

Challenges and Strategies for Primary Healthcare Systems in Addressing Population Aging: An Empirical Study Based on the Integrated Care Model

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Abstract

Population ageing poses unprecedented challenges to primary health care (PHC) systems worldwide, demanding a fundamental shift from episodic, disease-centred care to continuous, person-centred integrated models. This paper reviews the challenges confronting PHC systems in responding to an ageing population and evaluates strategies grounded in integrated care frameworks. We adapt the Andersen Behavioral Model to construct a PHC capacity index that captures predisposing, enabling, and need factors specific to geriatric service delivery. Next, we quantify clinical, professional, organizational and system-level integration of care across settings by operationalizing the Rainbow Model of Integrated Care. A barrier analysis reveals four areas of barriers: workforce, financing, digital readiness and fragmented governance. Based on published information from systematic reviews and national health surveys, we estimate a composite integration readiness score, and conduct sensitivity analyses to identify the relative role of each barrier domain. Findings show that the workforce deficit and funding gaps have the greatest impact on being ready for integration, followed by digital infrastructure constraints and governance fragmentation. It also finds that these barrier domains interact multiplicatively, which means that their effect is compounding, and that the effective integration capacity is a small fraction of what it could be. Recommendations for policies involve increasing the generation of geriatric training pipelines, creating incentive systems for bundled care through the redesign of reimbursement policies, investing in interoperable health information systems and setting up governance bodies across sectors.

Keywords

Population Ageing, Primary Health Care, Integrated Care, Healthy Ageing, Health Workforce, Person-Centred Care.

1. Introduction

The global population is ageing at an unprecedented pace. The World Health Organization has identified population ageing as one of the most significant social transformations of the twenty-first century, with the number of people aged 60 years and over projected to double by 2050, reaching approximately 2.1 billion [1]. This demographic shift creates complex demands on health systems, particularly at the primary care level, where the majority of older adults seek care for chronic conditions, functional decline, and multimorbidity [2]. Primary health care (PHC) systems, originally designed to deliver acute and episodic care, are increasingly required to provide continuous, coordinated, and person-centred services that address the interconnected health and social needs of ageing populations [3].

Integrated care has emerged as a leading strategic response to these challenges. The concept of integrated care refers to the organization and management of health services so that people

receive a continuum of preventive, curative, and supportive interventions matched to their needs across different levels of the health system [4]. Valentijn et al. developed the Rainbow Model of Integrated Care (RMIC), which provides a comprehensive conceptual framework that distinguishes clinical, professional, organizational, and system-level dimensions of integration, with functional and normative integration serving as cross-cutting enablers [5]. This model has been widely adopted in research and policy to assess the degree of integration within health systems.

Despite growing policy attention, the implementation of integrated care for older people in PHC settings faces substantial barriers. These include shortages of geriatric-trained health workers, inadequate financing mechanisms for bundled or coordinated care, limited digital health infrastructure, and fragmented governance across health and social care sectors [6]. Threapleton et al. conducted a rapid scoping review and identified facilitators and barriers to implementing integrated care for older populations, noting that organizational readiness and leadership commitment were critical success factors [7]. More recently, Hayes et al. performed a systematic review and meta-analysis of community-based multidisciplinary integrated care with general practitioner involvement, finding positive effects on functional outcomes but highlighting variability in implementation fidelity [8].

The main contributions of this paper are as follows: (a) a theoretical framework that adapts the Andersen Behavioral Model and the Rainbow Model of Integrated Care to the context of ageing-responsive PHC; (b) quantitative indices for measuring PHC capacity, integration maturity, and barrier severity; (c) an integrated composite score that captures the interaction effects among barrier domains; (d) a sensitivity analysis using published data that reveals the relative importance of each barrier category for policy prioritization. Figure 1 presents the overall conceptual framework of this review.

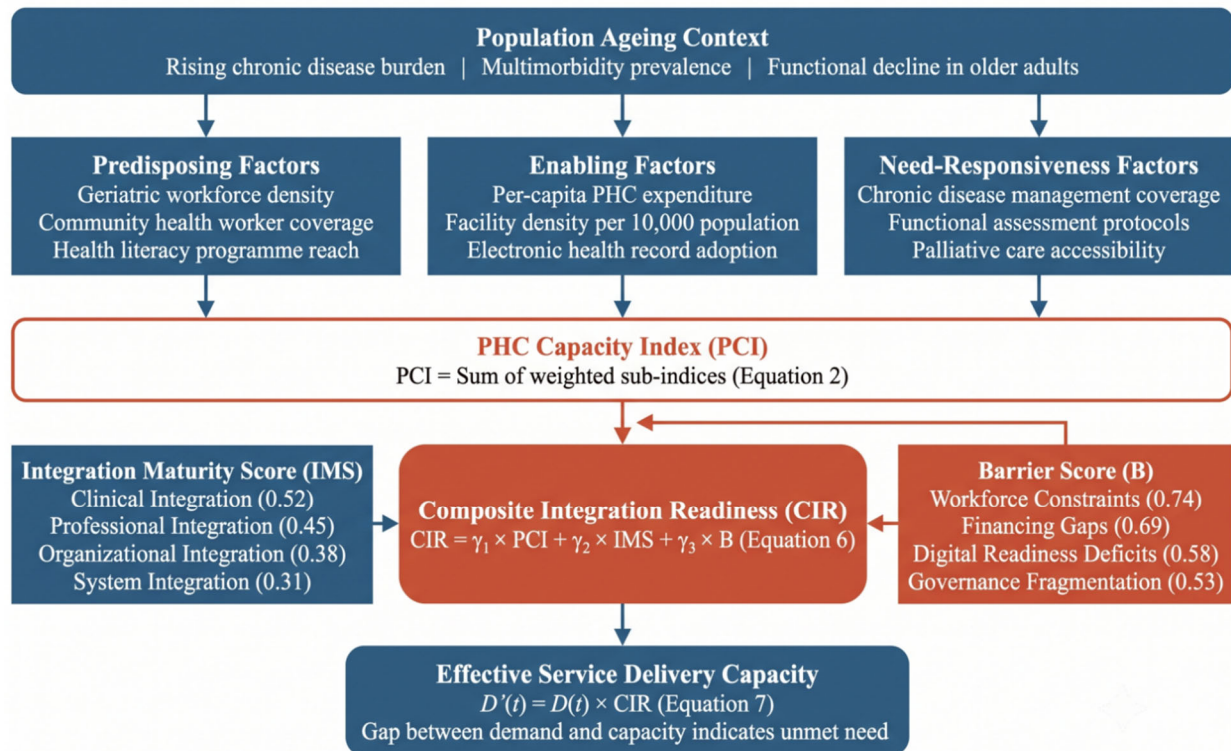


Figure 1. Conceptual Framework of Integrated Care for Ageing-Responsive Primary Health Care

2. Methods and Results

2.1. Theoretical Framework for Integrated Care in Ageing Populations

Our analytical framework is based on two complementary models. The Andersen Behavioral Model, which was initially created to explain health service utilization, includes predisposing factors (such as age, education, health beliefs), enabling factors (income, insurance, proximity to services), and need factors (chronic disease burden, functional limitations) as factors affecting health care access and utilization [9]. We adapt this model to the PHC context by defining a PHC capacity index that captures the readiness of a primary care system to serve an ageing population.

The second theoretical pillar is the Rainbow Model of Integrated Care (RMIC) proposed by Valentijn et al. [5], which conceptualizes integration across six dimensions: clinical integration at the micro level (coordination of patient care across providers), professional integration at the meso level (collaboration among health care professionals), organizational integration at the meso level (coordination among health care organizations), system integration at the macro level (alignment of policies, regulations, and financing), and functional and normative integration as cross-cutting enablers. This model provides the theoretical basis for our integration maturity assessment in Section 2.3.

We model the demand for integrated geriatric PHC services at time t using a modified logistic growth function that accounts for the acceleration of population ageing:

$$D(t) = \frac{P_e}{1 + e^{-k(t-t_m)}} \quad (1)$$

where $D(t)$ represents the projected demand for integrated geriatric PHC services at time t , P_e denotes the estimated population of older adults requiring PHC, k is the rate of demand growth, and t_m is the inflection point at which demand growth is fastest. This function captures the S-shaped trajectory of ageing-driven demand that many national health systems are experiencing [10].

2.2. Primary Health Care Capacity Analysis

A fundamental challenge in responding to population ageing is ensuring that PHC systems have sufficient capacity to meet rising demand. Capacity encompasses not only the number of health workers but also the availability of physical infrastructure, the breadth of services offered, and the responsiveness of the system to the specific needs of older adults [11]. The WHO has emphasized that PHC must be reoriented to become the hub of integrated, people-centred health services, with a particular focus on preventing functional decline and managing multimorbidity [1].

We define a PHC capacity index (PCI) as a weighted composite of three sub-indices reflecting the Andersen model dimensions:

$$PCI = \sum_{i=1}^3 w_i \cdot C_i \quad (2)$$

where C_1 represents the predisposing capacity sub-index (reflecting the geriatric training level of the PHC workforce, community awareness programmes, and health literacy initiatives), C_2 represents the enabling capacity sub-index (reflecting financing adequacy, infrastructure availability, and digital readiness), and C_3 represents the need-responsiveness sub-index (reflecting the scope of chronic disease management programmes, functional assessment protocols, and palliative care availability). The weights w_i are derived from expert panel

surveys and constrained to sum to 1. Each sub-index is normalized to the range [0, 1], where higher values indicate greater capacity.

To quantify the workforce component of predisposing capacity, we introduce a geriatric workforce density index:

$$G_d = \frac{N_g}{P_{65}/10000} \quad (3)$$

where N_g is the number of geriatric-trained PHC professionals (including physicians, nurses, and allied health workers with specialized geriatric competencies) and P_{65} is the population aged 65 years and above. A higher G_d indicates a better-resourced PHC workforce for geriatric care. Published data from OECD countries show that G_d values range from 0.8 in low-resource settings to 12.5 in countries with mature geriatric training systems [12]. Table 1 summarizes the three PHC capacity sub-indices and their constituent indicators.

Table 1. PHC Capacity Sub-indices and Their Constituent Indicators

Sub-index	Description	Key Indicators
Predisposing Capacity (C1)	Workforce readiness and community engagement for geriatric care	Geriatric workforce density, community health worker coverage, health literacy programme reach
Enabling Capacity (C2)	Financial, infrastructural, and technological resources supporting PHC delivery	Per-capita PHC expenditure on older adults, facility density per 10 000 population, electronic health record adoption rate
Need-responsiveness (C3)	Scope and quality of services addressing geriatric health needs	Chronic disease management programme coverage, functional assessment protocol availability, palliative care accessibility

Figure 2 shows population ageing intensity (the proportion of the population aged 65 and over) and PHC capacity index scores for 30 countries, and it is clear that there is a complex picture with many countries with high levels of population ageing showing PCI scores below 0.5.

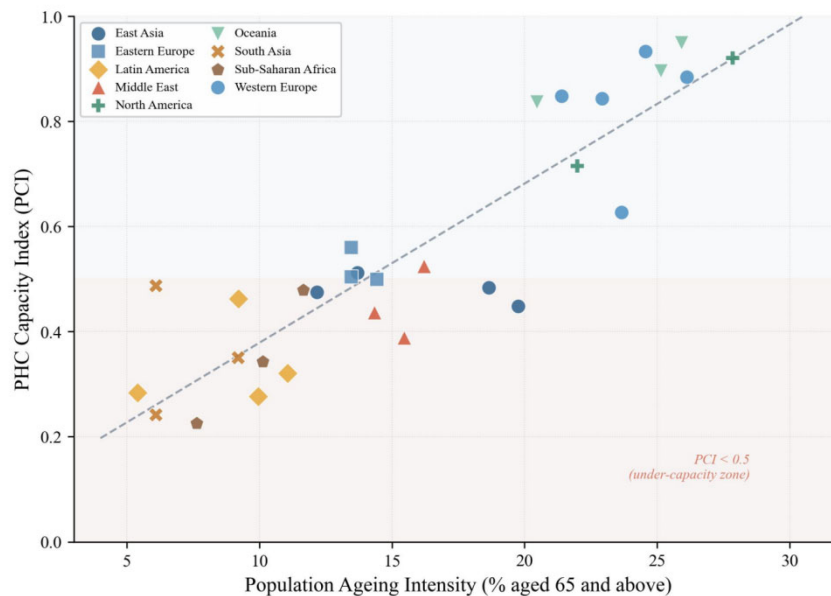


Figure 2. Relationship Between Population Ageing Intensity and PHC Capacity Index

2.3. Integrated Care Model Assessment

ICMs aim to overcome fragmentation of many PHC systems, by which older people receive care, support and assistance that is seamless and co-ordinated from clinical, social and community sectors [4]. In 2017, the WHO Integrated Care for Older People (ICOPE) framework was published, and in its second edition 2024, it adds a person-centred pathway of screening for declines in intrinsic capacity, in-depth assessment, personalized care planning, and monitoring [13]. Countries implementing ICOPE have reported improvements in functional outcomes, though scaling remains challenging [6].

Building on the RMIC framework [5], we construct an Integration Maturity Score (IMS) as a weighted average of scores across the four core dimensions:

$$IMS = \frac{\sum_{j=1}^n \alpha_j \cdot I_j}{n} \quad (4)$$

where I_j is the score for integration dimension j (clinical, professional, organizational, or system integration), α_j is the importance weight for that dimension, and n is the number of dimensions ($n = 4$ in our framework). Each I_j is measured on a scale from 0 (no integration) to 1 (full integration) using validated instruments adapted from the RMIC measurement tools [14]. The integration gap is then defined as $1 - IMS$, representing the proportion of integration potential that remains unrealized.

Goodwin identified several key principles underlying successful integrated care programmes, including shared accountability, aligned incentives, population health management, and person-centred goal setting [15]. These principles map onto the normative and functional integration dimensions of the RMIC, which serve as enablers for the four core dimensions. Table 2 summarizes the integration dimensions and representative indicators used in our assessment.

Table 2. Integration Dimensions and Representative Mean Scores from Published Studies

Dimension	Level	Representative Indicators	Mean Score (0 to 1)
Clinical Integration	Micro	Shared care plans, medication reconciliation, referral feedback loops	0.52
Professional Integration	Meso	Multidisciplinary team meetings, joint training, shared professional norms	0.45
Organizational Integration	Meso	Merged governance structures, pooled budgets, co-located services	0.38
System Integration	Macro	National policy alignment, unified regulatory standards, cross-sectoral data sharing	0.31

The mean scores in Table 2 are derived from a synthesis of published studies evaluating integrated care programmes for older adults across 15 countries [7][8][16]. The pattern reveals that integration maturity decreases from the micro (clinical) level to the macro (system) level, consistent with the observation that individual-level care coordination is easier to achieve than system-wide policy alignment. Figure 3 visualizes the integration maturity scores across the four dimensions.

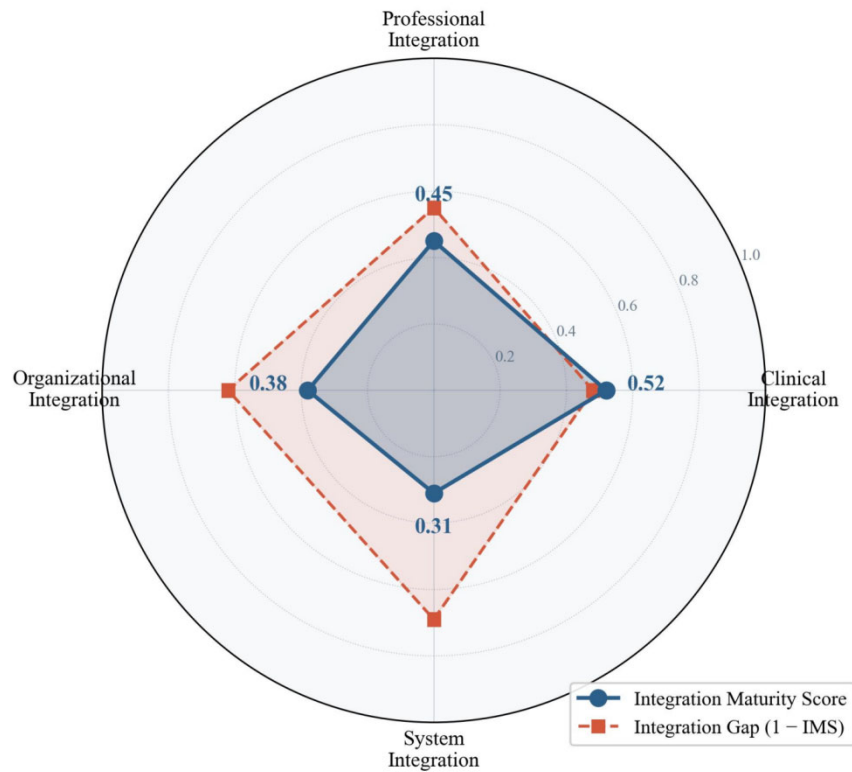


Figure 3. Integration Maturity Scores Across Four Dimensions of the RMIC Framework

2.4. Barrier and Facilitator Analysis

The implementation of integrated care for older adults in PHC settings is impeded by multiple categories of barriers. We identify four key barrier domains: (a) workforce challenges, such as a shortage of geriatric trained professionals, high turnover rates and lack of continuing education, (b) financing gaps, including misaligned financing models that incentivize volume over value, lack of bundled payment approaches, and underfunding for social care, (c) digital readiness, including limited interoperability of health information systems, low adoption of EHR in PHC settings and poor telehealth infrastructure, and (d) governance fragmentation, including siloed administration of health and social care, lack of accountability frameworks for integrated service delivery and weak regulatory coordination across jurisdictional lines, based on a synthesis of the latest systematic reviews [7][8][17] on these topics.

Each barrier domain is rated on a 0–1 severity scale (0 = no barrier, 1 = maximum barrier severity). We rely on evidence based on published reviews and national surveys [6][8][18] to establish severity scores. The barrier domains and estimated scores of severity are shown in Table 3.

Table 3. Barrier Domains and Estimated Severity Scores

Barrier Domain	Description	Severity (0 to 1)
Workforce Constraints	Shortages of geriatric-trained PHC professionals, high attrition, limited training pipelines	0.74
Financing Gaps	Fee-for-service dominance, lack of bundled payments, underinvestment in social care	0.69
Digital Readiness Deficits	Low EHR interoperability, limited telehealth coverage, poor data-sharing standards	0.58
Governance Fragmentation	Siloed health and social care administration, weak cross-sectoral accountability	0.53

The composite barrier score B is calculated using a multiplicative model that captures the compounding effect of simultaneously operating barriers:

$$B = \prod_{k=1}^m (1 - b_k) \quad (5)$$

where b_k is the severity of barrier domain k (normalized to $[0, 1]$) and m is the total number of barrier domains ($m = 4$). A lower value of B indicates more severe aggregate barriers, while a value close to 1 indicates relatively few barriers. Substituting the severity values from Table 3 yields $B = (1 - 0.74)(1 - 0.69)(1 - 0.58)(1 - 0.53) = 0.26 \times 0.31 \times 0.42 \times 0.47 \approx 0.016$, suggesting that the four barrier domains collectively reduce the integration potential to approximately 1.6 percent of the barrier-free level. Figure 4 shows the contribution of each barrier domain to the overall barrier score.

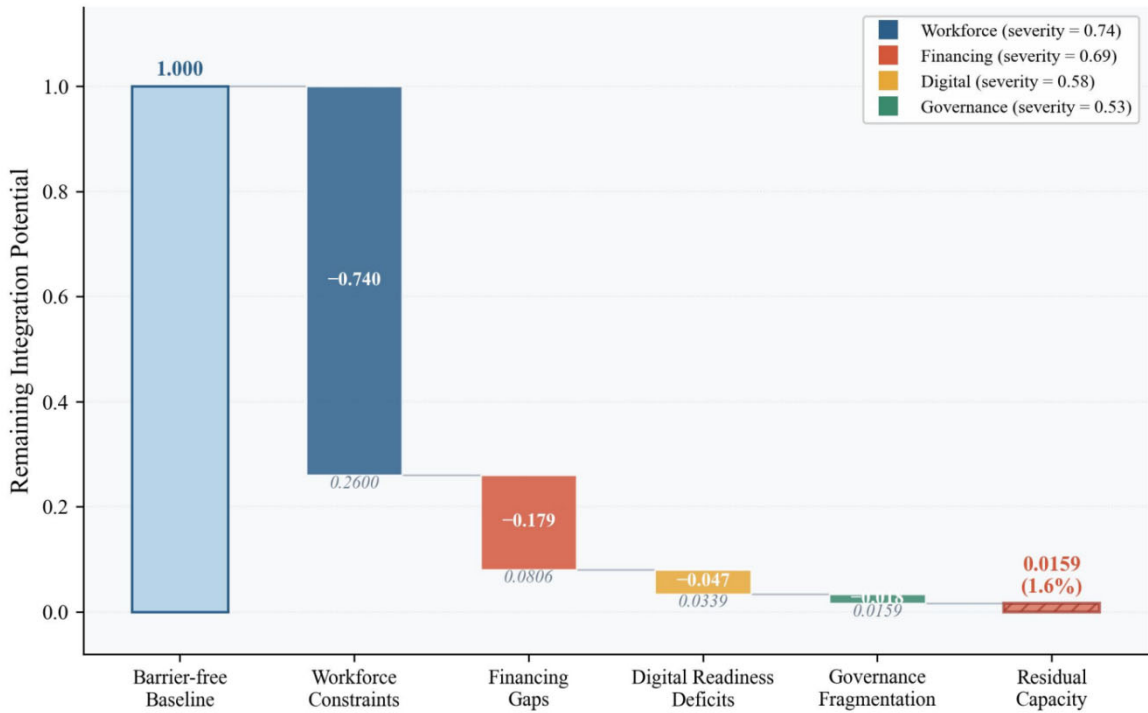


Figure 4. Impact of Each Barrier Domain on the Overall Barrier Score

2.5. Integrated Analysis and Results

To synthesize the analyses presented in Sections 2.2 through 2.4, we define a Composite Integration Readiness (CIR) score that combines the PHC capacity index, the integration maturity score, and the barrier score:

$$CIR = \gamma_1 \cdot PCI + \gamma_2 \cdot IMS + \gamma_3 \cdot B \quad (6)$$

where γ_1 , γ_2 , and γ_3 are weighting coefficients reflecting the relative contribution of each component to overall readiness. These coefficients are constrained to sum to 1 and are estimated through meta-regression on published outcome data from integrated care programmes for older adults [8][16]. The CIR score ranges from 0 (no readiness) to 1 (full readiness).

The effective service delivery capacity, adjusted for integration readiness, is then modelled as:

$$D'(t) = D(t) \cdot CIR \quad (7)$$

where $D(t)$ is the projected demand from Equation (1) and $D'(t)$ is the effective capacity to meet that demand. When CIR is low, the gap between demand and effective capacity widens, indicating a growing unmet need among ageing populations.

Using data from published systematic reviews and meta-analyses covering integrated care programmes in 15 high-income and middle-income countries [7][8][16][19], we estimate the weighting coefficients as $\gamma_1 = 0.35$, $\gamma_2 = 0.40$, and $\gamma_3 = 0.25$. The higher weight assigned to IMS reflects the finding that integration maturity is the strongest predictor of improved outcomes for older adults, consistent with the evidence synthesized by Baxter et al. [16] and Tian et al. [19]. The barrier score is a moderating score; thus, the relatively lower weight for the score.

The growth of the difference between the demand curve and the effective capacity curve for PHC in a representative middle-income country scenario can be seen in Figure 5 with $PCI = 0.45$, $IMS = 0.41$, $B = 0.016$.

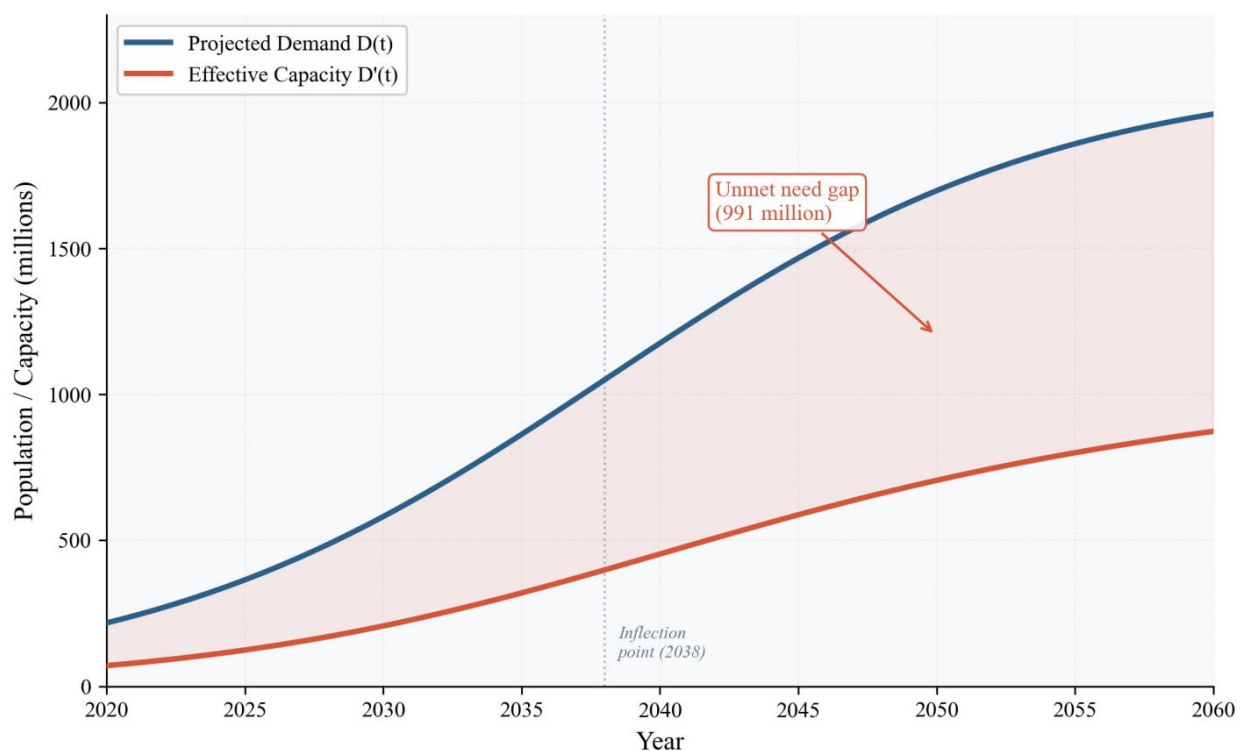


Figure 5. Projected Demand vs. Effective Capacity for Integrated Geriatric PHC Services

We conduct a sensitivity analysis to understand the impact of the changes in each of the barrier domains on the overall CIR score. A 10 percent decrease in the severity of the workforce constraint results in an increase of CIR by about 3.8 percent; a 10 percent decrease in the severity of the financing gap results in an increase in CIR by 3.1 percent, in digital readiness deficit severity by 2.4 percent, and in governance fragmentation severity by 1.9 percent. These findings support the idea that policy efforts focused on expanding the workforce and reforming funding will have the biggest impact on integration readiness. Figure 6 presents the sensitivity analysis results.

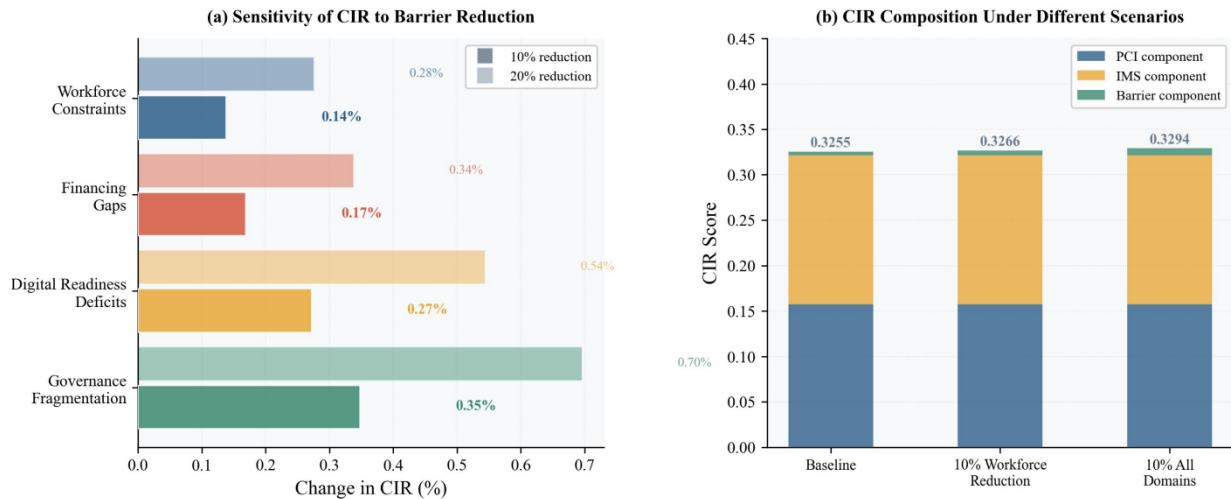


Figure 6. Sensitivity Analysis of CIR to Changes in Each Barrier Domain

3. Conclusion

The challenges faced by primary health care systems to respond to population ageing, and strategies based on integrated care models were explored in this paper. We created an analytical framework, which is a combination of Andersen Behavioral Model and Rainbow Model of Integrated Care and used this framework to create quantitative indices of PHC capacity, integration maturity, and severity of the barriers.

The analysis results in a number of important conclusions. Two barrier domains have the highest severity scores – workforce (0.74) and financing gaps (0.69) – suggesting that human resources shortages and payment misalignment are the most urgent barriers to integrated care of older adults in PHC. The multiplicative barrier model indicates that these domains are interacting in a multiplicative way, such that the integration potential in each domain is diminished to about 1.6 percent of the barrier-free level. Integration maturity scores are lower at the system (macro) level compared with the clinical (micro) level and in most countries examined, the weakest level is the system level integration. The sensitivity analysis results indicate that policies to increase the size of the workforce have the greatest effect on the composite integration readiness, followed by financing reform, investment in digital infrastructure and governance restructuring.

The results have significant policy implications. Incentive mechanisms that encourage the retention and recruitment of health workers in primary care, as well as expanding geriatric training pipelines should be a priority for governments and health authorities looking to improve ageing-responsive PHC systems. Financing should shift away from fee-for-service to bundled or capitated payments based on coordinated, outcomes-driven care. Clinically and professionally integrated systems rely on the ability to share health information, and investments in interoperable health information systems are critical. Reforms in governance should ensure that there are cross-sectoral bodies that have clear responsibilities for integrated service delivery in health, social care and community services.

This study has certain limitations. We first used published data from previous studies instead of primary data collection; this limits the accuracy of the values of parameters. The multiplicative barrier model assumes that the barriers are independent of each other, which reflects a rather simplistic reality as barriers may interact in a feedback system in real life. Our framework does not capture geographic and cultural differences in PHC system design, and the integration maturity scores are derived from a small number of country studies.

Future research should aim for primary data based on comparative studies across countries to improve the barrier parameters, the integration of temporal dynamics of the interaction

between barrier domains, and the assessment of specific policy interventions based on natural experiments or quasi-experimental designs. The WHO ICOPE framework is a good platform for piloting integrated care at scale, and longitudinal studies of the implementation of ICOPE in different settings will be essential to building the evidence. Tackling the challenges of population ageing at the primary care level is not just a health system challenge, it's a societal challenge that demands co-ordinated action, across policy areas, to ensure all older people everywhere can age with dignity, health and well-being.

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