



From Disease Burden to Workforce Policy: A Burden-Informed Framework for Health Workforce Planning in Indonesia

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ABSTRACT

Health workforce planning in Indonesia primarily relies on population ratios, facility-based standards, and workload indicators, with limited integration of disease burden evidence. This study aims to develop a burden-informed framework for health workforce planning in Indonesia using stroke as a tracer condition. A policy-oriented method was employed through secondary data analysis, spatial mapping, policy review, and conceptual framework development. The Global Burden of Disease (GBD) 2023 estimates, neurologist distribution, and CT scan readiness for thrombolysis services were analyzed across Indonesia's provinces. The findings identify two dominant workforce planning approaches currently adopted nationwide, i.e., population-based one and facility-based one, none of which systematically incorporates epidemiological burden indicators. Spatial analysis reveals substantial disparities in neurologist availability and thrombolysis service readiness, particularly in underserved regions. Several provinces categorized as adequately staffed according to conventional approaches simultaneously experienced high stroke burden pressure, indicating hidden workforce shortages and service inequities. In response, a burden-informed workforce planning framework consisting of four analytical stages was developed. The framework integrates disease burden evidence, diagnostic readiness, and workforce distribution into policy decision-making. This study suggests that burden-informed health workforce planning approaches may improve responsiveness, geographic equity, service readiness, and efficiency of health workforce policies in Indonesia.

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I. INTRODUCTION

Health systems worldwide are facing growing challenges in aligning health workforce capacity with rapidly changing population health needs. Demographic ageing, epidemiological transition, and the increasing burden of non-communicable diseases (NCDs) have created unprecedented demands for health services that are often inadequately reflected in conventional workforce planning approaches. Globally, NCDs account for approximately 74% of all deaths, with cardiovascular diseases remaining the worldwide leading cause of mortality and disability (Roth et al., 2020; WHO, 2024). These trends are particularly pronounced in low- and middle-income countries (LMICs), where health systems must simultaneously address persistent infectious diseases and a rapidly increasing burden of chronic conditions.

Indonesia is undergoing one of the most significant epidemiological transitions in Southeast Asia. Over the past three decades, the contribution of NCDs to mortality and disability has increased substantially, transforming the profile of health service needs across the country. According to the Global Burden of Disease (GBD) study 2023, stroke has emerged as the leading cause of death and disability in Indonesia, accounting for approximately 18% of all deaths and more than 10% of total Disability-Adjusted Life Years (DALYs) nationwide (Institute for Health Metrics and Evaluation, 2023). Beyond its health consequences, stroke imposes a considerable economic burden on Indonesia's health system. In 2023, stroke-related expenditures under the National Health Insurance (Jaminan Kesehatan Nasional/JKN) exceeded IDR 5.2 trillion, placing stroke among the costliest catastrophic conditions financed through the country's universal health coverage system (Kementerian Kesehatan, 2024).

The growing burden of stroke poses a major challenge for health workforce planning. Effective stroke prevention, acute management, and long-term rehabilitation require a multidisciplinary workforce involving general practitioners, neurologists, neurosurgeons, nurses, physiotherapists, radiologists, and rehabilitation professionals (Feigin et al., 2025). However, health workforce planning approaches in Indonesia, as in many LMICs, continues to rely primarily on population-based norms and facility staffing standards. These approaches typically estimate workforce requirements based on population size, health facility type, or

administrative staffing targets, with limited consideration of the epidemiological profile of the population being served (Boniol et al., 2022; WHO, 2023b). Population-based approaches, while deemed useful for determining aggregate workforce requirements, may be insufficient for identifying priority regions where disease burden substantially exceeds workforce capacity.

The limitations of population-based workforce planning have been increasingly recognized globally. In China, rapid expansion of physician production has improved overall workforce density, even though substantial regional disparities remain, since workforce allocation has not always reflected variations in population health needs (Bai et al., 2022; Zhu et al., 2019). Likewise, Thailand has successfully reduced rural workforce shortages through targeted recruitment and retention policies, although workforce planning remains largely driven by service coverage objectives rather than by epidemiological burden evidence (Pagaiya & Noree, 2009). Similarly, India has expanded access through community health workers and task-sharing approaches, but persistent imbalances between health needs and workforce distribution continue to challenge service delivery (Zodpey et al., 2021). More recently, several high-income countries have begun incorporating predictive analytics, population health intelligence, and disease forecasting into health workforce planning approaches so that they can more adequately anticipate future service needs (Birch et al., 2009).

As one source of evidence for health workforce planning, disease burden data are still deemed underutilized. The GBD study provides comprehensive and globally comparable estimates of mortality, morbidity, and disability across diseases, risk factors, and geographic locations (GBD 2019 Indonesia Subnational Collaborators, 2022). Unlike as DALY rate, offer a direct measure of population health loss, capturing both premature mortality and years lived with disability. Accordingly, these measures may provide a more meaningful basis for prioritizing workforce investments, particularly within settings characterized by substantial epidemiological heterogeneity across regions. However, despite the growing use of GBD data in health priority setting, health financing, and policy evaluation, its utilization in health workforce planning remains limited, particularly in the context of LMICs.

Indonesia is currently equipped with a relatively advanced health workforce information system and regularly produces disease burden estimates through the GBD framework. Nevertheless, these two sources of strategic information remain largely disconnected within workforce planning approaches. Existing planning mechanisms continue to emphasize population ratios, facility standards, and workload assessment, while epidemiological burden indicators are still rarely incorporated explicitly into decisions regarding workforce production, deployment, and redistribution. As a result, existing planning may inadequately respond to emerging health challenges associated with the ongoing NCD transition.

This study, therefore, aims to address this policy and methodological gap by exploring how disease burden estimates could be systematically integrated into health workforce planning in Indonesia. Using stroke as a tracer condition, this study examines the potential contribution of disease burden data to workforce planning approaches and proposes a burden-informed workforce planning framework that complements existing population-based approaches. Rather than replacing existing workforce planning methods, the framework proposed seeks to strengthen decision-making by integrating epidemiological burden evidence into workforce policy, allocation, and long-term planning. The findings would contribute to ongoing discussions on health workforce governance in Indonesia and provide insights for other LMICs facing similar demographic and epidemiological transitions. To certain extend, this study is among the first ones in Indonesia integrating epidemiological burden evidence, diagnostic service readiness, and specialist workforce distribution into a unified workforce planning framework.

II. ANALYTICAL FRAMEWORK

This study proposes a burden-informed workforce planning framework that integrates stroke burden trend, neurologist distribution, and CT scan availability into health workforce planning approaches in Indonesia. The framework conceptualizes stroke workforce planning not merely as a function of population size, but largely as a reflection of epidemiological burden evidence, geographic inequity, specialist workforce availability, and service readiness. Stroke was selected as a tracer condition since this disease has emerged as the leading cause of death and disability combined, ahead of ischemic heart

disease, also because it represents a suitable model for examining the interaction among disease burden evidence, health service readiness, and workforce planning within Indonesia's health system.

The availability of CT scan facilities constitutes a critical prerequisite for acute ischemic stroke thrombolysis, as timely neuroimaging is deemed essential. Therefore, the framework assesses the spatial distribution of CT scan and neurologist availability, corresponding with integrating maps of stroke burden across Indonesia to identify priority regions requiring simultaneous strengthening in workforce and infrastructure capacity.

The analytical framework illustrated in Figure 1 consists of four sequential analytical stages: (1) estimation of stroke burden trend, (2) assessment of neurologist distribution and thrombolysis service readiness, (3) identification of workforce and service gaps, and (4) development of a burden-informed workforce planning framework. Epidemiological burden evidence is positioned within this framework as a strategic input for workforce governance and policy formulation, shifting workforce planning approach from a predominantly demographic one toward a population health needs-based one. Within this framework, disease burden indicators function as strategic signals for workforce prioritization, redistribution, infrastructure strengthening, and policy intervention. The framework assumes that workforce requirements and acute stroke service readiness should be determined not only by population size, but also by the magnitude, geographic distribution, and clinical complexity of disease burden. Accordingly, regions showing higher stroke burden require proportionally greater specialist workforce capacity and diagnostic infrastructure readiness. This perspective aligns with recent literature on needs-based workforce planning emphasizing that workforce production and deployment should be responsive to population health needs rather than merely to demographic benchmarks. However, operational integration between epidemiological burden estimation and workforce governance remains particularly limited in LMICs, such as Indonesia.

Evidence from the GBD study demonstrates that stroke burden distribution across provinces in Indonesia is highly heterogeneous, with substantial regional variation in incidence, prevalence, mortality, and DALY rates.

Nevertheless, these epidemiological burden indicators still have not been systematically incorporated into national health workforce planning mechanisms, since existing planning approaches continue to rely predominantly on population-based indicators, such as physician-to-population or nurse-to-population ratios. Although administratively practical, such approaches often fail to capture regional differences in terms of epidemiological transition, disease burden intensity, service complexity, and health system readiness. These things are still rarely prioritized in existing decisions regarding planning mechanisms, service regions, and substantial intervention on workforce capacity.

Therefore, rather than replacing existing population-based approaches, the framework proposed serves as an additional layer of evidence designed to improve the responsiveness of health workforce planning to changing epidemiological conditions. The framework, therefore, represents a practical mechanism for linking disease burden evidence with health workforce governance and policy decision-making in Indonesia. Moreover, resulting evidence would also support policy actions related to digital health investment and telehealth nationwide adoption.

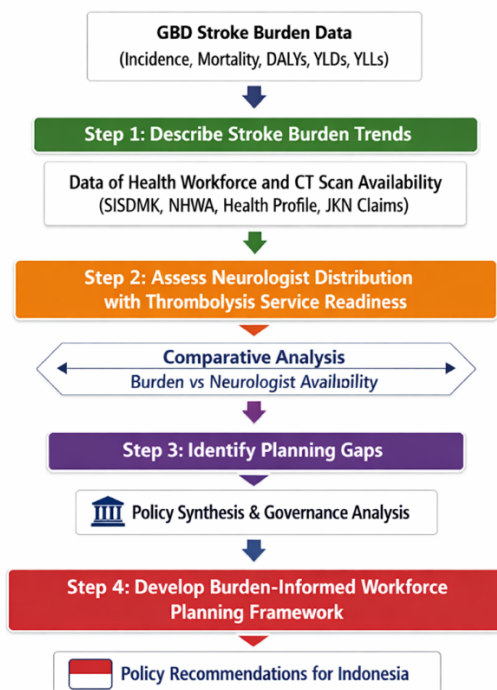


Figure 1. Analytical Framework for Stroke Burden Trend and Health Workforce Planning

III. METHODOLOGY

A. Study Design

This study employed a policy-oriented methodological design to develop a burden-

informed framework for health workforce planning in Indonesia. This study combined secondary data analysis, spatial mapping, policy review, and conceptual framework development to explore how disease burden evidence could be systematically integrated into health workforce planning approaches. This study did not aim to estimate precise workforce requirements. Instead, it sought to identify opportunities for integrating epidemiological intelligence into health workforce planning framework and develop a practical system for supporting workforce policy decisions.

The burden-informed workforce planning framework was developed through an iterative four-stage analytical process: (1) epidemiological burden assessment, (2) workforce and thrombolysis service distribution assessment, (3) comparative gap analysis, and (4) framework synthesis and policy integration. The overall process aimed to examine the relationship among population health needs, diagnostic capacity, and specialist workforce distribution for establishing burden-informed workforce planning policy in Indonesia.

The first analytical stage examined temporal and geographic trends in stroke burden using the GBD 2023 estimates, focusing on incidence, prevalence, mortality, and DALY rates. The analysis focused on age-standardized incidence, mortality, and DALY rates as indicators of population health needs and future service demand. DALY rate was prioritized owing to its ability to capture both premature mortality and disability burden, providing a more thorough representation of epidemiological pressure relevant to long-term workforce and health service planning. Descriptive trend was analyzed across provinces and over time to identify regions with high stroke burden and increasing epidemiological pressure.

The second analytical stage assessed the health workforce planning approaches currently adopted in Indonesia, with a view of geographic distribution and density of neurologists alongside the availability of CT scan facilities for thrombolysis service readiness. This service readiness was operationally defined as the concurrent availability of neurologists and CT scan 64-slice capacity required for stroke care intervention (Ho & Powers, 2024). This definition aligns with WHO recommendations emphasizing timely diagnosis, referral readiness, and access to essential diagnostic technologies as key components of effective stroke care systems (WHO, 2021). The analysis examined provincial

service readiness distribution as well as the density and concentration of neurologist and CT scan availability across regions. The JKN claims data were additionally analyzed to estimate stroke-related service utilization patterns and the fiscal burden associated with stroke treatment across provinces.

In parallel, this study reviewed existing workforce planning approaches currently adopted in Indonesia. Relevant policy documents, workforce planning guidelines, technical regulations, and governance frameworks were examined to identify the primary indicators, assumptions, strengths, and limitations of existing workforce planning approaches. Particular attention was given to population-based planning, facility-based planning, and burden-informed workforce planning approaches. The review aimed to examine the extent to which current workforce planning systems incorporate epidemiological burden evidence into planning and allocation processes.

The third analytical stage comprised comparative spatial analysis among stroke burden indicators, neurologist distribution, and CT scan availability to identify provinces with high epidemiological burden, but limited-service readiness in workforce and diagnostic infrastructure capacity. Spatial overlay analysis was conducted to compare provincial stroke burden patterns with neurologist distribution and CT scan availability in order to identify geographic mismatches and service inequities in acute stroke care readiness. Districts and provinces were subsequently categorized into four thrombolysis service readiness groups: (1) regions with both neurologists and CT scan facilities, (2) regions with neurologists but lacking CT scan facilities, (3) regions with CT scan facilities but without neurologists, and (4) regions lacking both neurologists and CT scan facilities. This classification enabled identification of geographic disparities in stroke service readiness and priority regions requiring workforce and technological infrastructure strengthening. Existing gap was identified through burden-to-workforce mapping and comparative service readiness analysis—rather than merely through population-based criteria—to assess whether conventional workforce planning indicators and burden-informed assessment produced different interpretations of workforce adequacy, which reflected actual disease burden patterns.

The final analytical stage synthesized findings from epidemiological analysis, workforce and

service readiness assessment, spatial inequity analysis, and policy review to develop a burden-informed framework for health workforce planning in Indonesia. The framework development was guided by the following sources: the GBD study, the WHO's National Health Workforce Accounts (NHWA) framework, the WHO's Workload Indicators of Staffing Need (WISN) methodology, spatial equity perspectives, and evidence-informed policymaking approaches. The resulting framework integrates epidemiological burden indicators, diagnostic capacity, neurologist distribution, and governance mechanisms into a planning model aimed to support more equitable resource allocation, responsive, and geographically sensitive workforce policy decision-making for stroke care intervention in Indonesia.

B. Data Sources

This study used multiple national and global secondary data sources to support framework development and analysis. Secondary datasets were obtained from the GBD 2023 estimates, the Statistics Indonesia (BPS), the Indonesian Health Workforce Information System (SISDMK), NHWA, the Indonesia Health Profile reports, the JKN claims data, and stroke-related service distribution mapping data. The integration of these datasets enabled triangulation among epidemiological burden evidence, infrastructure readiness, workforce availability, and service demand.

Stroke burden data were obtained from the GBD study 2023. Indicators included incidence, prevalence, mortality, and DALY rates. These measures were used to assess temporal trends in stroke burden and to illustrate the potential integration of epidemiological intelligence into workforce planning. Demographic data were obtained from the Statistics Indonesia, while health system information was obtained from national policy documents, the Ministry of Health reports, and relevant health sector planning documents. These sources were used to provide contextual information on population health needs and workforce planning approaches in Indonesia.

Health workforce data were obtained from SISDMK, NHWA, and the Ministry of Health's workforce planning documents. Information searched included provincial workforce availability/density, production, and deployment. Meanwhile, CT scan availability data and thrombolysis stroke care intervention mapping

datasets were obtained from national health facility reports.

C. Analytical Process

Temporal trends in age-standardized stroke incidence, mortality, prevalence, and DALY rates between 2000 and 2023 were analyzed descriptively using the GBD 2023 estimates. The analysis aimed to identify epidemiological burden patterns relevant to health workforce planning and future service demand. Existing workforce planning approaches currently adopted in Indonesia were reviewed using policy documents, technical guidelines, and workforce planning regulations. Planning approaches were categorized into population-based one and facility-based one. Each approach was assessed in terms of its primary indicators, strengths, and limitations for aligning workforce planning with population health needs.

A planning gap analysis was conducted to examine the extent to which disease burden data are integrated into existing workforce planning approaches. The analysis compared information currently used in workforce planning with epidemiological burden evidence available through disease burden estimates. The analysis focused on identifying gaps related to workforce planning methodology, which applies a supply-demand approach to estimate workforce availability and distribution needs across provinces (Ministry of Health of the Republic of Indonesia, 2026). To illustrate the potential implications of burden-informed workforce planning, workforce fulfillment estimates were compared with burden-to-neurologist ratios calculated using provincial stroke DALYs and neurologist availability data. The burden-to-neurologist ratio was calculated using the following formula:

$$\text{Burden-to-Neurologist Ratio} = \frac{\text{Stroke DALYs}}{\text{Number of Practicing Neurologists}}$$

Higher values indicate greater stroke burden per available neurologist and may suggest higher workforce pressure. To facilitate interpretation, provincial burden-to-neurologist ratios were ranked and classified into four quartiles based on the distribution of ratios across provinces. Quartile thresholds were determined using the 25th, 50th, and 75th percentiles. Provinces were subsequently grouped into four burden pressure categories, the results of which are shown as follows:

Table 1. Grouping of Provinces based on Burden Pressure Categories

Quartile	Category	Interpretation
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Q1 ($\leq$ P25)	Low Burden Pressure	Lowest burden per neurologist
Q2 (P25–P50)	Moderate burden pressure	Moderate burden per neurologist
Q3 (P50–P75)	High burden pressure	High burden per neurologist
Q4 ($>$ P75)	Very high burden pressure	Highest burden per neurologist

Burden-informed assessment using the burden pressure categories aimed to see whether workforce fulfillment status in several provinces differed from that of resulted by conventional workforce planning metrics. As revealed, several provinces were interpreted as potentially experiencing workforce shortages, i.e., the ones that were classified as adequately staffed according to conventional approaches, but simultaneously categorized as facing high or very high burden pressure. This categorization aimed to demonstrate how burden-informed assessment may reveal workforce pressures that are not detected via conventional workforce planning methods.

Next, the framework proposed was assessed against Indonesia's current health system interventions, such as the implementation of the National Medium-Term Development Plan (RPJMN), health system transformation initiatives, workforce strengthening strategies, and digital health development policies. This assessment aimed to identify potential entry points for integrating burden-informed workforce planning into existing policy and planning approaches.

This study used publicly available secondary data and aggregated administrative information. No individual-level data were used, and no human subjects were directly involved. Therefore, formal ethical approval was not required in accordance with applicable national research ethics guidelines.

IV. RESULTS

A. Stroke Remains Workforce Planning Challenge

Stroke has emerged as the leading cause of mortality and health loss in Indonesia. According to the GBD study 2023, stroke accounted for approximately 18% of all deaths and 10.7% of total DALYs, making it the single largest contributor to national disease burden (Institute for Health Metrics and Evaluation, 2023).

Although age-standardized stroke incidence, mortality, and DALY rates declined between 2000 and 2023 (Figure 1), stroke remains the leading

cause of mortality and disability in Indonesia. The persistence of high disease burden despite improvements in age-standardized rates reflects the combined effects of population growth, population ageing, and continued exposure to major risk factors, such as hypertension, smoking, obesity, and unhealthy dietary patterns (Feigin et al., 2024; GBD 2021 Risk Factors Collaborators, 2024). In 2023, the age-standardized stroke incidence rate reached approximately 271 cases per 100,000 people, while the mortality rate was estimated at 139 deaths per 100,000 people (Institute for Health Metrics and Evaluation, 2023).

Moreover, national economic consequences due to stroke are equally significant. The JKN expenditure for stroke exceeded IDR 5.2 trillion in 2023, placing stroke among the most costly catastrophic diseases financed through Indonesia's universal health coverage system (Kementerian Kesehatan, 2024). These findings indicate that stroke not only poses a major public health challenge, but also generates substantial demand for health workforce capacity.

The findings also demonstrate that inadequate neurologist distribution frequently coincided with

limited availability of CT scan facilities, restricting the operational capacity for thrombolysis services in underserved provinces. In several regions, CT scan facilities were available without neurologist support, while other regions experienced shortages in both specialist workforce and diagnostic infrastructure. These patterns suggest that workforce maldistribution and infrastructure inequity jointly contribute to disparities in acute stroke care readiness. Given these geographic constraints, the analysis identified telehealth models as potential adaptive strategies for improving access to specialists in underserved regions. Provinces with limited neurologist availability, but existing CT scan infrastructure, may benefit from hub-and-spoke telemedicine networks that enable remote neurologist consultation, image interpretation, and thrombolysis service decision support from tertiary stroke care centers.

As the leading cause of nationwide mortality, disability, and high health expenditure, stroke—used as a tracer condition—illustrates how disease burden evidence could provide useful insights on workforce planning decisions.

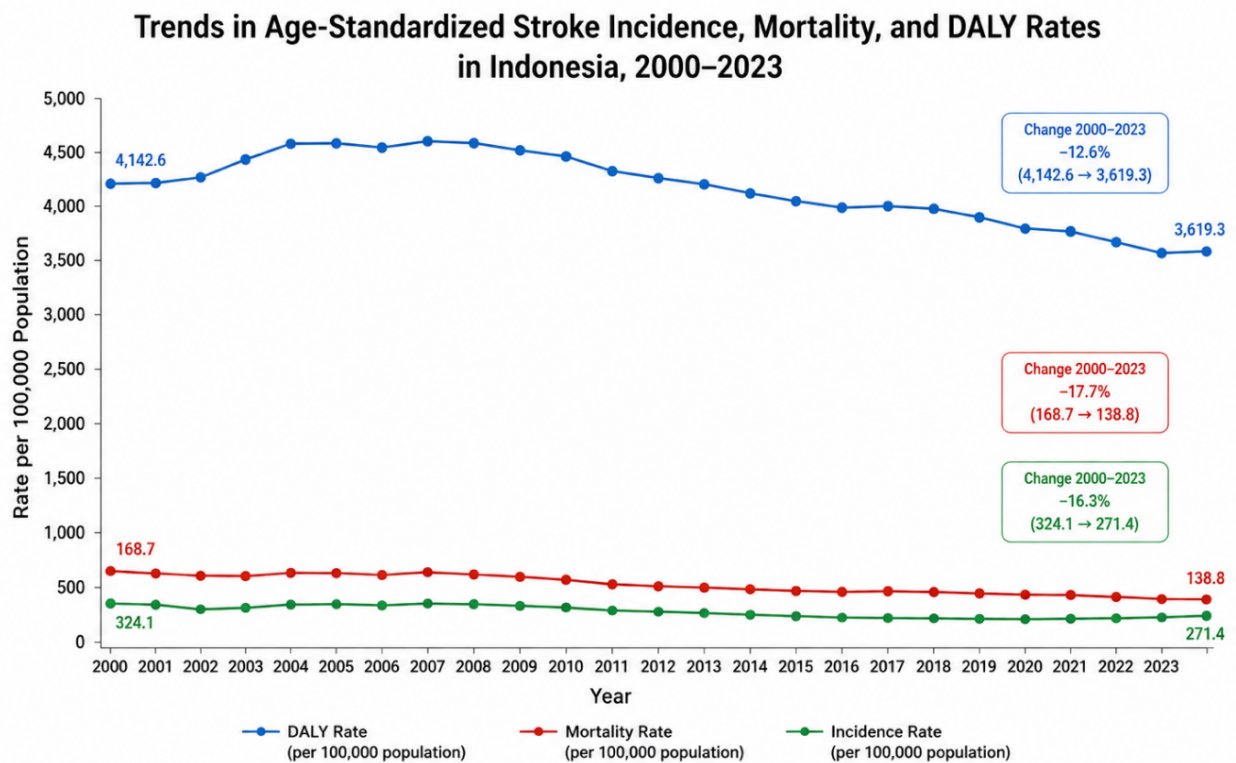


Figure 2. Trends in age-standardized stroke incidence, mortality, and DALY rates in Indonesia from 2000 to 2023 (Source: Institute for Health Metrics and Evaluation, 2023)

As seen in Figure 2, all age-standardized indicators show gradual declines from 2000 to 2023: incidence rate decreased from 324.1 to 271.4 per 100,000 people, mortality rate declined from 168.7 to 138.8 per 100,000 people, and DALY rate decreased from 4,142.6 to 3,619.3 per 100,000 people, as reported by the GBD study 2023. However, despite these improvements, stroke remains the leading cause of mortality and disability in Indonesia, highlighting the continued need for strategic workforce planning and health system strengthening.

B. Existing Workforce Planning Approaches Not Fully Capture Changing Health Needs

Review of current health workforce planning mechanisms in Indonesia identifies two major planning approaches currently adopted: population-based one and facility-based one. These approaches as a whole provide foundation for workforce production, allocation, deployment, and monitoring activities within national health system. Population-based planning estimates workforce requirements using workforce-to-population ratios and remains widely used for setting national workforce targets and monitoring workforce density. Meanwhile, facility-based planning focuses on staffing norms, facility types, and service packages to support operational workforce allocation. These approaches provide valuable tools for workforce management and have contributed substantially to workforce planning and policy development in Indonesia. However, analysis of current workforce planning approaches suggests that epidemiological burden indicators are still rarely incorporated into health workforce planning decisions. Although disease

burden data are increasingly available through the GBD study and other health information systems, workforce planning continues to be driven primarily by demographic, administrative, service delivery, and workforce supply considerations. This delimitation becomes increasingly problematic given Indonesia's ongoing epidemiological transition. As non-communicable diseases, such as stroke, account for a growing share of mortality and disability, workforce planning systems based primarily on population size, staffing standards, workload measures, or workforce availability may not thoroughly reflect variations in population health needs across geographic regions.

Global experience demonstrates a growing shift toward integrating population health intelligence into health workforce planning. Several countries have begun incorporating predictive analytics, disease burden estimates, health needs assessments, and service demand modeling into workforce governance to improve alignment between workforce capacity and population health needs (Birch et al., 2015). These developments suggest that disease burden evidence may provide a useful complementary source of information for strengthening workforce planning and prioritization.

Table 2 summarizes the major workforce planning approaches currently adopted in Indonesia and highlights their respective strengths and limitations. The burden-informed workforce planning approach proposed is presented here as a complementary framework designed to address limitations identified in existing approaches while building upon their established strength.

Table 2. Comparison of Existing and Proposed Health Workforce Planning Approaches in Indonesia

Approach	Primary Indicator	Strength	Limitation
Population-based Planning	Population size, workforce-to-population ratios	Simple, standardized, suitable for national target setting, easy to communicate to policymakers	Assumes uniform health needs, does not account for disease burden patterns, less sensitive to epidemiological transitions
Facility-based Planning	Facility type, staffing norms, service packages	Supports operational workforce allocation, aligns with service delivery requirements	Focuses on facility standards rather than on population health needs, may not reflect changing disease patterns
Burden-informed Planning (Proposed)	Disease burden data (DALYs, incidence, prevalence, mortality), workforce data, population data	Aligns workforce planning with population health needs, supports prioritization, responsive to epidemiological transitions	Requires integration of multiple data systems and analytical capacity

C. Planning Gap and Opportunities for Integration

Despite the availability of data sources in the form of comprehensive disease burden estimates and increasingly sophisticated workforce information systems, they remain largely disconnected within

current workforce planning approaches in Indonesia. Existing workforce planning approaches primarily rely on population-based ratios, staffing standards, and workload measures, while epidemiological burden indicators, such as incidence, mortality, prevalence, and DALY rates,

are still rarely incorporated into health workforce planning decisions.

As a result, existing workforce planning systems may be effective in identifying workforce shortages from supply perspective, but less capable of detecting mismatches between workforce capacity and population health needs. This disconnection practically limit the planners' ability to prioritize workforce investments, deployment strategies, and specialist training programs based on disease burden patterns.

To illustrate this planning gap, an exploratory comparison was conducted between conventional workforce planning indicators and burden-informed assessment using neurologist services and stroke burden as the examples. Neurologists were selected as an illustrative workforce category because stroke has been viewed as the leading cause of mortality and disability in Indonesia, and specialist neurological services play a critical role in stroke prevention, diagnosis, acute management, and rehabilitation. Figure 3A presents provincial neurologist workforce fulfillment based on the Ministry of Health's supply-demand workforce planning methodology. Meanwhile, Figure 3B presents burden pressure categories derived from provincial stroke DALY-to-neurologist ratios. These two figures were compared to examine whether provinces classified

as adequately staffed according to conventional workforce planning approaches also demonstrate lower burden pressure when assessed using disease burden indicators.

Conventional workforce fulfillment estimates indicate that several provinces have achieved adequate or near-complete neurologist workforce fulfillment according to projected workforce supply and demand. However, burden-informed assessment reveals a different pattern. As revealed by the assessment using stroke DALYs per neurologist, five provinces were classified as adequately staffed according to conventional workforce planning approaches, but simultaneously categorized as experiencing high or very high burden pressure (Table 3). These findings suggest that workforce adequacy based on projected workforce supply and demand does not necessarily correspond to lower workforce pressure from population health perspective. In other words, provinces that appear adequately staffed according to conventional workforce planning metrics may continue to experience substantial unmet service needs associated with high disease burden. This discrepancy highlights the importance of complementing conventional workforce planning indicators with burden-informed assessment that more thoroughly reflect population health needs and service demand.

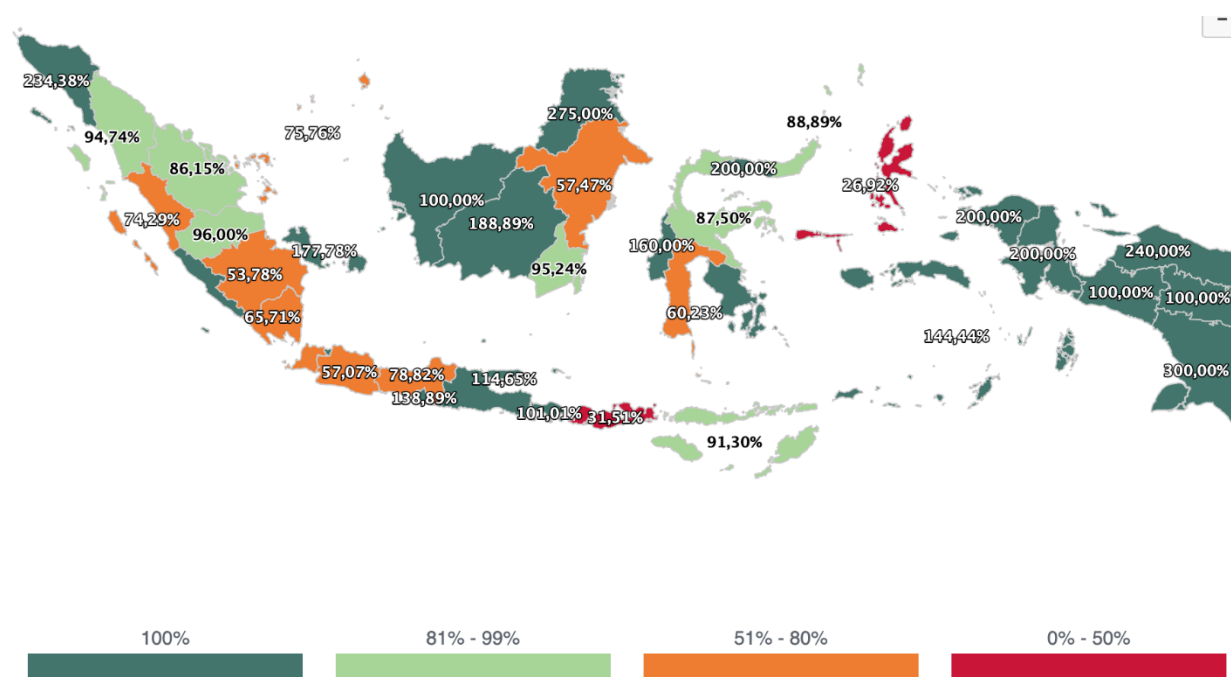


Figure 3A. Provincial Neurologist Workforce Fulfillment Based on Conventional Workforce Planning Approaches in Indonesia (Source: Ministry of Health of the Republic of Indonesia, 2026)

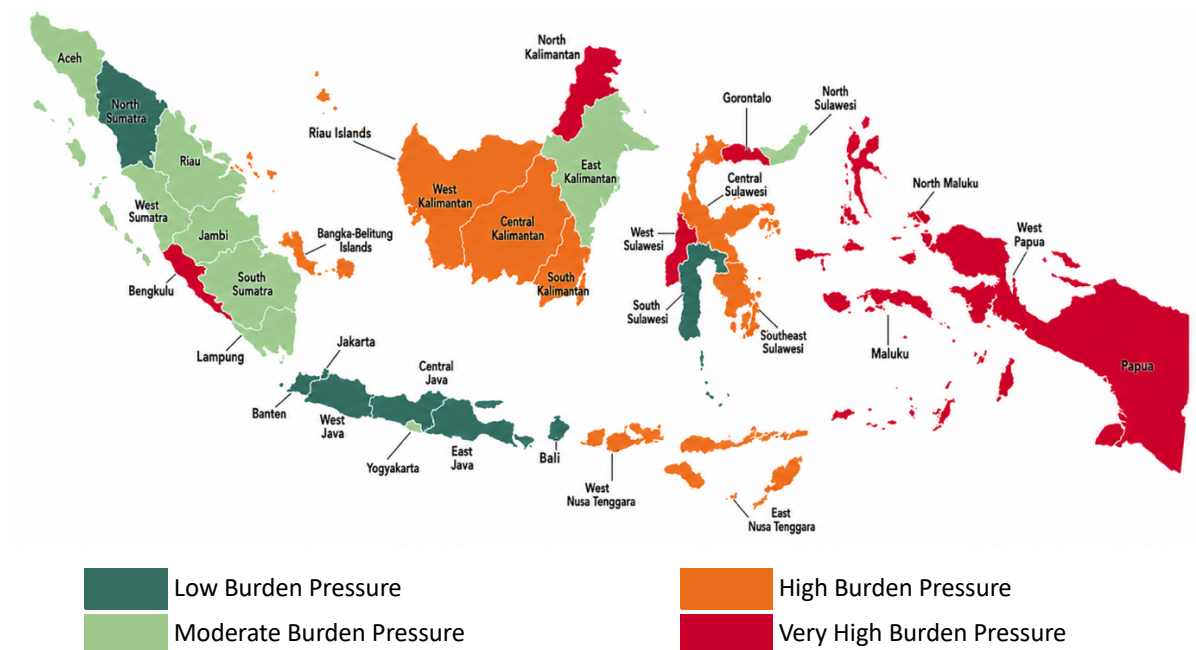


Figure 3B. Provincial Burden Pressure Categories Based on Stroke DALY-to-Neurologist Ratios in Indonesia

Provincial neurologist workforce fulfillment rates (%) showed in Figure 3A were calculated using the Ministry of Health's supply-demand workforce planning methodology. Workforce fulfillment represents the proportion of projected neurologist supply relative to projected workforce demand at the provincial level. Provinces were classified into four fulfillment categories: low (0–50%), moderate (51–80%), high (81–99%), and full fulfillment (100%).

As seen in Figure 3B, provinces were classified into four quartiles (Q1–Q4) based on the distribution of burden-to-neurologist ratios. Low burden pressure indicates relatively lower stroke burden per neurologist, while very high burden pressure indicates substantially greater burden per available neurologist. Higher burden pressure categories may reflect increased service demands relative to available capacity of specialist workforce.

Distribution of Cities/Districts capable providing thrombolysis services

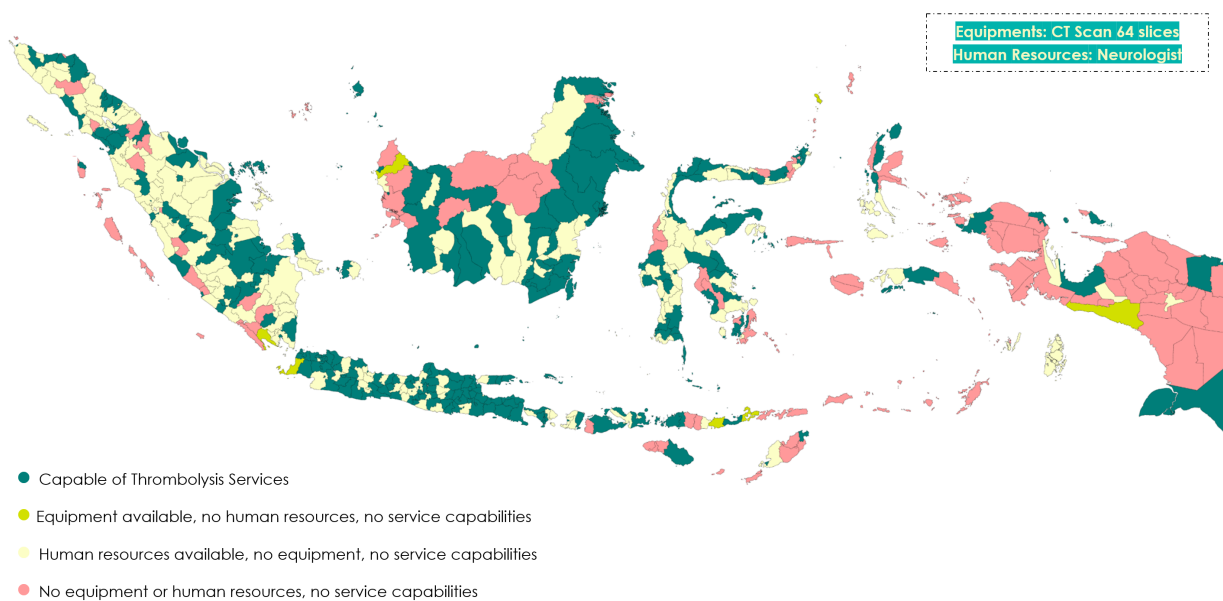


Figure 3C. Distribution of Thrombolysis Service Capacity (Availability of CT Scan Facilities and Neurologists) (Source: Ministry of Health of the Republic of Indonesia, 2025)

The spatial distribution map shown in Figure 3C demonstrates substantial geographic disparities in thrombolysis service readiness across regions in Indonesia, highlighting regions with limited availability of diagnostic infrastructure and human resources. Districts and cities capable of providing thrombolysis services, indicated by the concurrent availability of neurologists and CT scan facilities, were predominantly concentrated in western Indonesia, particularly in Java and several urbanized regions of Sumatra and Sulawesi. In contrast, many regions in eastern Indonesia, especially Papua, Maluku, and several parts of Nusa Tenggara, lacked both specialist workforce and diagnostic infrastructure required for acute stroke thrombolysis services. The map also illustrates varying patterns of service readiness gaps. Several regions possessed neurologists but lacked CT scan facilities, suggesting infrastructure limitations despite workforce availability. Conversely, a smaller number of regions had CT

scan facilities without neurologists, indicating persistent specialist workforce maldistribution. Overall, the findings highlight significant inequities in access to evidence-based acute stroke care intervention as well as demonstrate a mismatch between geographic service readiness and the need for timely thrombolysis services across Indonesia.

Table 3 presents illustrative examples of provinces where conventional workforce planning indicators and burden-informed assessment produce different interpretations of workforce adequacy. Bengkulu, West Sulawesi, Maluku, and North Kalimantan were categorized as adequately staffed according to conventional workforce planning approaches, but simultaneously experienced very high burden pressure. Central Kalimantan demonstrated a similar pattern, with adequate workforce fulfillment but high burden pressure.

Table 3. Illustrative Examples of the Planning Gap between Conventional Workforce Planning Indicators and Burden-Informed Assessment

Province	Workforce Fulfillment Status	Burden Pressure Category	Interpretation
Bengkulu	Adequate	Very High	Hidden workforce shortage
West Sulawesi	Adequate	Very High	Hidden workforce shortage
Maluku	Adequate	Very High	Hidden workforce shortage
North Kalimantan	Adequate	Very High	Hidden workforce shortage
Central Kalimantan	Adequate	High	Hidden workforce shortage

Table 4. Proposed Burden-Informed Health Workforce Planning Framework

Element	Data Source	Key Indicator	Planning Function
Epidemiological Intelligence	GBD estimates, <i>SKI</i> , <i>Riskesmas</i> , routine surveillance	Incidence, prevalence, mortality, DALYs, risk factors	Identify current and future population health needs
Demographic Intelligence	Statistics Indonesia	Population size, age structure, population growth, migration	Estimate population demand and future service needs
Workforce Intelligence	<i>SISDMK</i> , NHWA, professional councils	Workforce stock, distribution, productivity, vacancies, retirement trends	Assess workforce availability and capacity
Service Utilization Intelligence	<i>JKN</i> claims, hospital information systems	Service volume, referral patterns, utilization rates, treatment costs	Estimate service demand and workforce workload
Planning & Prioritization	Integrated analysis of epidemiological and workforce data	Priority diseases, priority provinces, workforce gaps	Determine workforce priorities and resource allocation
Policy Implementation	Ministry of Health, provincial governments, educational institutions	Recruitment, deployment, redistribution, training capacity, retention strategies	Translate planning outputs into workforce policies
Monitoring & Evaluation	Health information systems, workforce registries, program reports	Workforce performance, service coverage, health outcomes	Monitor implementation and support continuous improvement

The observed discrepancy highlights the potential value of integrating disease burden indicators into health workforce planning approaches. While conventional workforce planning indicators remain essential for estimating workforce requirements and monitoring workforce availability, burden-informed assessment provides complementary information on population health

needs and service demand. Together, these findings emphasize the need for a more integrated workforce planning approach that combines epidemiological intelligence with workforce intelligence to improve workforce policy decisions and resource allocation. The observed planning gap also highlights the need for a more systematic mechanism to integrate

epidemiological intelligence into health workforce planning approaches. In response to this challenge, a burden-informed workforce planning framework was developed. Table 4 operationalizes the framework presented in Figure 1 by specifying data sources, key indicators, and planning functions of each element. Several operational elements, i.e., demographic intelligence, service utilization intelligence, and monitoring and evaluation, are embedded within the four stages illustrated in Figure 1.

V. DISCUSSION

A. Why Matters for Workforce Planning

This study highlights the potential value of disease burden evidence as a complementary input to health workforce planning. While conventional workforce planning approaches in Indonesia have relied primarily on population-based ratios and facility staffing standards, the findings suggest that these approaches may not fully capture changing patterns of population health needs. Similar concerns have been raised globally, where workforce planning approaches have often been criticized for focusing on workforce supply rather than on population health needs (Birch et al., 2015; Ono et al., 2013).

Although age-standardized stroke incidence, mortality, and DALY rates have declined over the past two decades, stroke remains the leading cause of mortality and disability in Indonesia (Institute for Health Metrics and Evaluation, 2023). This finding suggests an important principle for workforce planning: workforce requirements are determined not solely by population size or workforce availability, but also by the geographic distribution and magnitude of population health needs. In this regard, rather than mere population counts, disease burden indicators, such as DALY rate, are deemed more reliable, since they provide a direct measure of health loss by combining premature mortality and disability burden, offering a more comprehensive basis for identifying priority health needs (Murray et al., 2012).

Previous studies have demonstrated the utilization of disease burden estimates in health priority setting, resource allocation, and health financing decisions (GBD 2019 Indonesia Subnational Collaborators, 2022; Murray, 2020). However, their application in workforce planning remains limited, particularly in LMICs, where the approaches continue to rely primarily on population size and administrative criteria (Boniol et al., 2022). This study, therefore, contributes to

an emerging research area of workforce planning by proposing a structured mechanism that integrates epidemiological intelligence into workforce governance and planning approaches.

Beyond its policy relevance, this study contributes to existing literature on health workforce planning by extending conventional workforce planning frameworks through the integration of epidemiological intelligence. Since existing approaches, such as population-based planning, workforce supply forecasting, and the WISN manual, primarily focus on workforce availability and service delivery requirements, the framework proposed in this study, therefore, provides a complementary health-needs perspective by incorporating disease burden evidence into health workforce planning decisions.

B. Moving Beyond Population-Based Workforce Planning

The findings suggest that burden-informed workforce planning framework should be viewed as a complement rather than as a replacement of existing workforce planning approaches. Indonesia's current workforce planning methods provide an important foundation for workforce management, workforce production planning, and resource allocation. However, the increasing availability of disease burden data presents opportunities to further strengthen workforce planning by incorporating additional intelligence on population health needs.

Population-based approaches remain useful for setting national workforce targets and monitoring workforce density, while facility-based approaches and the WHO's WISN manual continue to provide valuable tools for operational workforce management (WHO, 2023b). The illustrative neurologist case study presented here does not suggest drawbacks in the existing Ministry of Health's supply-demand workforce planning methodology. Instead, the case demonstrates how disease burden indicators may provide complementary insights into workforce pressures that are not always captured through conventional workforce planning metrics.

However, workforce planning approaches based solely on population ratios assume relatively uniform health needs across populations and geographic regions. This assumption becomes increasingly problematic during epidemiological transitions characterized by substantial variation in disease burden and service demand (Birch et al., 2009). Prior studies have argued that workforce planning should be grounded in health needs and

expected service requirements rather than merely in workforce supply trends (Birch et al., 2015).

Globally, workforce planning is increasingly moving toward integrated models that combine workforce intelligence, service utilization data, and population health indicators. The WHO's NHA framework emphasizes the importance of linking workforce information systems with broader health system performance indicators to support evidence-informed decision-making (WHO, 2017). Similarly, health workforce planning frameworks in Canada, Australia, and the United Kingdom increasingly incorporate health needs assessments and demand forecasting approaches (Dreesch et al., 2005).

The burden-informed framework proposed in this study aligns with these developments and responds to the specific context of Indonesia. By integrating disease burden estimates with workforce and service utilization data, the framework seeks to strengthen evidence-informed decisions regarding workforce production, deployment, redistribution, and retention.

C. Policy Implications

The framework proposed has several implications for workforce governance and health policy in Indonesia. Firstly, disease burden evidence could be systematically incorporated into health workforce planning approaches supporting the implementation of the National Medium-Term Development Plan (RPJMN) and ongoing health system transformation initiatives. Integrating epidemiological burden indicators into workforce planning decisions may improve prioritization of workforce investments toward health conditions that contribute disproportionately to mortality, disability, and healthcare expenditure (GBD 2019 Indonesia Subnational Collaborators, 2022). Such approach would enable workforce policies to be more responsive to changing population health needs and emerging epidemiological challenges.

Secondly, burden-informed planning may strengthen workforce deployment and redistribution policies, since existing workforce allocation mechanisms often rely heavily on population size and administrative criteria. These indicators, although remain important, may not fully capture geographic variations in disease burden and service demand. Thus, incorporating disease burden estimates could improve the planners' ability to identify provinces and districts where health needs substantially exceed available workforce capacity. Similar approaches have been

recommended by WHO as part of efforts to improve workforce equity and access to essential health services (WHO, 2023a)

Thirdly, the framework may support more strategic workforce production decisions. Educational investments, residency allocations, and specialist training programs could be informed not only by projected workforce shortages, but also by future disease burden and expected service demand. Aligning workforce production with epidemiological trends may help in ensuring that future workforce capacities would be more thoroughly reflect the evolving population health needs. This approach is consistent with global recommendations that workforce production should be guided largely by population health needs rather than merely by historical staffing patterns (Boniol et al., 2022).

Fourthly, burden-informed planning creates opportunities to leverage digital health innovations to address workforce shortages and geographic inequities. Provinces showing high disease burden, but limited specialist availability, may benefit from telehealth approaches, such as tele-neurology, teleradiology, and remote rehabilitation services. Evidence suggests that digital health interventions can improve access to specialists as well as reduce geographic barriers to healthcare, particularly within geographically dispersed settings (WHO, 2021). The findings support the notions that technological adaptation strategies, particularly telehealth and telestroke approaches, may provide an important complementary solution for addressing workforce maldistribution within resource-constrained settings. Previous studies have demonstrated that telestroke networks can improve access to thrombolysis services, reduce treatment delays, and support evidence-based stroke care intervention in rural and underserved regions. In LMICs, telemedicine-based hub-and-spoke models have been increasingly recognized as feasible approaches for extending neurologists' expertise to regions with limited specialist availability. In the context of Indonesia, telehealth adoption may be particularly relevant for provinces where CT scan facilities are already available, but neurologist distribution remains inadequate. Under such arrangements, provincial or district hospitals could perform rapid neuroimaging locally while receiving remote consultation and decision support from neurologists located in tertiary referral centers. This approach may help optimize existing

infrastructure capacity as well as reduce geographic barriers to acute stroke care intervention.

Importantly, these policy implementations do not need to replace existing workforce planning approaches. Instead, they demonstrate how disease burden evidence can complement current workforce planning systems by providing additional intelligence on population health needs and service demand. Integrating epidemiological burden evidence into health workforce planning, therefore, may strengthen existing approaches as well as improve the responsiveness, efficiency, and equity of workforce policies in Indonesia.

D. Relevance for Other Low- and Middle-Income Countries

Although this study focuses on Indonesia's case, the framework proposed may have broader relevance for other LMICs undergoing demographic and epidemiological transitions. Many LMICs have invested substantially in workforce information systems and disease burden measurement, although continue to run their workforce primarily using population ratios and staffing norms (Boniol et al., 2022).

The integration of disease burden estimates into existing workforce planning approaches may provide a practical mechanism for improving alignment between workforce capacity and population health needs within resource-constrained settings. This is particularly important as NCDs account for an increasing proportion of mortality and disability across LMICs and place growing demands on health systems (WHO, 2024).

VI. CONCLUSION

This study demonstrates the potential value of integrating disease burden evidence into health workforce planning in Indonesia. Using stroke as a tracer condition, the integration of epidemiological burden evidence, and stroke care intervention capacity through neurologist distribution and CT scan availability, the findings show that conventional workforce planning indicators and burden-informed assessment generate different perspectives on workforce adequacy, reflecting actual service demand and disease burden patterns.

To address this gap, this study proposes a burden-informed health workforce planning framework that integrates epidemiological intelligence, workforce intelligence, planning and prioritization processes, and policy implementation mechanisms for better health system outcomes.

Rather than replacing existing workforce planning approaches, the framework complements them by incorporating measures of population health needs and health loss into workforce decision-making.

Moreover, the framework may also offer lessons for other LMICs experiencing similar demographic and epidemiological transitions. Regarding acute stroke care intervention for provinces with persistent neurologist shortages, telehealth and telestroke approaches may provide feasible transitional strategies for improving access to specialists in underserved regions. However, telehealth adoption should not be viewed as a substitute for long-term workforce strengthening, mainly because developing a sustainable stroke care intervention system essentially requires equitable workforce deployment, strengthening of referral systems, improvement of emergency transport pathways, and investment in diagnostic infrastructure in underserved provinces. Therefore, telehealth adoption should be positioned as part of an integrated strategy to strengthen health system rather than as a stand-alone technological intervention.

The framework proposed provides a practical mechanism for strengthening workforce production, deployment, redistribution, and digital health innovations in response to changing disease patterns. By linking disease burden evidence with workforce governance, the framework has the potential to improve the responsiveness, efficiency, and equity of workforce policies in Indonesia. The framework, therefore, serve as a conceptual model that could be adapted and tested in other contexts.

Beyond stroke burden trend, future studies could also examine other high-burden conditions, such as cardiovascular disease, cancer, and mental health disorders. In this sense, the suggested methods are testing the framework prospectively and evaluating its impact on workforce allocation, service delivery, and health outcomes. In addition, future studies are also recommended to explore how burden-informed planning could be integrated into workforce forecasting models, health financing mechanisms, and digital health platforms.

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