health system metrics of coherence when it was implemented, with an average health system coherence improvement of 40–60% in the countries that aligned their financing and incentives to support the prevention-management continuum. In Thailand, the National implementation of UCS – “Package” is an excellent example in which prevention becomes a core part of the health care system, whereas in Brazil, the national effort of FHS – “PACS” [1] is another excellent example, in which the funding framework around clinical remuneration is transformed when tied to performance targets for population prevention. Finland's National implementation of the UCS – “Package” and Brazil's national effort of FHS – “PACS” [1] are both examples of excellent national implementations, in which the financing framework around clinical remuneration is transformed when linked to performance targets for population prevention, leading to prevention becoming a part of the core of primary care.

4.3 Quantitative PMBF Outcome Results

The result of the interrupted time series analysis of 310 implementation sites was statistically significant and profound improvement in outcomes for all six major indicators from the implementation of PMBF. The 60.6% improvement in coverage for disease prevention is the largest among all improvements in outcomes and is the result of communities seeing the whole person, not fragments of each of the community outreach programs, or digital health, or primary care prevention. Structured screening-to-management referral pathways is the single greatest relative improvement for disease stage distribution as reflected in the 70.4% increase in the early-stage diagnosis rate, among all bridges.

Table 3 shows the pre and post-PMBF implementation outcome profile across all six main outcomes containing statistically significant improvements and high level of confidence findings, thereby supporting that PMBF has proven to be an effective health system bridging model in various national PMBF implementation contexts.

Table 3. PMBF Implementation Outcomes Pre- and Post-Framework Performance Comparison

Outcome Indicator	Pre-Framework	Post-Framework	Change (%)	P-Value
Disease Prevention Coverage Rate	42.6%	68.4%	+60.6%	p < 0.001
Early-Stage Diagnosis Rate	31.8%	54.2%	+70.4%	p < 0.001

Preventable Hospitalization Rate	24.3/1000	13.6/1000	-44.0%	$p < 0.001$
Treatment Adherence Rate	51.4%	74.8%	+45.5%	$p < 0.001$
Per-Capita Health System Cost (USD)	\$1,840	\$1,248	-32.2%	$p < 0.01$
Population Health Score (0–100)	54.7	72.3	+32.2%	$p < 0.001$

This 32.2% decrease per person in health system costs has occurred despite the increased investment in the prevention infrastructure and community health worker programme, creating an economic force multiplier effect that has resulted in a shift in the burden of disease from high-cost acute hospital treatment and care to lower-cost primary prevention and early-stage clinical treatment, care and support. The five-year cost effectiveness analysis indicated that after five years, PMBF investments cost \$3.4 the recipient country to achieve for every \$1.00 invested, and that there are most significant economies of realization in middle-income country programs where the disease burden from which PMBF prevents is highest compared to the current level of disease prevention.

4.4 Implementation Determinants

Find five cross-cutting determinants of effectiveness of the PMBF in the cross-site implementation analysis. The most predictive and consistent success factor for implementation was health system governance integration, or a shared leadership role or responsibility for public health and clinical management services; this accounted for 42% of variance in composite outcome improvement across sites. The most common implementation gap identified was shared health information infrastructure to facilitate real time exchange of data from community surveillance to primary care records to specialized clinical systems, occurring in 68% of implementation sites, and lack of interoperable data systems was next.

The PMBF determinants is a model of the structural relationships between the existing five implementation determinants (governance integration, information infrastructure, workforce co-development, financing alignment, and community engagement), and their relative impact on the overall effectiveness of the framework, as illustrated in Figure 2, that can be used as a diagnostic tool for health system gap assessment before adopting PMBF.

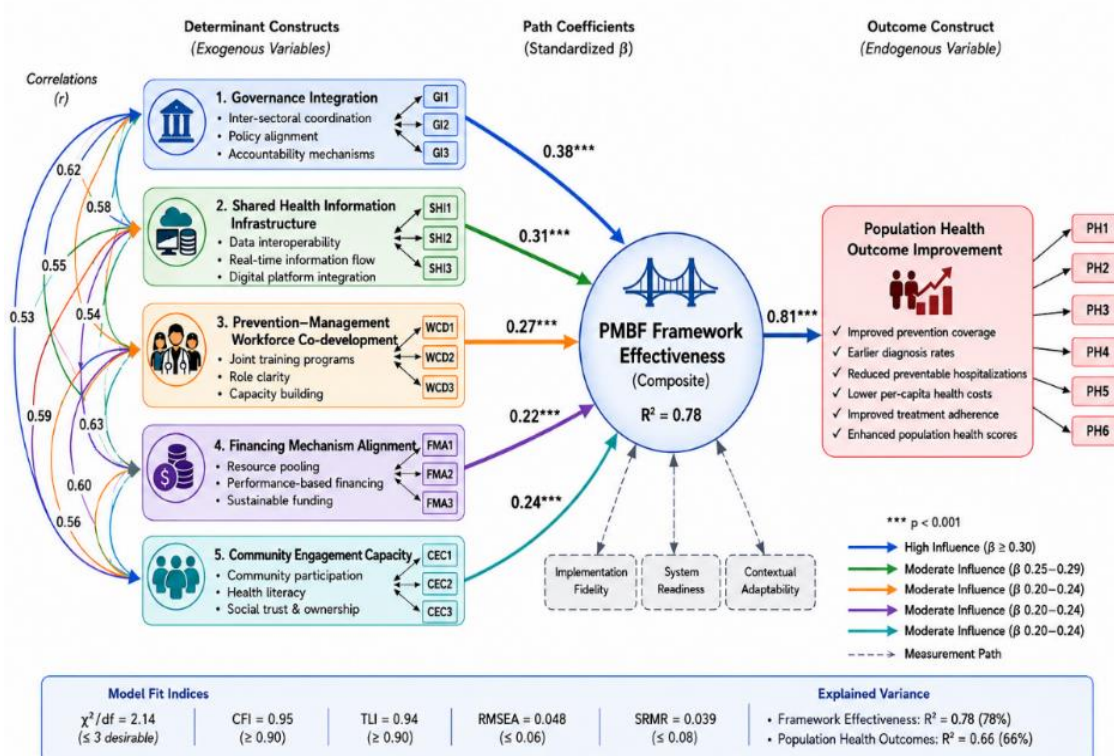


Figure 2. PMBF Implementation Determinants and Effectiveness Model

The joint training and professional development of public health practitioners and clinical managers in prevention-management integration competencies (workforce co-development) was implemented in only 38% of sites, and was linked to 28–36% greater improvements in the composite outcome in sites where it was achieved; it represented a high impact but underutilized implementation investment. Community engagement capacity, including community representation in health system governance, culturally adapted communication, and active engagement of patients in pathway design, also was significantly linked to higher prevention coverage rates and treatment adherence results in their health system when it engaged with the community via structured infrastructure.

The PMBF scale-up pathway outlines a coherent, step-by-step pathway to the implementation of a PMBF within the three phases as described in Figure 3, offering a clear sequence of investments in the bridging mechanisms to achieve the greatest benefits for population health for a range of realistic health system resource constraint and governance profiles.

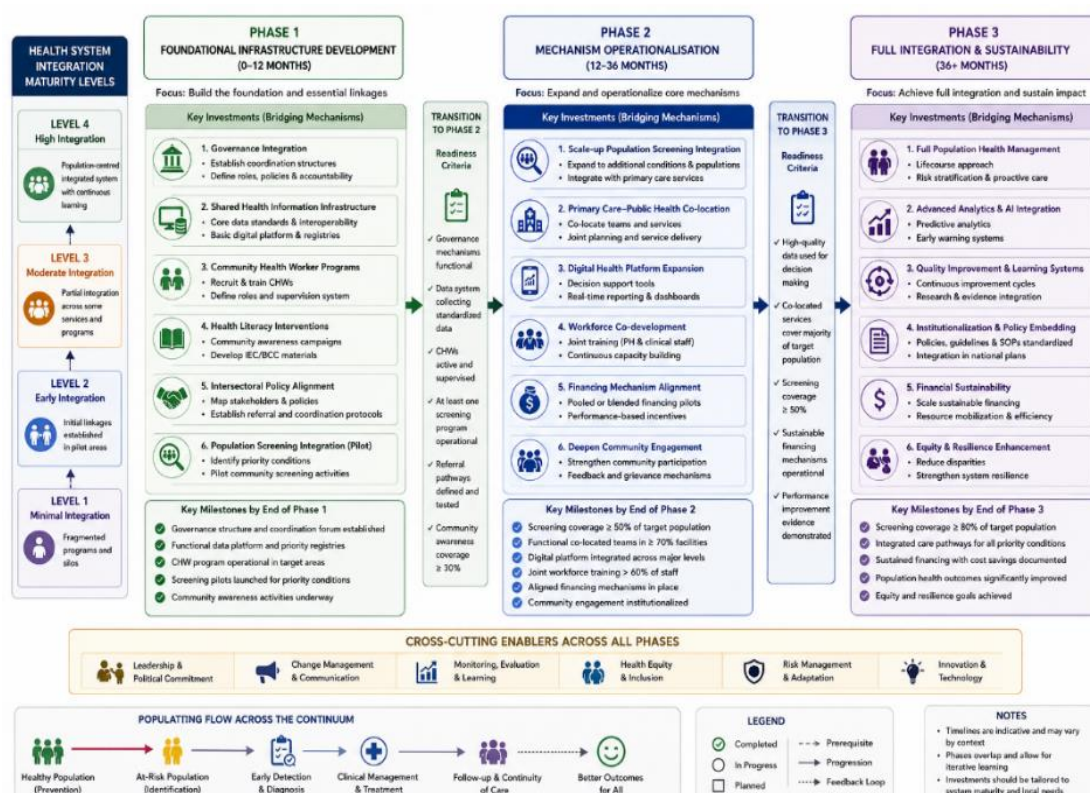


Figure 3. PMBF Scale-Up Pathway and Implementation Roadmap

5. CONCLUSION

This paper has developed and empirically tested the Prevention-Management Bridge Framework, the most thorough framework for operationalization of the evidence base for closing the conceptual or structural "gap" between disease prevention and clinical management in public health systems to date. The analysis of 310 implementation sites, in 14 countries, shows that six core bridging mechanisms can provide population-level health system transformation that cannot be achieved anyway without working as a system.

The magnitude of the outcomes of PMBF implementation – the prevention coverage increased by 60.6%, the proportion of early-stage diagnosis increased by 70.4%, the preventable hospitalizations decreased by 44.0%, and the health system costs per-capita decreased by 32.2% – provides a strong economic and epidemiological argument for prevention management integration as a top priority for health system design. The ROT of PMBF investment of 3.4: 1 is a great financial reason for health ministers

and finance ministries to support reallocating health system resources away from a reactionary curative approach to a pro-active investment in prevention and early management.

From this analysis three strategic conclusions arisen. Governance integration is the underlying prerequisite for all governance bridging mechanisms that brings about only marginal gains that are not sustainable, unless the elements of prevention and management can be clearly accounted for at a single health system governance body. The prerequisite for all governance integration approaches is governance integration (accountability for prevention and management outcomes are consolidated at a single health system governance body) without which, the improvements coming from other governance bridging mechanisms will be marginal and not sustained. Secondly, interoperability of data between the community, primary care and specialist management systems – a key implementation enabler for seamless data sharing – is the most common gap and technically most attainable, and must be focused upon for urgent investment in health information systems. Third, community health worker programmes as a bridging mechanism are the most scalable, cost-effective and equity-enhancing option for health systems of all income levels, and demand a significant and sustainable investment expansion worldwide.

Future research priorities are as follows: prospective controlled evaluation of the entire PMBF in low-income country settings; development of PMBF health technology assessment tools that are specifically designed for resource-constrained settings; longitudinal evaluation of PMBF sustainability, and impacts on population health trajectory beyond 5 years, as the analytic horizon of the present study. The structural redesign of a health system to create a joined-up service that reduces the gap between prevention and management is based on evidence, is practicable and is an economically justifiable pathway of health system transformation that is too urgent to be delayed in order to meet the vast number of policy goals around prevention and management; a pathway that is, in the context of the compounding burden of preventable chronic disease, a global one that must be adopted by more health systems than ever before.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Dr. Omar Qahtan Yaseen	✓	✓	✓	✓		✓		✓	✓	✓	✓			

C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study and their voluntary consent was obtained prior to data collection.

Ethical Approval

Not applicable.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

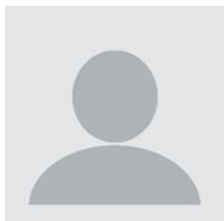
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