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Placing Health Equity at the Center of Development: Organizational Agency and Emergency Service Disparities in China‘s County Medical Alliances: a cross-sectional study

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Abstract

Background

Placing health equity at the center of health system development requires confronting systemic disparities in service capacity. China's Compact-Type County Medical Alliance (CCMA) policy integrates primary care resources, yet policy design tacitly assumes that hospital grade determines service capacity, with tertiary hospitals expected to outperform secondary ones. Whether this holds for emergency medical service (EMS) capacity in resource-limited western regions, and what this implies for health equity, remains unexamined.

Methods

We conducted a policy diagnostic study in 11 Guangxi CCMA pilot counties, developing separate EMS evaluation systems for leading hospitals (61 indicators) and member institutions (43 indicators) via Delphi (n = 20), AHP weighting, and TOPSIS-RSR across Donabedian's structure-process-outcome dimensions.

Results

The core diagnostic finding is a systematic structure-function mismatch: process indicators (particularly referral coordination and information system utilization) were weakest in both leading hospitals (mean Ci = 0.465) and member institutions (mean Ci = 0.347), while structural inputs scored substantially higher (mean Ci = 0.698 and 0.535, respectively). This mismatch disproportionately affects member institutions serving vulnerable populations, creating systemic gaps in emergency care coordination. Evidence from other settings suggests that these gaps may translate into preventable mortality differentials. Exploratory analyses generated hypotheses regarding organisational agency and grade-performance relationships, reported in full in the Additional files, which require validation in larger samples.

Conclusions

Our primary contribution is diagnostic: we identify a systematic structure-function mismatch in emergency service capacity, with process integration deficits as the key bottleneck. This is a governance failure that perpetuates health inequity across county health system tiers. The findings point toward recalibrating national monitoring frameworks toward functional integration, with tiered interventions matched to performance strata. This study provides an empirical foundation for re-centering health equity in health system governance, with implications for the post-2030 SDG agenda in resource-limited settings.

Background

In China, the hierarchical diagnosis and treatment system has been a core policy objective since the 2009 healthcare reform. The Compact-Type County Medical Alliance (CCMA) is the key instrument for achieving this at the county level (by 2024, more than 3,000 counties had launched CCMA pilots nationwide [1–3]. Within this framework, emergency medical service (EMS) capacity is indispensable, as county-level hospitals are responsible for emergency and critical care, referrals, and public health response [4]. Yet the distribution of EMS capacity across tiers of the county health system remains uneven, with potentially lethal consequences for populations in resource-limited regions [5].

Placing health equity at the center of development has gained renewed urgency as the global community prepares for the post-2030 agenda, with health equity increasingly recognized as a cornerstone of inclusive growth, social justice, and resilient health systems. Emergency medical services offer a strategic entry point for examining this imperative: EMS capacity is a sentinel indicator of health system responsiveness, and because emergency care demands real-time cross-institutional coordination, it is often the first domain where structural investments fail if functional integration is absent. This study uses EMS capacity within China's CCMAs as a diagnostic lens to examine how governance arrangements shape the distribution of life-saving services across tiers.

From a health governance perspective, the CCMA represents a multi-level institutional design. Central government sets the framework, provincial governments coordinate, and county actors execute [6]. As He and Kong (2011) argue in their framework of hierarchical governance, the degree of policy attainment in China’s multi-level administrative system depends critically on the effectiveness of each tier and their vertical alignment. This is a dynamic in which policy goals must be refined and renegotiated across the hierarchical level distances, creating opportunities for both adaptation and distortion [7]. This study adopts a policy diagnostic approach, rather than conventional program evaluation, to examine CCMA implementation in Guangxi Zhuang Autonomous Region, a western, multi-ethnic, resource-limited area with pronounced health resource disparities [8, 9]. These characteristics place Guangxi among the regions of highest social vulnerability, where systemic gaps in emergency care may translate directly into preventable deaths.

The premise that systemic gaps in emergency care constitute a lethal dimension of health inequity is grounded in evidence from the Chinese context. Xu et al. (2020) documented a striking mortality gradient across hospital tiers: in-hospital mortality for ST-segment elevation myocardial infarction was 10.2% at county-level hospitals, compared with 3.1% at province-level hospitals [10]. Cheng et al. (2023) further revealed that county-level emergency departments in Henan Province had fewer physicians (median: 11 vs 23), fewer emergency beds (median: 4 vs 7), and substantially lower in-hospital CPR success rates (median ROSC: 25.0% vs 42.8%) compared with provincial-level hospitals [11]. These findings establish that disparities in emergency care capacity translate directly into survival differentials, positioning emergency care as a critical arena for understanding the lethal impact of health inequities. The broader international evidence on functional integration and mortality outcomes, including the role

of care coordination in reducing preventable deaths, is revisited in the Discussion where we examine the mechanisms linking structural deficits to patient outcomes.

A tacit assumption underpins current CCMA policy discourse: hospital grade (tertiary vs. secondary) determines service capacity. This assumption is embedded in resource allocation mechanisms, performance benchmarking, and the public's perception of quality [4, 12, 13]. The 2024 National Monitoring Indicator System for CCMAs (issued by the National Health Commission, the National Healthcare Security Administration, the National Administration of Traditional Chinese Medicine, and the National Disease Control and Prevention Administration) explicitly emphasizes resource allocation downwards from higher-grade institutions to grassroots levels. While the 2024 revision introduced 14 indicators across five domains with an emphasis on 'integration and efficiency,' process-oriented functional integration remains underrepresented relative to structural inputs. Yet this assumption has never been empirically tested in the CCMA context, particularly in resource-limited western regions where the relationship between structural designation and actual service delivery may be mediated by factors that formal grade does not capture. If grade does not reliably predict performance, then resource allocation based on grade may inadvertently perpetuate, rather than reduce, systemic disparities in emergency care. Indeed, empirical evidence from China suggests that the relationship between hospital grade and performance is far from straightforward: a study of 306 secondary and tertiary hospitals in Sichuan Province found that within the same grade, hospitals clustered into "Excellent," "Middle," and "Inferior" performance groups, and that "Excellent"-cluster tertiary hospitals performed worst in cost efficiency and mortality of middle- and low-risk cases. These patterns collectively question the validity of using grade as a proxy for actual service capacity [14].

This study challenges this assumption by proposing organizational agency as an alternative explanatory framework: the discretionary efforts of hospital leadership to prioritize emergency services, invest in process innovation, and cultivate accountability mechanisms. The concept derives from three complementary theoretical traditions. First, strategic prioritization draws on Mintzberg's conceptualization of strategy as "a pattern in a stream of decisions" [15]: organizational strategy emerges from the cumulative pattern of resource allocation and attention that leadership chooses to sustain over time, observable in whether hospitals allocate dedicated personnel, training budgets, and equipment to emergency services. Second, process innovation is grounded in Damanpour's meta-analytic framework of organizational innovation, which identified managerial attitude toward change, specialization, and internal communication as the strongest determinants of innovation adoption [16]; in healthcare, this translates into leadership's willingness to adopt and diffuse new care protocols, referral pathways, and information system tools. Third, accountability mechanisms build on Emanuel and Emanuel's stratified model of accountability in healthcare, which distinguishes among professional, economic, and political models and identifies the loci, domains, and procedures through which accountability is enacted [17]. In the CCMA setting, this manifests in whether leadership establishes regular audit-feedback systems, performance dashboards, and clear lines of responsibility for emergency care coordination. These three dimensions are operationalized through proxy measures embedded within the SPO framework (see Methods).

To underpin the empirical analysis, we draw on two complementary theoretical frameworks with distinct analytical roles. Donabedian's Structure-Process-Outcome (SPO) model provides the descriptive architecture for indicator construction and performance measurement [9], it specifies what to measure and enables systematic identification of where deficits are most pronounced. To explain why these deficits arise and persist, we draw on two mutually reinforcing lenses. First, Gillies et al.'s integration framework [18] distinguishes structural, functional, and clinical integration, positing that formal affiliation agreements (structural) are necessary but insufficient; without shared information systems (functional) and standardized protocols (clinical), performance alignment across tiers remains incomplete. Second, organizational agency (operationalized through strategic prioritization, process innovation, and accountability mechanisms) offers an institution-level explanation for why some organizations perform better than others despite similar structural endowments. Together, these explanatory lenses address different levels of analysis: Gillies' framework diagnoses system-level integration failures, while organizational agency explains institution-level performance variation. A parallel qualitative study in the same counties identified "inefficient coordination" as the key bottleneck [19], triangulating our quantitative approach.

From a governance perspective, health equity is not an automatic byproduct of resource inputs but requires deliberate institutional design that actively counteracts structural disparities. This study adopts a governance lens to examine how CCMA implementation shapes the distribution of EMS capacity across tiers, specifically assessing whether the current governance logic, centered on hospital grade as a proxy for capacity, inadvertently perpetuates inequity, and whether alternative governance mechanisms, centered on functional integration and organizational agency, offer more promising pathways for placing equity at the center of health system development.

Against this backdrop, this study pursues a primary diagnostic aim with an auxiliary exploratory component:

Primary diagnostic aim (RQ1 and RQ2): To systematically assess CCMA policy implementation across structure, process, and outcome dimensions using TOPSIS-RSR, and to identify whether a systematic structure-process-outcome gap exists and, if so, which dimension constitutes the primary bottleneck. These analyses constitute the core empirical contribution of this study.

Auxiliary exploratory component (RQ3): To examine—within the strict limits of an exploratory sample (n = 11 leading hospitals, ≈ 45% power for moderate effects)--whether hospital grade shows any association with EMS performance, and whether a proxy measure of organizational agency exhibits patterns worthy of future investigation. Crucially, all findings from this exploratory component are hypothesis-generating only; they cannot support confirmatory conclusions and require validation in adequately powered, multi-province samples. All findings from this exploratory component are reported in full in Additional file 3.

Governance translation (RQ4): To derive policy implications from the diagnostic findings, proposing a tiered governance framework for strengthening emergency service capacity in resource-constrained

settings.

The diagnostic logic is structured around these questions:

RQ1 (Core diagnosis): What is the current level of EMS capacity within Guangxi's CCMAs, and how is it distributed across leading hospitals and member institutions?

RQ2 (Core diagnosis): Is there a systematic gap between structural inputs, process mechanisms, and outcome measures? If so, which dimension represents the primary bottleneck?

RQ3 (Exploratory, hypothesis-generating): To what extent does hospital grade explain variation in EMS capacity across institutions, and are organizational factors beyond grade (particularly those reflecting organizational agency) associated with performance differences in ways that warrant future testing?

RQ4 (Governance translation): What are the governance implications of the diagnostic findings for policy optimization in resource-constrained settings?

As detailed below, our findings reveal a systematic structure–function mismatch, with process indicators scoring substantially lower than structural inputs, challenging the tacit assumption that hospital grade determines EMS capacity, and pointing to actionable pathways for strengthening systemic capacity in emergency care.

Methods

Study design

- This was a cross-sectional, theory-informed evaluation study conducted in 11 CCMA pilot counties of Guangxi Zhuang Autonomous Region, China, a region characterized by pronounced health resource disparities and high social vulnerability, making it a critical setting for examining systemic inequities in emergency care delivery.
- Analytical logic: integrating descriptive and explanatory frameworks. This study employs two complementary theoretical frameworks in sequence. First, Donabedian's Structure-Process-Outcome (SPO) framework [9] serves as the descriptive architecture for indicator construction and performance measurement: it specifies what to measure across the three dimensions and enables systematic identification of where deficits are most pronounced. Second, organisational agency serves as an explanatory lens for understanding why performance varies across institutions with similar structural endowments. It is operationalized through three dimensions (strategic prioritisation, process innovation, and accountability mechanisms) derived from Mintzberg's strategy framework [15], Damanpour's organisational innovation theory [16], and Emanuel and Emanuel's accountability model [17]. The analytical logic linking the two frameworks is that SPO identifies where the system fails (descriptive diagnosis), while organisational agency offers a pathway explanation for why some institutions outperform others despite comparable structural

conditions (explanatory analysis). Gillies et al.'s three-level integration model [18] further informs interpretation of inter-tier associations by distinguishing structural, functional, and clinical integration. This integrative logic, measurement first and explanation second, guided both the indicator system development and the subsequent exploratory analyses.

Sampling and participants

- We used a multi-stage stratified sampling approach. From the 39 Guangxi CCMA pilot counties, 11 were purposively selected to ensure geographic (eastern, central, western) and economic diversity. The selected counties did not differ significantly from the remaining 28 in per-capita GDP, rural population proportion, or bed density (all $p > 0.05$; Table 1), supporting representativeness within Guangxi. Within each county, one leading hospital and three township health centers were included. Health centers were selected based on: (1) geographic location; (2) service population size (large, medium, small); and (3) distance from the county seat (< 10 km, 10–30 km, > 30 km) to capture within-county variation. The final sample comprised 11 leading hospitals and 33 member institutions. This two-tier structure enabled systematic comparison of capacity gaps across organisational levels. Data were collected for the 2023 calendar year; all institutions were anonymized.

Table 1
Comparison of key indicators between sampled counties and other CCMA pilot counties in Guangxi (2023)

Indicator	Sampled counties (n = 11)	Other pilot counties (n = 28)	p-value*
Per capita GDP (RMB, mean ± SD)	35,247 ± 5,123	34,892 ± 5,876	0.624
Rural population proportion (%, mean ± SD)	65.3 ± 8.1	67.0 ± 7.4	0.451
Hospital beds per 1,000 population (mean ± SD)	4.52 ± 0.79	4.38 ± 0.85	0.507

*Independent samples t-test. No significant differences were found for any indicator ($p > 0.05$ for all).

Indicator system development

- The evaluation system was developed through a structured, multi-stage process guided by Donabedian's SPO framework [9].
- Literature review and preliminary formulation. We reviewed EMS-related policy documents and peer-reviewed literature, formulating separate preliminary indicator pools for leading hospitals and

member institutions across structure, process, and outcome dimensions. The initial draft contained 65 indicators for leading hospitals and 45 for member institutions.

- Delphi expert consultation. A two-round Delphi process was conducted with 20 purposively invited experts (emergency medicine: n = 9; health service management: n = 5; clinical medicine: n = 3; nursing: n = 3; 100% response rate). Experts rated each indicator's importance on a 5-point Likert scale and provided qualitative feedback. Indicators were retained if they met: (1) mean importance ≥ 3.5; (2) coefficient of variation ≤ 0.25; and (3) consensus agreement > 70%. This process reduced indicators to 61 for leading hospitals and 43 for member institutions. Expert authority coefficients (Cr) ranged from 0.885 to 0.930, well above the 0.70 threshold; Kendall's W coefficients ranged from 0.243 to 0.395 (all $p < 0.001$), indicating strong consensus.
- AHP weighting. The same panel performed pairwise comparisons using Saaty's 1–9 scale to determine weights via Analytic Hierarchy Process. All consistency ratios were < 0.1. Process dimension received the highest weight for both leading hospitals (0.4677) and member institutions (0.5668), followed by structure and outcome. Full indicator lists and weights are provided in Additional file 1.

Data collection

- Data were collected from three sources: (a) Guangxi Health Statistical Yearbook 2024; (b) annual hospital quality reports; and (c) a structured questionnaire completed by emergency department directors or quality management officers. To mitigate social desirability bias, self-reported electronic referral system utilisation rates were cross-verified against system login logs (available for 6 of 11 leading hospitals) and monthly referral reports. The correlation between self-reported and log-verified rates was strong ($r = 0.81$, $p = 0.015$), supporting the validity of self-reported data. All data were double-entered into EpiData 3.1 and cross-checked. Missing data were < 1.5% and confirmed completely at random (Little's MCAR, $p > 0.05$), handled by listwise deletion.

Statistical analysis

- Analytical hierarchy: core diagnosis and exploratory auxiliary analysis. This study addresses four research questions with a clear analytical hierarchy. RQ1 and RQ2 constitute the core diagnostic contribution: they assess the current level and distribution of EMS capacity and identify whether a systematic structure-process-outcome gap exists. These analyses are based on the full indicator system and TOPSIS-RSR methods, and their findings are descriptive in the sense that they characterise the observed system state. RQ3 is explicitly positioned as an exploratory auxiliary analysis: it examines whether hospital grade explains performance variation and whether organisational agency shows associations with performance differences. Critically, with only 11 leading hospitals, the study has approximately 45% power to detect a moderate correlation ($\rho = 0.50$) and adequate power (80%) only for large effects ($\rho \geq 0.75$). Consequently, any findings from RQ3, whether grade-performance correlations or agency-performance associations, cannot support

confirmatory conclusions. They are hypothesis-generating and require validation in larger, adequately powered samples. This analytical hierarchy, descriptive core diagnosis (RQ1/RQ2) followed by exploratory hypothesis generation (RQ3), structures the presentation of results and the interpretation of findings throughout this paper.

- TOPSIS-RSR evaluation. EMS capacity was evaluated using combined TOPSIS-RSR methods [20]. Raw data were normalised by vector normalisation and multiplied by AHP-derived weights to obtain weighted normalised values. Positive and negative ideal solutions were defined, and relative closeness (Ci) was calculated as $Ci = D^{-}/(D^{+}+D^{-})$. Institutions were ranked by Ci (higher = better). To stratify performance, Ci values were substituted for RSR values, converted to Probit units, and classified into three tiers via linear regression: excellent (Probit > 6), medium ($4 \leq$ Probit ≤ 6), and poor (Probit < 4). Sensitivity analyses (alternative percentile thresholds and removal of lowest-weight indicators) confirmed classification stability (91% for both leading hospitals and member institutions) [20]. Analyses used SPSS 26.0 and Excel 2019.
- Normality of continuous variables was assessed using the Shapiro–Wilk test. Group comparisons were performed using independent samples t-tests for normally distributed data. Correlation analyses used Spearman's rank correlation coefficient due to the small sample size (n = 11 leading hospitals). All tests were two-sided, and statistical significance was set at $p < 0.05$.

Organisational agency composite index: an exploratory construct

- Consistent with the analytical hierarchy stated above (see Statistical analysis), the examination of organizational agency is explicitly exploratory and hypothesis-generating. We constructed a composite index to operationalize three theoretical dimensions (strategic prioritization, process innovation, and accountability mechanisms) drawn from Mintzberg's strategy framework [15], Damanpour's organizational innovation theory [16], and Emanuel and Emanuel's accountability model [17]. The detailed indicator mapping, scoring procedures, and reliability assessments are provided in Additional file 3. In brief, for leading hospitals, the index comprised six binary indicators (e.g., dedicated improvement plan, electronic referral system utilization above median, regular audit-feedback systems); for member institutions, four indicators (e.g., platform access, regular system use, performance oversight, joint training participation). Internal consistency was acceptable (Cronbach's α: 0.74 and 0.71, respectively).
- Crucially, because (a) this index was derived from the same dataset as the EMS performance measures, introducing potential common-method bias, and (b) the sample size (n = 11 leading hospitals) provides only ≈ 45% power to detect moderate correlations, all analyses involving this index are strictly hypothesis-generating. Detailed results of all analyses involving this index are presented in Additional file 3; the main text reports only a brief summary.

Ethical considerations

- The study was approved by the Institutional Review Board of Guangxi Medical University (Approval No. KY20250406) and conducted in accordance with the Helsinki Declaration. Written informed consent was obtained from all Delphi experts and participating institutions. No patient-level data were collected.

Results and discussion

Basic Characteristics and Indicator Reliability

The sample included 11 leading hospitals (5 tertiary, 6 secondary) and 33 member institutions (24 meeting national standards, 9 not) from 11 counties across eastern (n = 4), central (n = 4), and western (n = 3) Guangxi. Median annual emergency visits were 42,150 (IQR: 28,700–61,200) for leading hospitals and 8,230 (IQR: 4,510–13,620) for member institutions.

Cronbach's α for the leading hospital toolkit was 0.87 (structure, 22 items), 0.91 (process, 26 items), and 0.79 (outcome, 13 items); for member institutions, α was 0.83, 0.89, and 0.74, respectively, with all values exceeding the 0.70 threshold. AHP consistency ratios were all < 0.1. Process dimension received the highest weight (leading: 0.4677; member: 0.5668), followed by structure and outcome.

Leading Hospital EMS Capacity

Table 2 presents TOPSIS results for the 11 leading hospitals. Mean overall Ci was 0.5309 (SD = 0.106). Structure dimension had the highest mean Ci (0.6980), followed by outcome (0.5302) and process (0.4647). RSR classification yielded two "excellent" (18.2%), seven "medium" (63.6%), and two "poor" (18.2%) hospitals. This pattern represents a "large middle, small ends" distribution. Process subdomain decomposition identified referral coordination (mean = 0.38) and information system utilization (mean = 0.41) as the weakest components.

Table 2
Comprehensive evaluation results of EMS capacity in leading hospitals

Rank	Leading hospital	Structure Ci	Process Ci	Outcome Ci	Overall Ci
1	A	0.7138	0.7036	0.6007	0.7138
2	I	0.6622	0.6335	0.5432	0.6622
3	E	0.6273	0.6195	0.4059	0.6273
4	G	0.6089	0.4951	0.6517	0.6089
5	F	0.5586	0.3805	0.7972	0.5586
6	B	0.5052	0.3511	0.6453	0.5052
7	D	0.4748	0.3537	0.5682	0.4748
8	J	0.4520	0.5183	0.4503	0.4520
9	K	0.4414	0.3376	0.4371	0.4414
10	C	0.4206	0.3379	0.2608	0.4206
11	H	0.3750	0.3809	0.4717	0.3750
Mean	–	0.5309	0.4647	0.5302	0.5309
Note: Excellent: Ci > 0.642; medium: 0.426–0.642; poor: Ci < 0.426.					

Member Institution EMS Capacity

Table 3 summarizes TOPSIS results for the 33 member institutions. Mean overall Ci was 0.4117 (SD = 0.117). As with leading hospitals, process had the lowest mean Ci (0.3474), with structure at 0.5353 and outcome at 0.6115. RSR classification identified six "excellent" (18.2%), 24 "medium" (72.7%), and three "poor" (9.1%) institutions. Process decomposition showed information system utilization (mean = 0.28) and referral coordination (mean = 0.31) as the weakest subdomains. These were significantly lower than leading hospitals ($p < 0.001$ for information system utilization).

Table 3
Representative TOPSIS results for member institutions: top six and bottom five performers (full ranking available in Additional file 2)

Overall rank	Member institution	Corresponding leading hospital	Structure Ci	Process Ci	Outcome Ci	Overall Ci
1	A1	A	0.6637	0.6543	0.7949	0.6637
2	I1	I	0.6892	0.6094	0.9063	0.6460
3	E1	E	0.6880	0.6049	0.8087	0.6369
4	G1	G	0.9012	0.5084	0.9652	0.6116
5	F1	F	0.9453	0.4350	0.9692	0.5647
6	A2	A	0.6342	0.4803	0.6598	0.5337
29	K2	K	0.3867	0.2747	0.1427	0.2944
30	J3	J	0.2886	0.2691	0.4916	0.2917
31	C3	C	0.1932	0.2696	0.4040	0.2656
32	K3	K	0.2454	0.2693	0.0916	0.2565
33	H3	H	0.1942	0.2685	0.0724	0.2458
Mean (all 33)	–	–	0.5353	0.3474	0.6115	0.4117

Note: The full ranking of all 33 member institutions is provided in Additional file 2. Excellent: Ci > 0.515; medium: 0.287–0.515; poor: Ci < 0.287.

Exploratory analyses

Consistent with the pre-specified analytical hierarchy, we conducted exploratory analyses to generate hypotheses for future research. Detailed results (including grade-performance correlations, organisational agency composite index construction and associations, cross-level (inter-tier) correlations, and sensitivity analyses) are presented in Additional file 2 and Additional file 4. In brief, the exploratory analyses suggest potential patterns worthy of future investigation in adequately powered samples: (a) in resource-limited western regions, formal hospital grade may not be a sufficient predictor of EMS performance; (b) a composite proxy for organisational agency (operationalized through strategic prioritisation, process innovation, and accountability mechanisms) showed exploratory associations with EMS performance that warrant validation in larger, longitudinal or quasi-experimental designs; and (c) a positive inter-tier association was observed between leading hospital EMS capacity and mean member institution performance, though this alignment was incomplete, with performance gaps ranging from 0.050 to 0.068 Ci units. These patterns are strictly hypothesis-generating and should not be interpreted as confirmatory evidence. All exploratory findings, including the detailed results presented in Additional file 2 and Additional file 4, require independent validation.

Sensitivity Analysis

Tier classification remained stable for 91% of leading hospitals (10/11) and 91% of member institutions (30/33) under alternative percentile thresholds and after removing lowest-weight indicators, confirming robustness of the "large middle" pattern and the exploratory positive inter-tier association pattern.

Given the cross-sectional nature of our data, all associations reported herein should be interpreted as correlational rather than causal. The analytical hierarchy established in the Methods dictates the inferential boundaries: RQ1 and RQ2 constitute the core diagnostic contribution; RQ3 is explicitly exploratory and hypothesis-generating, and its findings require validation in adequately powered samples.

Below, we organise the discussion around four sequential diagnostic arguments: identifying the core problem, explaining why it persists, theorising variation across institutions (exploratory), and deriving policy responses. These correspond to RQ1–RQ4.

Module I: Core diagnosis—A systematic structure–function mismatch with direct implications for health equity

Both leading hospitals and member institutions exhibited pronounced weakness in the process dimension (mean Ci: 0.465 and 0.347, respectively), while structural inputs scored substantially higher (structure Ci: 0.698 and 0.535). This structure–function mismatch (policy investments in hardware outpacing investments in functional integration) was consistent with Zhang et al.'s findings in Shandong [21], but Guangxi's absolute process scores were considerably lower, suggesting that western regions face amplified barriers. Critically, this mismatch creates a systemic gap in emergency service capacity that disproportionately affects member institutions. These are the very facilities serving rural and peri-urban populations.

Our subdomain decomposition identified referral coordination (mean = 0.38 in leading hospitals; 0.31 in member institutions) and information system utilization (mean = 0.41 and 0.28, respectively) as the weakest components. Particularly notable was the electronic referral system utilisation rate, which ranged from 0.12 to 0.89 among member institutions. These are not merely technical shortfalls; they represent governance failures. The National Health Commission's 2024 Monitoring Indicator System for CCMAs, while encompassing five domains, places insufficient weight on cross-institutional process integration, creating a governance bias: structural indicators, readily quantifiable and politically visible, are prioritised over harder-to-measure functional integration mechanisms. This bias perpetuates systemic disparities in emergency care delivery.

The pathway from this governance failure to health inequity follows a discernible chain: structural investments concentrated in leading hospitals → weak process mechanisms that fail to channel resources and patients effectively downward → member institutions left with persistently lower emergency service capacity → patients in underserved communities face delays in recognition, transfer,

and definitive care → potentially increased risk of preventable mortality. This hypothesized link, while plausible, requires direct testing in future studies with patient-level mortality data. The empirical pattern observed (process scores for member institutions substantially below those of leading hospitals, with information system utilisation rates as low as 0.12 in some institutions) provides direct evidence for each link in this chain up to the point of care delivery delays, but does not directly quantify the final mortality outcome. What is clear is that the governance logic driving this mismatch, prioritising what is measurable over what matters for functional integration, systematically disadvantages the very populations that CCMA policy was designed to serve.

The potential consequences are underscored by evidence from other contexts. Wang et al. (2022) found that hospital mergers with full functional integration were associated with significant mortality reductions [22]. Hilland et al. (2023) demonstrated that municipal acute care units in Norway, a functional integration intervention, were associated with lower mortality and fewer readmissions [23]. In rural China, research in Hunan found that a substantial proportion of under-five deaths occurred without any medical treatment, with care-seeking delays identified as a primary contributing factor [24]. Studies from Guangxi and other western regions have similarly documented substantial disparities in health resource accessibility [8, 25]. Taken together, these converging lines of evidence reinforce the plausibility that the systemic gaps in emergency service coordination documented here could contribute to preventable deaths in underserved populations. This hypothesis merits direct empirical investigation in future research.

Module II: Exploratory observation—Incomplete performance alignment as a potential driver of systemic disparity

An exploratory positive inter-tier association was observed between leading hospital EMS capacity and mean member institution performance, consistent with vertical integration facilitating performance alignment [26] (detailed results in Additional file 3). However, the alignment is incomplete: performance gaps between leading hospitals and their top member institutions ranged from 0.050 to 0.068 Ci units. These gaps represent tangible disparities in service capacity that, for patients in underserved areas, may translate into differential access to life-saving emergency care.

Gillies et al.'s integration framework [18] offers a plausible interpretation of this exploratory pattern: while structural integration (formal affiliation) is largely in place in all 11 counties, functional integration (shared information systems) and clinical integration (standardised protocols) remain underdeveloped, as evidenced by low electronic referral utilisation and poor referral coordination scores. This interpretation is triangulated by Hughes et al.'s (2020) systematic review finding that successful integration depends less on formal contracts and more on shared systems and collaborative governance [27], and by a parallel qualitative study in the same counties identifying "inefficient coordination" as the key bottleneck [19]. Thus, the persistence of incomplete alignment reflects not a lack of policy intent, but

a failure to translate structural mandates into functional integration. This is a recurring theme in health systems that perpetuate inequity.

Module □: Exploratory observations and hypotheses for future research

This Module is explicitly exploratory and hypothesis-generating. It does not provide confirmatory evidence about the determinants of EMS performance.

As detailed in the Methods and fully reported in Additional file 3, we conducted exploratory analyses to examine whether hospital grade and a composite proxy for organisational agency showed any association with EMS performance. The grade-performance correlation was inconclusive due to limited statistical power (≈ 45% for moderate effects with n = 11 leading hospitals); no directional inference (whether "grade matters" or "grade does not matter") can be drawn from this sample. The organisational agency composite index showed exploratory associations in correlational analyses, but these estimates are unstable, susceptible to common-method bias (both agency indicators and performance measures derived from the same institutional survey), and derived from a small sample. Therefore, they should be interpreted strictly as testable hypotheses, not as confirmed determinants.

We offer two hypotheses for future investigation: (a) in resource-limited western regions, formal hospital grade may not be a sufficient predictor of EMS performance, and process-oriented organisational variables may need to be incorporated to explain performance variation more fully; and (b) organisational agency (operationalized as leadership discretion in strategic prioritisation, process innovation, and accountability mechanisms) may warrant further study as a potential mediator or moderator of the link between institutional arrangements and service performance. These hypotheses require validation in larger (e.g., ≥ 50 leading hospitals), longitudinal or quasi-experimental studies with independent measures of organisational factors and patient-level outcome data.

Module IV: Governance pathway—A tiered framework for translating diagnostic evidence into equitable policy action

The "large middle, small ends" distribution observed in our RSR classification provides a clear empirical rationale for differentiated rather than uniform policy approaches. This tiered governance framework embodies a core principle of equity-centered development: interventions should be calibrated to the specific deficits of each tier, rather than applying uniform mandates that may inadvertently widen disparities. One-size-fits-all mandates are unlikely to succeed, as the performance deficits of poor-tier institutions (structural gaps) differ fundamentally from those of medium-tier institutions (process integration failures) and excellent-tier institutions (sustainability challenges). Specifically, poor-tier institutions lack foundational inputs such as hardware, staffing, and equipment, requiring structural gap-filling as the first priority. Medium-tier institutions have adequate structural capacity but fail to translate it into coordinated care delivery, necessitating process mechanism building. Excellent-tier institutions, by contrast, have achieved both structural adequacy and functional integration; their challenge is not

capacity-building but sustaining high-level performance over time: preventing quality erosion due to staff turnover, resource fluctuations, or diminishing attention once initial policy momentum wanes. We therefore propose a tiered governance framework (Table 4) that matches differentiated interventions to performance strata.

Table 4
Tiered governance framework for CCMA EMS capacity optimization

Tier	Institutions (n)	Policy Focus	Specific Actions
Poor-tier	2 leading, 3 member	Structural gap-filling	Infrastructure investment; HR development; equipment upgrades
Medium-tier	7 leading, 24 member	Process mechanism building	Electronic referral systems; standardized pathways; joint training; interoperable platforms
Excellent-tier	2 leading, 6 member	Quality sustainability	Regional training centers; cross-provincial benchmarking; QI networks

Note: Tier classification derived from RSR analysis as described in the Results.

The tiered framework operates on a diagnosis-intervention matching logic: performance deficits are first localised to specific SPO dimensions (using subdomain scores from the TOPSIS analysis), then interventions are matched to the diagnosed deficit profile. For excellent-tier institutions, the rationale for focusing on sustainability rather than capacity-building is threefold: their structural scores already approach the ceiling (mean structure Ci = 0.698 for leading hospitals), their process scores, while not perfect, are substantially above the medium-tier average, and their greatest vulnerability lies in the erosion of hard-won gains over time. This is a risk that regional training centers, cross-provincial benchmarking, and continuous quality improvement networks are specifically designed to mitigate.

Building on this diagnostic-intervention logic, we offer five recommendations for health governance in resource-constrained settings:

First, recalibrate the national monitoring framework to give process indicators meaningful weight. The current framework's emphasis on structural indicators (readily quantifiable inputs) creates a governance bias that obscures functional integration deficits. Second, shift from structural signing to functional enabling by mandating interoperable electronic referral systems, standardised clinical protocols, and shared performance dashboards rather than merely requiring affiliation agreements. Third, activate organisational agency through performance-based incentives and leadership training, recognising that structural mandates alone do not produce process-level convergence. Though this recommendation derives from exploratory findings, it should be implemented with evaluative components to test its effectiveness. Fourth, adopt tiered governance rather than uniform mandates, matching intervention intensity and type to diagnosed performance deficits. Fifth, integrate cost-effectiveness considerations into policy design: the structure-function mismatch documented here suggests potential allocative

inefficiency in current CCMA resource allocation, a hypothesis supported by Tan et al.'s (2024) finding that vertical integration increased primary care expenditures without corresponding quality gains [28].

Collectively, these recommendations provide a roadmap for translating diagnostic evidence into equitable policy action, addressing the systemic disparities in emergency care capacity that place underserved populations at risk of adverse outcomes.

Implications for the Post-2030 SDG Agenda: Re-centering Health Equity in Health System Development

- The findings of this study carry implications for the post-2030 SDG agenda that extend beyond the specific context of CCMA emergency services. As the 2030 deadline approaches, scholars have critically interrogated the SDG framework itself, arguing that its reliance on voluntary commitments and non-binding targets (in the absence of enforceable accountability mechanisms) risks reproducing the very asymmetries of power and resources they purport to address [29]. In global health, this critique has particular force: the dominant model of public–private partnerships, while central to SDG implementation, raises persistent concerns around legitimacy, transparency, and accountability [30]. For health systems in resource-limited settings, how the post-2030 agenda frames equity, governance, and accountability will materially shape the availability and distribution of life-saving services such as emergency care.
- Against this backdrop, our findings offer three specific contributions to the post-2030 governance debate.
- First, the structure–function mismatch documented here illustrates a general governance challenge that has been identified in the broader literature on post-2030 development governance: structural investments, readily quantifiable and politically visible, tend to crowd out functional integration mechanisms that are harder to measure but essential for equitable service delivery. Alamro (2026) identifies this as a fundamental gap between integrated health system reforms (implemented across financing, service delivery, digital health, and governance) and the indicator-based frameworks used to monitor SDG 3, which remain designed for discrete interventions rather than systemic transformation [31]. For the post-2030 agenda, this suggests that monitoring frameworks must move beyond input-based indicators toward process-oriented measures that capture the actual functioning of health systems for marginalised populations.
- Second, the exploratory observation that formal grade may not fully account for performance variation raises questions about the assumption that structural hierarchy is a reliable proxy for service capacity, although this observation is statistically inconclusive and requires validation in larger samples. This resonates with Makama's (2026) critique of the "Development-Goals" model, which argues that global health governance cannot continue to rely on this model to address health inequalities and suggests a more country-to-country, context-specific approach [32]. In the post-2030 era, equity-oriented health system development requires performance assessment frameworks that do not conflate formal designation with substantive capability. The tiered

governance framework proposed in this study (Table 4) offers one approach to this challenge: matching interventions to diagnosed deficits rather than relying on uniform, grade-based mandates.

- Third, the organisational agency composite index, while exploratory, raises the hypothesis that leadership discretion and accountability mechanisms may be underutilised levers for promoting equity. This observation aligns with calls from the HD Alliance (2025) for global health architecture reform that goes beyond temporary initiatives or "rhetorical solidarity" toward concrete, actionable mechanisms, recognising that the current architecture remains tilted toward external control, vertical programmes, and fragmented governance [33]. For the post-2030 agenda, investing in agency-enabling mechanisms (performance-based incentives, leadership training, and audit-feedback systems) may yield greater equity returns than further structural investments alone. This hypothesis is consistent with the broader argument that the post-2030 Global Social Contract must move beyond voluntary commitments to impose enforceable obligations, embed structural restitution through debt and tax justice, and democratise health governance [29].
- Collectively, these implications position this study not merely as an empirical evaluation of a regional policy, but as a contribution to the emerging evidence base for re-centering health equity in health system governance. This is a critical endeavour as the global community moves beyond the 2030 framework toward a new generation of development commitments.

Limitations

- Several limitations should be considered. First, the cross-sectional design precludes causal inference; the associations reported reflect correlational patterns that require longitudinal confirmation. Second, the analytical hierarchy of this study warrants emphasis: RQ1/RQ2 constitute the core diagnostic contribution, while RQ3 is exploratory. With only 11 leading hospitals (≈ 45% power for moderate effects), the grade-performance analysis is inconclusive, and the agency composite findings are hypothesis-generating. We have explicitly framed RQ3 as exploratory throughout the introduction, methods, results, and discussion, and avoid claiming that grade has no relationship with performance or that agency is a "confirmed determinant". Third, while the 11 sampled counties are statistically representative of Guangxi's 39 CCMA pilots (Table 1), supporting internal generalizability, direct extrapolation to other western provinces requires further validation. These provinces differ in economic development, ethnic composition, and health system characteristics. This study therefore establishes a diagnostic baseline for Guangxi rather than a generalizable model for all western regions. Fourth, despite VIF checks, the 61/43 indicators may have residual redundancy, though the Delphi consensus process and AHP weighting were designed to mitigate this. Fifth, self-reported data may be subject to social desirability bias, though cross-validation against system logs ($r = 0.81$) supported validity. Sixth, cost and patient-level data were not collected, limiting direct testing of allocative inefficiency and precluding analysis of the relationship between service capacity gaps and actual patient outcomes, including mortality. This is a critical dimension for understanding the lethal consequences of health inequities. Seventh, the lack of non-CCMA controls prevents attribution of EMS capacity specifically to the CCMA policy.

Eighth, we cannot rule out reverse causality in the organisational agency–performance association: Higher-performing institutions may attract more capable leadership, rather than agency driving performance. Future longitudinal studies are needed to disentangle these directions of influence.

- These limitations notwithstanding, the study provides a systematic empirical diagnosis of how structural and organisational factors shape EMS capacity gaps in a resource-limited, multi-ethnic region. This is a necessary foundation for translating health equity research into policy action aimed at reducing preventable deaths in underserved populations.

Conclusions

This policy diagnostic study establishes that placing health equity at the center of health system development requires confronting systemic disparities in emergency service capacity. In Guangxi's CCMA pilot counties, we found a systematic structure–function mismatch that disproportionately affects member institutions serving marginalised populations. This mismatch reflects not a failure of structural investment, but a governance logic that privileges institutional hierarchy over functional integration. This logic inadvertently perpetuates, rather than reduces, health inequity.

Our primary contribution is diagnostic: we identify process integration deficits as the key bottleneck in emergency service capacity, particularly in referral coordination and information system utilization. This finding, based on the core analyses (RQ1 and RQ2), provides the empirical foundation for our policy recommendations.

Regarding the exploratory component (RQ3), we emphasise that the grade-performance analysis is inconclusive due to limited statistical power; no conclusion about the presence or absence of a grade-performance relationship can be drawn from this sample. The organisational agency proxy showed exploratory associations, but these are strictly hypothesis-generating, not confirmatory, and require validation in larger, adequately powered studies.

The practical implications follow directly from the diagnostic logic. The tiered governance framework (Table 4) operationalizes a diagnosis-intervention matching approach that avoids one-size-fits-all mandates by aligning interventions with dimension-specific deficits. More broadly, recalibrating national monitoring frameworks toward process integration and subjecting structural versus process investments to cost-effectiveness scrutiny would translate these diagnostic findings into equitable policy action, addressing the systemic disparities that place underserved populations at risk of adverse outcomes.

By diagnosing the mechanisms through which systemic disparities in emergency care arise and persist, this study contributes an empirical anchor for the post-2030 SDG agenda's ambition to re-center health equity in health system governance. This contribution's translational pathway is outlined in Module IV.

Abbreviations

AHP Analytic Hierarchy Process

CCMA Compact-type county medical alliance

Ci Closeness value (TOPSIS)

CR Consistency ratio (AHP)

EMS Emergency medical service

IQR Interquartile range

RSR Rank sum ratio

SPO Structure-Process-Outcome

TOPSIS Technique for Order Preference by Similarity to Ideal Solution

VIF Variance inflation factor

Declarations

Ethics approval and consent to participate

This study was reviewed and approved by the Institutional Review Board (Academic Research Ethics Committee) of Guangxi Medical University (Approval No. KY20250406). All procedures were conducted in accordance with the ethical standards of the Helsinki Declaration.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data.

Availability of data and materials

The raw data supporting the conclusions of this article are available from the corresponding author upon reasonable request. The full exploratory analysis dataset, including the organisational agency composite index scores and inter-tier correlation data, is available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

X.S. contributed conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, writing – original draft, and writing – review & editing. F.Y. contributed investigation, validation, and writing – review & editing. S.W. contributed data curation, visualization, and writing – review & editing. Q.F. contributed formal analysis, investigation, methodology, project administration, supervision, validation, writing – review & editing. X.S. and Q.F. share corresponding authorship. Q.F. serves as Lead Contact.

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