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Mapping Inter-State Disparities in India's Rural Health Human Resources: An Ecosystem-Level Analysis

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Abstract

In a large federal-type health system governance like India, where health is decentralized but nationally guided, an integrated study aimed at inter-state variation in rural health human resources provides a critical window into structural inequalities in public health service delivery patterns. This study examines the structural patterns of public-sector rural health human resource (RHHR) distribution across Indian states and Union Territories, focusing on key categories of RHHR deployed at different levels of rural health care. Using secondary data on RHHR and applying correspondence analysis (CA), the study explores the association between state-centric categories of RHHR. The results of CA reveal a statistically significant and non-random association, highlighting distinct inequalities in RHHR composition and distribution. The first four dimensions of the correspondence analysis explain 77.3% of the total inertia, suggesting that these dimensions summarize the primary associations and contrasts in the RHHR data.

The findings indicate that administratively developed states exhibit diversified and hospital-centric RHHR ecosystems, while smaller states rely on limited and substitutive health cadres. Such imbalances reflect deeper social and structural inequalities that influence access to public healthcare services. By empirically mapping these disparities, the study contributes to broader discussions on social equity, public service delivery and health system governance. The paper underscores the need for the development of context-sensitive and state-specific RHHR policies to address persistent public health inequities in India. The present paper further tries to establish an alignment of the CA dimensions with the specific and relevant Sustainable Development Goals of the UNDP.

1. Introduction and Background

India's rural healthcare system forms the backbone of health service delivery for nearly two-thirds of the country's population (Chitti et al. 2021) and it relies heavily on the availability, composition and deployment of health human resources (Nair et al. 2022). This paper refers to these health human resources as Rural Health Human Resources (RHHR), following the framework of the World Health Organization's World Health Report 2006. Despite the national norms and human resource planning guidelines, India continues to exhibit noticeable inter-state disparities in the availability and composition of rural health workers (Karan et al. 2021; K. D. Rao et al. 2012). The Indian perspective has ramifications from a global perspective since distinct and contextual human resource ecosystem configurations across states and Union Territories, highlight how federal-system driven asymmetries and administrative capacity differentials influence access to public healthcare. There is the need to unfurl context-sensitive, state-specific human resource governance strategies that move beyond uniform staffing norms toward structurally symmetrical health system design. While some Indian states have developed relatively complex and diversified health human resource systems, others remain constrained by limited cadre diversity and persistent dependence on a narrow set of frontline workers (Karan et al. 2021; Palaniraja et al. 2025; K. D. Rao et al. 2012). This problem has typically been characterized in terms of population-to-provider ratios, vacancy rates, or aggregate shortages in previous empirical research and policy

discussions (Garg et al. 2022; Nair et al. 2022; Mehta et al. 2024; Jeevitha 2025). While these metrics are useful for pointing out deficiencies, they don't provide much information about how health-specific human resource systems are structurally organized across states and regions.

According to a growing body of research on health systems, in addition to the total number of human resources, the arrangement and skill-mix of the cadres that coexist and interact inside the health system, determine the overall effectiveness of rural healthcare system (Alawode et al. 2025; K. D. Rao et al. 2012; Sonderegger et al. 2021). Thus, following this viewpoint, RHHR can be considered as ecosystems in which community health workers, physicians, nurses and paramedical personnel all work in unison to shape the healthcare service delivery framework. However, there is a dearth of systematic empirical analyses of these ecosystem-level patterns in the Indian literature, especially when compared across Indian states. Therefore, there is a need to address this issue by examining the multidimensional linkages between RHHR categories and to assess policies in a unified and integrated manner. Hence, we need to introduce an ecosystem-level thinking in the context of RHHR as interdependent human resource configurations that comprise different facets that make up a unique whole supporting the larger suprasystem. To this end, the present research intends to undertake a structured and systematic analysis of human resource ecosystems in a large federal and policy-driven democracy, providing insights for quasi-decentralized health system governance in the context of the Global South and beyond.

India is an exemplar of a federal-type health system governance, with constitutionally divided responsibilities between the Union and the States. While health is primarily a state subject, financing and national norms (e.g., NRHM/IPHS) are largely centrally guided thereby making the healthcare system a centrally guided and locally governed system wherein situational factors play a significant role in forming and driving the system. Beyond its national importance, the issue of RHHR deployment is closely tied to the global development agenda, especially with respect to three specific and relevant Sustainable Development Goals (SDGs). Essentially, an ecosystem level analysis with respect to rural healthcare can be assessed in terms of SDG 3, which aims to ensure healthy lives and promote well-being for everyone at all ages and also SDG 10, which focuses on reducing inequalities. Achieving universal health coverage (UHC) under SDG 3 requires not only expanding healthcare infrastructure but also ensuring fair and context-sensitive distribution of healthcare human resources. Documented disparities among states in RHHR composition are not just governance issues, these are real obstacles to India’s progress toward its relevant SDG goals. Additionally, SDG 16 signifying peace, justice and strong institutions underscores the significance of developing effective institutions.

In a federal-type health system governance, the healthcare system coincides with subnational autonomy in implementation. This kind of an arrangement generates structural convergence and divergence in public service delivery capacity. In this perspective, the issue of RHHR needs to be situated from an ecosystem-level and people-centric configurational variations emanating from federal-type health system governance and structural human resource asymmetries can be explored. Further, national and subnational health system governance issues revolving around structural capacity, public sector

healthcare service delivery and the concomitant RHHR ecosystems as structural outcomes can be addressed through an analytical lens. As a secondary research objective, the study can also be contextualized in terms of the Implications for SDG-driven health system governance highlighting structural readiness, interstate inequality and institutional depth which are all SDG-driven outcomes that provide a context for ecosystem level analysis vis-à-vis RHHR.

2. Review of Literature

Research on health human resources in India has consistently emphasized on the critical role of human resource availability in shaping health system performance, particularly in rural and underserved areas (Kalne et al. 2022; Karan et al. 2021; Nair et al. 2022; Palaniraja et al. 2025; K. D. Rao et al. 2012). Studies have shown that there are persistent shortages of doctors, nurses and specialists in rural public health facilities, often highlighting gaps between sanctioned posts and in-position staff across Sub-Centres, Primary Health Centres and Community Health Centres (Garg et al. 2022; Nair et al. 2022; M. Rao et al. 2011). These studies have played a significant role in highlighting regional disparities and quantitative deficiencies in the availability of health workers to the attention of policymakers.

Most studies on RHHR in India rely on ratio-based indicators, such as population-to-doctor ratios, nurse-to-doctor ratios, or vacancy percentages at different levels of care (M. Rao et al. 2011; Karan et al. 2021; Garg et al. 2022; Nair et al. 2022; Mehta et al. 2024; Jeevitha 2025). Although these metrics offer an easily accessible assessment of human resource adequacy, they implicitly treat health human resource categories as independent entities and presume that numerical sufficiency is the primary driver of human resource effectiveness. As a result, the relational and organizational dimensions of human resource deployment such as how various cadres coexist, replace or enhance one another remain underexplored. In a health system as diverse as India, where states differ significantly in institutional capacity, governance structures and service delivery models, this limitation is particularly prominent.

Inter-state disparity has been observed to be a recurrent theme in the Indian health human resource literature. Several studies have demonstrated that economically and administratively robust states tend to have stronger and better distributed RHHR, while economically backward and demographically challenged states lag behind (Pallikadavath et al. 2013; K. D. Rao et al. 2012). However, these comparisons are typically conducted using indicators that do not explain or portray internal structural variation within state-level human resource systems.

International health systems research has increasingly emphasized on the importance of skill mix, task shifting and human resource diversification in achieving effective service delivery under resource constraints (Deussom et al. 2022; Fulton et al. 2011; Namaganda et al. 2015). Various research from low and middle-income nations shows how paramedical staff, community health workers and non-physician clinicians frequently play crucial roles in making up for the lack of doctors, especially in rural areas (Couper et al. 2018; Das et al. 2024; Syed et al. 2012). This literature highlights that health human resources act as flexible systems, where roles can shift among team members based on contextual

challenges. However, these ecosystem-focused viewpoints have only been partially included in studies revolving around a developing country's healthcare system and the concomitant RHHR perspective. Hence, a study aimed to understand the intricate and interlinked issues in RHHR from the Indian perspective is likely to contribute substantially to the international literature.

Methodologically, multivariate approaches to health human resource analysis are still somewhat rare mainly in the perspective of studies revolving around developing economies. Few studies have used methods like principal component analysis or composite indices to summarize health system performance (Anand 2014; Kaur et al. 2023; Pal et al. 2023). However, these methods often reduce human resource diversity to single scores, which makes it harder to understand the roles of different RHHR categories. In contrast, methods that allow simultaneous examination of different categories like Correspondence Analysis (CA), have been widely used in fields like regional economics, education and labour market studies to uncover underlying structural relationships. However, these methods remain underused in health human resource research in India.

In summary, the current literature on RHHR in India has made a significant contribution to document shortages and regional inequalities, but these still seem to be deficient when it comes to understanding how human resource systems are structurally organized and interrelated leading to the ecosystem perspective. There is a gap in research in the sense that we need to go beyond just counting staff and examining ratios. It needs to focus on RHHR as a complex, interconnected system. Under this backdrop, a study using a suitable multivariate analysis technique on state-level RHHR data is necessary in order to fill this research gap. It would provide a novel, structure-based view of the differences in RHHR deployment among the Indian states. Additionally, there is an academic need to undertake a study wherein the Indian perspective becomes a strategic lens to assess the facets of RHHR from an ecosystem perspective since Indian context presents a unique case from the backdrop of developing economies. As an outcome it shall provide a yardstick for assessing the degree of alignment with relevant and specific SDGs of the United Nations Sustainable Development Goals.

3. Research Design, Data and Methodology

3.1. Research Design

The present study adopts a structural–configurational perspective, considering RHHR as an interdependent human resource ecosystem shaped by institutional and contextual variation across states. In this exercise, we have considered the State/Union Territory as the unit of analysis and parameters associated with State-level rural public health systems connote the level of aggregation. Finally, we have considered State × RHHR Cadre configuration as the analytical space for our study. From this perspective, the research design may be considered as an ecological multivariate design, rather than a discrete-level human resource analysis. Thus, in this paper, we aim to undertake an ecosystem-level analysis wherein we conceptualize RHHR not comprising isolated cadres of various categories of human resources but as interdependent configurations shaped by institutional capacity, governance

arrangements and contextual constraints. Instead of focusing on absolute shortages, this approach examines how different RHHR categories co-exist, substitute and combine within state-level health systems. In this exercise, CA is particularly suited to address such an ecosystem-level analysis, as it facilitates the joint mapping of states and human resource categories, thereby enabling the unfolding of the latent structural patterns in RHHR deployment across Indian states and Union territories.

3.2. Data Source

The present study uses secondary data drawn from Rural Health Statistics (RHS) 2021–22, published by the Government of India, Ministry of Health and Family Welfare (MoHFW), Statistics Division. RHS is the most authoritative and comprehensive source of information on India's public rural healthcare infrastructure and human resource deployment, providing standardized and comparable data across all States and Union Territories. The RHS reports in-position head counts of RHHR across different tiers of the public healthcare system, namely Sub-Centres (SCs), Primary Health Centres (PHCs), Community Health Centres (CHCs), Sub-District Hospitals (SDHs) and District Hospitals (DHs). This study focuses on the in-position RHHR so that the analysis reflects the actual operational human resource rather than sanctioned posts or vacancies.

For this study, we have identified RHHR categories that represent the full spectrum of health care service delivery roles, comprising frontline and community-based workers (e.g., female and male health workers at SCs and PHCs), medical officers and doctors at PHC, CHC, SDH and DH levels, Specialist cadres of doctors (surgeons, physicians, obstetricians & gynaecologists, paediatricians, anaesthetists, eye surgeons), Nursing staff and Paramedical and diagnostic personnel (pharmacists, laboratory technicians, radiographers and other para-medical staff). By covering multiple cadres across all levels of care, the dataset enables a system wide examination of RHHR composition rather than a narrow focus on individual human resource categories.

3.3. Construction of the State × RHHR Table

The empirical analysis is based on a State × RHHR category contingency table (Table 02), where rows represent Indian States and Union Territories and columns represent distinct RHHR categories. Each cell of Table 02 records the in-position count of a specific RHHR category within a given state. In order to facilitate multivariate analysis and ensure consistency across categories, all states and RHHR types were systematically abbreviated using standardized codes (Table 01). The final contingency table captures RHHR deployment across SC, PHC, CHC, SDH and DH levels for all eligible States and Union Territories.

Table 01
Abbreviated Codes for State/UTs and RHHR Categories

State/UTs	Abbreviations	RHHR Category	Abbreviations
Andhra Pradesh	AP	*ANAESTHETISTS in Position at CHC*	ANACHC
Arunachal Pradesh	AR	*AYUSH Doctors in Position at PHC*	AYUSHPHC
Assam	AS	*Doctors in Position at DH*	DOCDH
Bihar	BR	*Doctors in Position at PHC*	DOCPHC
Chhattisgarh	CG	*Doctors in Position at SDH*	DOCSDH
Goa	GA	*Eye Surgeons in Position at CHC*	EYECHC
Gujrat	GJ	*GDMOs Allopathic in Position at CHC*	GDMOCHC
Haryana	HR	*GDMOs AYUSH In Position at CHC*	GDMOAYUSHCHC
Himachal Pradesh	HP	*Health Assistant in Position at PHC*	HAPHC
Jharkhand	JH	*In Position Health Worker Female/ ANM at PHC*	HWFPHC
Karnataka	KA	*In Position Health Worker Female/ ANM at SUB CENTRE*	HWFSC
Kerala	KL	*In Position Health Worker Male at SUB CENTRES*	HWMSC
Madhya Pradesh	MP	*Lab Technicians in Position at CHC*	LABCHC
Maharashtra	MH	*Lab Technicians in Position at PHC*	LABPHC
Manipur	MN	*Nursing Staff in Position at CHC*	NURSECHC
Meghalaya	ML	*Nursing Staff in Position at PHC*	NURSEPHC
Mizoram	MZ	*OBSTETRICIANS & GYNAECOLOGISTS in Position at CHC*	OBGYCHC
Nagaland	NL	*PAEDIATRICIANS in Position at CHC*	PDCHC
Odisha	OD	*Pharmacists In Position at CHC*	PHARMACHC
Punjab	PB	*Pharmacists In Position at PHC*	PHARMAPHC
Rajasthan	RJ	*PHYSICIANS In Position at CHC*	PHYCHC
Sikkim	SK	*Para Medical Staff in Position at DH*	PMSDH

State/UTs	Abbreviations	RHHR Category	Abbreviations
Tamil Nadu	TN	*Para Medical Staff in Position at SDH*	PMSSDH
Telangana	TS	*Radiographers In Position at CHC*	RADIOCHC
Tripura	TR	*Surgeons In Position at CHC*	SRGNCHC
Uttarakhand	UK		
Uttar Pradesh	UP		
West Bengal	WB		
A&N	AN		
Chandigarh	CH		
Dadra & Nagar Haveli and Daman & Diu	DD		
Delhi	DL		
J&K	JK		
Ladakh	LA		
Lakshadweep	LD		
Puducherry	PY		

Inclusion-Exclusion Criteria and Missing Data

All States and Union Territories reported in RHS 2021–22 were initially included in the contingency table. RHHR categories were retained only if they were reported for a substantial proportion of states. States and RHHR categories with more than 45% missing values were excluded from the analysis to avoid distortion of profile-based comparisons. In the RHS data, some entries are marked as “Not Available” or “Not Applicable.” These were coded as zero values, reflecting the absence of that cadre in the corresponding state-level service structure. This treatment is appropriate within Correspondence Analysis, as CA operates on relative profiles and allows zero entries without violating methodological assumptions. After data cleaning and filtering, the final analytical dataset consisted of 34 States and Union Territories and 25 RHHR categories forming a 34 × 25 contingency table (Table 02) suitable for multivariate structural analysis.

3.4. Correspondence Analysis as an Analytical Tool

In order to unfurl the latent structural patterns in RHHR deployment across states, we have employed CA, a multivariate exploratory technique designed for large contingency tables. CA is appropriate here because the contingency table consists of in position numbers of RHHR categories and the method is

specifically designed for such categorical data (Clausen 1998). CA is particularly suited for this analysis, as it allows simultaneous examination of states and RHHR within a common multidimensional space, emphasizing relative profiles rather than absolute magnitudes (Abdi and Williams 2010; Bond and Michailides 1997; Clausen 1998). The correspondence table's overall chi-square statistic is broken down by CA into a set of orthogonal dimensions, each of which represents a separate axis of association between states and RHHR categories. *IBM SPSS Statistics 26* was used for the analysis and symmetrical normalization was used to interpret row and column points simultaneously.

3.5. Model Adequacy

As presented in the Table 03, with 792 degrees of freedom, the correspondence table produced a chi-square statistic of 212,723.13, which is statistically significant at $p < 0.001$. This permits the use of CA and shows that the observed patterns represent systematic structural differences rather than random variation. It also confirms a strong non-random association between States/UTs and RHHR categories. The total inertia of the solution represents the overall strength of association captured by the CA model.

4. Results

4.1. Overall Dimensional Structure

CA of the State × RHHR contingency table (Table 02) reveals a clear and interpretable multidimensional structure underlying inter-state variation in RHHR deployment in India. Out of the 24 dimensions that were extracted from the analysis (Table 03), the first four explain a significant amount of the total inertia, suggesting that States/UTs and RHHR categories have a strong systematic association rather than random variation.

We have observed that the first four dimensions of the CA together explain 77.3% of the total inertia (Table 03) of the correspondence table: Dimension 1 accounts for 25.7% of inertia, Dimension 2 explains 23.5%, bringing cumulative inertia to 49.1%, Dimension 3 contributes 17.1%, raising cumulative inertia to 66.2% and Dimension 4 adds 11.0%, resulting in a cumulative explanation of 77.3%. CA explaining around 60–70% of inertia with the leading dimensions is considered methodologically robust. The concentration of inertia in the first four dimensions therefore suggests a clearly defined latent structure governing RHHR deployment across states.

Rationale for Selected Dimensions

Given their high explanatory power and substantive interpretability, the first four dimensions were retained for detailed analysis. Subsequent dimensions each explain marginal proportions of inertia and primarily capture residual or highly localized variation. The retained dimensions collectively represent the dominant structural axes along which Indian states differ in terms of RHHR composition, service orientation and human resource ecosystem complexity.

4.2. Interpretation of Latent Dimensions

Dimension 1: Core-Peripheral RHHR Deployment Gradient

Dimension 1 emerges as the dominant structural axis, accounting for the largest share of inertia (25.7%). This dimension differentiates the Indian states along a core-periphery gradient of RHHR deployment, reflecting differences in institutional depth, service complexity and human resource diversification. It can be observed from the Row Points Table of the CA, presented in Table 04, some Indian states such as West Bengal (WB), Tamil Nadu (TN), Karnataka (KA), Andhra Pradesh (AP), Maharashtra (MH) and Uttar Pradesh (UP) exhibit high absolute scores and make strong contributions to the inertia of this dimension. Also, from the Fig. 1 we can see that these states are closely associated with institutionalized RHHR categories, comprising Doctors at District and Sub-District Hospitals (DOCDH, DOCSDH); Para-medical staff at SDH and DH levels (PMSSDH, PMSDH); Nursing staff at PHC and CHC levels (NURSEPHC, NURSECHC). In contrast, smaller states and Union Territories-such as Lakshadweep (LD), Andaman & Nicobar (AN), Puducherry (PY), Sikkim (SK) and Dadra & Nagar Haveli and Daman & Diu (DD) are positioned on the opposite side of the dimension, indicating limited diversification of RHHR cadres and greater reliance on a narrow set of human resource categories. Dimension 1 can therefore be interpreted as a structural capacity axis, separating states with complex, hospital-centric RHHR ecosystems from those operating with basic or constrained human resource configurations.

Dimension 2: Primary Care vs Specialist Orientation

Dimension 2 explains 23.5% of total inertia and captures variation in service delivery orientation, distinguishing states that emphasize primary healthcare outreach from those oriented toward specialized and referral-level services. As presented in Table 04 states such as Bihar (BR), Uttar Pradesh (UP), Rajasthan (RJ), Jharkhand (JH) and Odisha (OD) display strong positive alignment along this dimension. Also, from Fig. 1 we can see that these states are closely associated with frontline and community-based RHHR categories, including Health Assistants at PHC (HAPHC); Female and Male Health Workers at PHC and Sub-Centres (HWFPHC, HWFSC, HWMSC); AYUSH doctors at PHC (AYUSHPHC). Conversely, states with negative scores on this dimension are more closely associated with specialist cadres at the CHC level, such as physicians, surgeons, obstetricians & gynaecologists and paediatricians, indicating a relatively stronger secondary care orientation. Thus, Dimension 2 represents a primary care-specialist service continuum, highlighting systematic differences in how states balance outreach-based versus referral-oriented healthcare delivery.

Dimension 3: Human Resource Diversification and Skill-Mix Substitution

Accounting for 17.1% of inertia, Dimension 3 captures patterns related to human resource diversification and skill-mix substitution, particularly in contexts of constrained doctor availability. As presented in Table 04, North Eastern states such as Mizoram (MZ), Meghalaya (ML), Manipur (MN), along with Ladakh (LA) exhibit distinctive positions on this dimension. From Fig. 2 we can see that their placement on this dimension is driven by strong associations with paramedical and diagnostic cadres, including Laboratory technicians at PHC and CHC (LABPHC, LABCHC); Radiographers at CHC (RADIOCHC); Pharmacists at PHC and CHC (PHARMAPHC, PHARMACHC). These patterns suggest adaptive human

resource strategies, where service delivery is maintained through strengthened diagnostic and paramedical staffing rather than reliance on specialist doctors alone. Dimension 3 can therefore be interpreted as a functional substitution axis, reflecting how states reconfigure RHHR skill mixes to cope with structural and geographic constraints.

Dimension 4: Context-Specific and Peripheral Deviations

Dimension 4 contributes 11.0% of total inertia and captures localized, context-specific deviations that are not explained by the broader structural gradients of the first three dimensions. As presented in Table 04 and Fig. 3 this dimension is particularly influenced by Union Territories (e.g., Puducherry, Lakshadweep) and small northeastern states, as well as by states exhibiting unusually high or low concentrations of specific RHHR categories. These deviations reflect unique administrative arrangements, geographic isolation, population size effects and state-specific policy choices. Although secondary in explanatory power, Dimension 4 is analytically important because it highlights outlier human resource configurations that may require tailored policy responses rather than uniform national staffing norms.

4.3. Row-Column Biplot Interpretation

The symmetrical normalization biplots presented in Figs. 1, 2 and 3 enable simultaneous interpretation of States/UTs and RHHR categories, providing visual validation of the latent dimensions identified above. Proximity between a state and a particular RHHR category in the biplot indicates above-average representation of that cadre within the state's human resource profile. Several clear patterns emerge: Tamil Nadu and West Bengal are positioned close to nursing and para-medical cadres, reflecting long-standing investments in public hospital staffing and nursing education. Uttar Pradesh and Bihar cluster near PHC-level doctors and frontline health workers, underscoring the continued importance of basic service delivery in high-population states. Smaller Union Territories are located far from most RHHR categories, reinforcing their limited human resource diversity and simplified service structures. These joint row-column patterns validate the dimension-wise interpretations and provide empirical evidence of ecosystem-level disparities in RHHR deployment across India. Rather than a uniform national human resource model, the results reveal multiple coexisting RHHR ecosystems shaped by state capacity, service orientation and contextual constraints.

5. Discussions

5.1. Purpose and Analytical Orientation

The purpose of this discussion is to interpret the empirical findings by situating them within a broader health human resource ecosystem perspective. By moving beyond headcounts and vacancies, this study seeks to explain how and why Indian states configure their RHHR differently under varying structural, demographic and institutional constraints. The CA results therefore cannot be read as isolated statistical patterns, but as expressions of adaptive human resource systems operating within uneven state

capacities, governance arrangements and service delivery requirements. This interpretive shift is central to establishing the study's contribution to the literature on health human resource planning and decentralized health systems.

5.2. RHHR as State-Specific Human Resource Ecosystems

A key insight emerging from the analysis is that Indian states function as distinct RHHR ecosystems, rather than scaled versions of a single national human resource model. The latent dimensions reveal that RHHR deployment is structured along multiple interacting axes, such as capacity, service orientation, diversification and contextual constraint. It indicates that human resource composition is an outcome of system-level adaptation rather than mere compliance with national staffing norms. States positioned along the "core" end of the core-periphery gradient exhibit institutionally dense ecosystems, characterized by diversified cadres, hospital-centric staffing and layered referral structures. In contrast, peripheral states and Union Territories operate simplified ecosystems, where service delivery depends on a limited set of cadres and where institutional depth is necessarily constrained by scale, geography and administrative capacity. This ecosystem framing helps reconcile why similar staffing norms produce vastly different human resource realities across states.

5.3. Context-specific Adaptive RHHR Configurations

The findings demonstrate that states do not respond to RHHR shortages uniformly. Instead, they reconfigure human resource composition strategically depending on feasibility and context. The emergence of a distinct skill-mix substitution dimension highlights how states compensate for doctor and specialist shortages by strengthening paramedical, diagnostic and pharmacy cadres. Such substitution is not just a second-best response but reflects adaptive rationality within constrained systems. In geographically remote or demographically small states, expanding diagnostic and paramedical capacity can sustain service delivery when specialist recruitment is structurally difficult. This supports the arguments in the literature that task-shifting and role diversification are not temporary fixes, but features of resilient health systems when appropriately institutionalized. These adaptations remain largely invisible in conventional vacancy-based or ratio-based analyses, which implicitly treat deviations from staffing norms as failures rather than as context-sensitive solutions.

5.4. Why Uniform RHHR Staffing Norms Fail Empirically

One of the most significant implications of this study is its empirical demonstration that uniform staffing norms are structurally misaligned with observed human resource realities. The multidimensional patterns revealed by CA show that states differ not only in the quantity of RHHR, but fundamentally in the configuration and functional logic of their human resource systems. Uniform norms assume interchangeability of states, linear scaling of cadres with population size and a single optimal skill-mix applicable nationwide. The results challenge all three assumptions. States vary in institutional maturity, service delivery priorities and feasible human resource pathways. Consequently, enforcing identical staffing templates across such heterogeneous systems risks producing chronic vacancies, inefficient deployment and misaligned incentives. The empirical failure of uniform norms is thus not a problem of

implementation, but of conceptual design, a misreading of how health human resource systems actually function in diverse federal contexts.

5.5. Alignment with SDG Architecture

The findings of this paper are aligned with the United Nation's SDG architecture. The extracted CA dimensions can be considered as goal attainment facets. In other words, if outcomes are to be achieved, the system must be integrated through an adequate human resource structure, structural depth, governance capacity and equitable distribution of RHHR. WHO's thrust on SDG 3 underscores RHHR concentration and distribution. To this end, the CA results of this paper divulge the relevance of administrative choice between diversified and mono-cadre RHHR systems, specialist-rich and frontline-heavy RHHR, hospital-centric and primary-care-centric ecosystems. States with diversified RHHR ecosystems are structurally better aligned with the targeted goals. From the extracted dimensions, SDG 3 alignment can be implied from structural human resource maturity and diversification which measures goal attainment and health system readiness, not just RHHR headcounts.

Secondly, SDG 10 is concerned with inequalities reduction within countries which in the context of the present paper is aligned with inter-regional disparities, structural disparities and institutional depth disparities. The results of CA underscore some regional clusters with high specialist diversification which empirically establish horizontal federal-type health system governance inequality. This reflects structural and policy-driven inequality rather than economic inequality.

Thirdly, SDG 16 emphasizes on peace, justice and strong institutions. It is in this context that the findings of the paper assume greater significance. In the context of the present paper, RHHR, the CA dimensions pinpoints towards administrative competence, health system planning sophistication, administrative layering and maturity. The findings reveal that Indian states with diversified RHHR skill-mix, multi-tier RHHR deployment and balanced primary-secondary-tertiary structure possess governance capability and administrative coherence. Therefore, RHHR ecosystem diversity becomes an indicator of health system governance strength. Thus, we are able to address institutional robustness indirectly which strongly covers the goals achievement vis-à-vis SDG 16.

5.6. Re-engaging with the Literature and Conceptual Framework

In India, the majority of the RHHR literature to date has concentrated on doctor-to-population ratios, shortages and vacancies. Although useful, these methods subtly present human resource issues as deficit-related rather than structural. This study, on the other hand, supports and expands on growing demands for compositional and systemic analyses of health human resources. The CA framework operationalizes this shift by revealing latent organizational principles that remain obscured in univariate or normative assessments. In doing so, the study empirically grounds the human resource ecosystem concept, demonstrating that RHHR systems are internally coherent, adaptive and path-dependent.

This contributes to the literature by providing a multivariate, ecosystem-level comparison of states, demonstrating that human resource diversity and substitution are structural features, not anomalies and offering a methodological template for analyzing human resource systems beyond deficit metrics.

5.7. Intellectual Contribution and Theoretical Implications

Taken together, it is established that India's RHHR cannot be meaningfully understood through universal benchmarks alone. Instead, RHHR must be conceptualized as a set of interacting, state-specific ecosystems, each shaped by its own constraints, capacities and strategic adaptations. By empirically validating this perspective the study advances both theory and policy discourse. It reframes human resource planning from a problem of "filling gaps" to one of ecosystem design and optimization, thereby opening space for more realistic, flexible and context sensitive RHHR policies. In this sense, the contribution of the study lies not only in identifying disparities, but in redefining how those disparities should be interpreted.

6. Policy Relevance and Planning Implications

6.1. Rethinking RHHR Planning Paradigms

From Vacancy Filling (Head Count) to Configurational Design

Prevailing RHHR planning approaches in India remain conceptually anchored in vacancy filling logics, where deviations from national staffing norms are treated as deficits to be corrected. However, the empirical data shows that states vary in terms of both the structural arrangement of their RHHR systems and the availability of workers. Planning frameworks that only concentrate on filling sanctioned posts run the risk of ignoring the functional interactions between cadres within the healthcare system. Therefore, the focus needs to change from counting missing employees to creating logical human resource configurations that take into account the institutional capacity, service delivery model and geographic limitations of each state. This change recasts RHHR planning as a system design issue as opposed to a numerical compliance issue.

State-Specific RHHR Archetypes

The present analysis's multifaceted patterns suggest that different RHHR 'archetypes' exist in different Indian states. While some states function as hospital-centric, institutionally dense ecosystems, others place a greater emphasis on frontline and primary care cadres, as well as on strategies for diagnostic and paramedical substitution. By identifying these archetypes, planners can move away from one-size-fits-all templates to archetype-informed planning, in which investment priorities, performance standards and staffing expectations are customized for structurally similar states rather than being uniformly enforced across the country. Such an approach is especially relevant in a federal system where health system maturity is widely heterogenous.

6.2. Skill-Mix and Task Substitution

Formalizing Informal Adaptations

The fact that skill mix substitution is already taking place de facto in many states is a crucial policy relevant finding of this study. States have strengthened their paramedical, diagnostic and pharmacy cadres to maintain service delivery in situations where hiring specialists is consistently limited. However, these adaptations are still unofficial, poorly acknowledged and loosely regulated. RHHR policy must therefore formally recognize and legitimize these substitutions as structural elements of state human resource ecosystems rather than seeing them as deviations from ideal staffing. This would enable clearer role definitions, accountability mechanisms and career pathways for non-physician cadres who already perform critical system functions.

Implications for Training and Regulation

Formal recognition of task substitution directly affects training programs, practice regulations and accreditation systems. Human resource planning must connect with the educational and regulatory changes that prepare groups with the skills needed for expanded roles, especially in diagnostics, chronic disease management and emergency care in limited-resource settings. Without this connection informal task shifting can lead to quality and governance issues. On the other hand, thoughtful skill mix planning can improve system resilience while keeping service quality and professional credibility intact.

6.3. Differentiated Approaches for Small States and Union Territories

Why Scaled-Down Models Fail

The results clearly show that small states and Union Territories do not operate like smaller versions of large states. Their RHHR systems are influenced by different administrative scales, population sizes, geographic isolation and service demand. Implementing smaller versions of large state staffing rules in these areas leads to mismatches and inefficiencies. Standard rules assume economies of scale and referral depth that often aren’t present in small regions. Consequently, these norms create ongoing vacancies or unnecessary staff that cannot be used effectively.

Need for Adaptive Ecosystem Designs

Policy frameworks must therefore move towards adaptive RHHR ecosystem designs for small states and UTs. This may involve a greater reliance on multi-skilled cadres, regional sharing of specialists, telemedicine-supported service models and flexible deployment arrangements that prioritize functional coverage over cadre completeness. Importantly, differentiation should not be seen as lowering standards but as context-sensitive improvement, matching human resource design with realistic service delivery pathways.

6.4. Monitoring Beyond RHHR Headcounts

Composition and Diversity Indicators

Current RHHR monitoring systems primarily track absolute numbers, vacancies and doctor to population ratios. These indicators are useful but insufficient to capture the structural composition and functional diversity of human resource ecosystems. Monitoring frameworks should include indicators such as cadre diversity, balance between clinical, nursing and paramedical roles, sill-mix profiles across levels of care and degree of human resource diversification relative to state context. Such indicators would allow policymakers to distinguish between structurally weak systems and those that are differently configured but functionally adaptive.

Implications for National RHHR Dashboards

At the national level, RHHR dashboards and performance assessments need to change from tools focused on compliance to instruments that can show differences at the ecosystem level. It should integrate composition-based metrics to create more detailed benchmarks, promote peer learning among similar states and help with decentralized human resource planning. If these insights are included in the national monitoring systems, it would connect RHHR governance with the real conditions of India's national health system. This would improve planning effectiveness and the legitimacy of policies.

7. Conclusion

This study tries to move from the typical "deficit" narrative of a developing country's RHHR and instead addresses how RHHR are actually organized across regions, specifically the States and Union Territories in India. Using CA on state-wise RHHR data, the paper shows that differences among states are not random or just about head counts. Rather, they tread through a few clear structural patterns vis-à-vis healthcare ecosystem perspective.

The findings suggest that each state works like its own RHHR ecosystem, shaped by local capacity, service delivery models, skill-mix choices and on-the-ground constraints. Hence, from an ecosystem perspective, contextual factors have an important role to play. It is evident from the findings that large and established states tend to have complex, hospital-centered human resource structures, while smaller states and UTs rely on simpler but often more flexible arrangements. Role substitution, diversification of roles and informal task shifting appear to be common patterns of states that cope with persistent human resource challenges. These patterns raise questions about the generic one-size-fits-all human resource deployment norms in RHHR planning. The problem is not only poor execution of policies but the assumption that all states function in similar ways which in fact is based on state-specific contingencies. RHHR policy planning that is primarily based on vacancy numbers and fixed ratios misses how state health systems actually work in a developing country like India. The study also shows the value of multivariate methods like CA, which help reveal human resource structures that simple counts cannot capture.

Overall, the paper argues for undertaking RHHR planning that is more context-sensitive and ecosystem-oriented, focusing on human resource configurations rather than just headcounts. Therefore, achieving equitable and sustainable rural healthcare, which is consistent with India's commitments under SDG 3,

requires a suitable governance framework that recognizes structural diversity across states and supports differentiated, ecosystem-based human resource deployment strategies. Future work could track how these ecosystems change over time or link them to service and health outcomes. In the end, it can possibly be opined that rural health care in developing countries like India will depend not just on how many human resources are available, but on how well state-specific human resource systems are designed and managed from an ecosystem perspective. While the extant empirical analysis is carried out in the Indian perspective, the findings of this research offer broader ramifications for federal and decentralized health systems from the global perspective as well. By exhibiting how human resource configurations reflect institutional capacity and governance mechanisms, the study substantially contributes to comparative public administration, health systems research and SDG-oriented policy framework beyond the Indian perspective.

Declarations

Declarations

Competing Interests:

The authors declare that they have no known financial or non-financial competing interests that could have appeared to influence the work reported in this paper.

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Data Availability: The data that support the findings of this study are available from the authors upon reasonable request.

Ethics Declaration: This study utilized secondary data from publicly available government health statistics report and did not involve direct contact with human participants. Therefore, ethics declaration is not applicable.

Author Contribution

C.M.R. conceived the study, conducted data collection and analysis, and drafted the manuscript. P.S. provided overall supervision, contributed to the research design and methodological framework, critically reviewed the manuscript, and offered intellectual guidance throughout the study. Both authors read and approved the final version of the manuscript.

Data Availability

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

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Tables

Tables 2 to 4 are available in the Supplementary Files section.

Figures

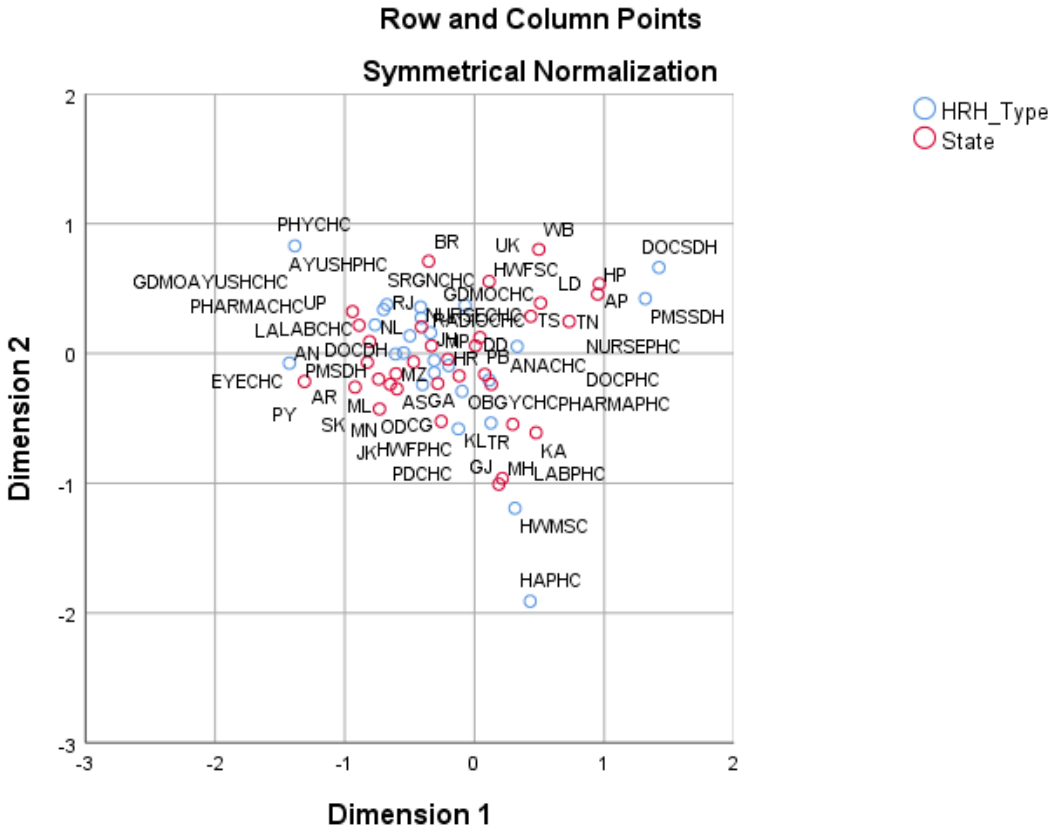


Figure 1

Row and Column Biplot of Dimension 01 vs Dimension 02

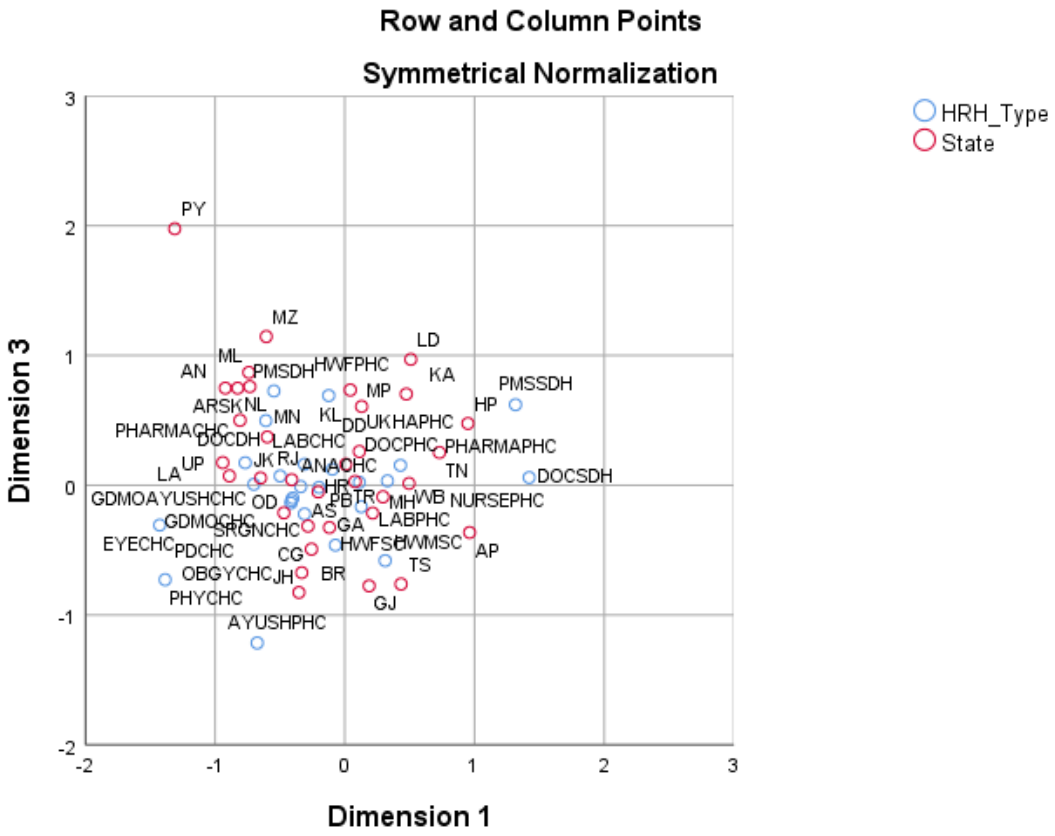


Figure 2

Row and Column Biplot of Dimension 01 vs Dimension 03

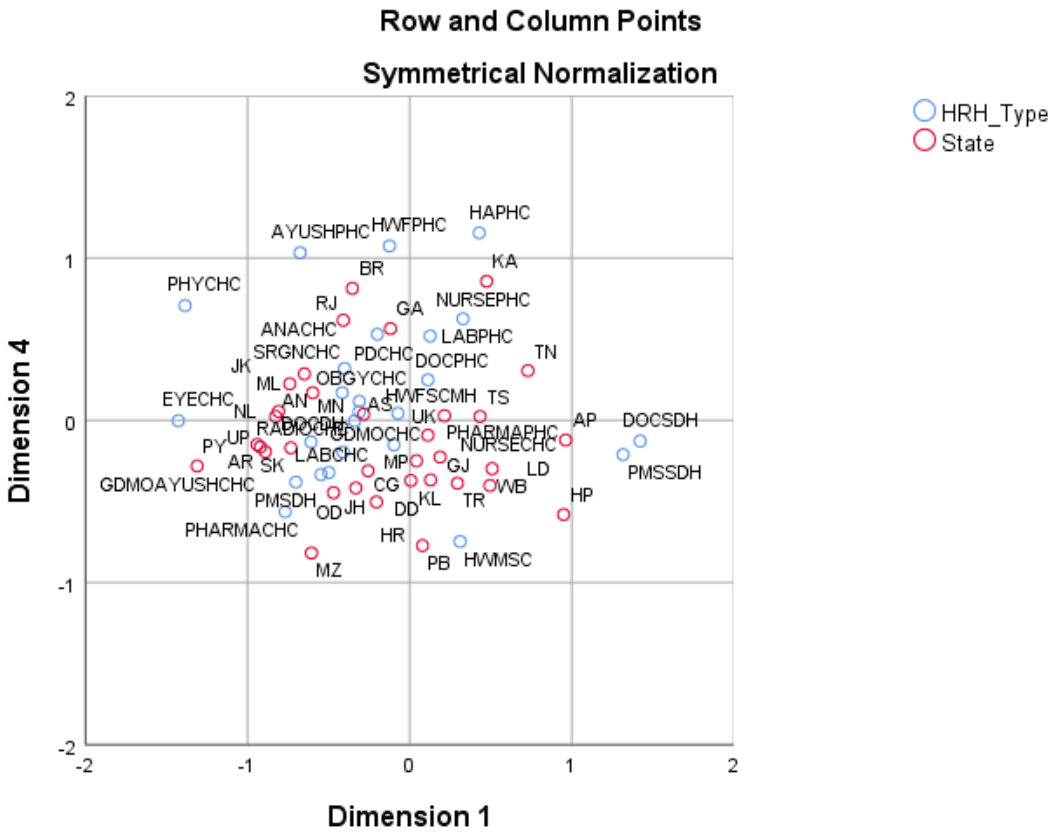


Figure 3

Row and Column Biplots of Dimension 01 vs Dimension 04

Supplementary Files

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- Table0204.docx