Evaluating Centralized Drug Procurement in a Resource-Constrained Setting: Evidence from a Northwestern Province in China

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Abstract. Centralized drug procurement has become an important policy instrument for controlling pharmaceutical expenditure and improving access to medicines, yet most existing evaluations of China's National Centralized Drug Procurement programme have focused mainly on price reductions, large urban hospitals, or economically developed regions. This study contributes new evidence by evaluating centralized drug procurement implementation in a resource-constrained northwestern provincial setting and by examining multidimensional performance across different governance models. A retrospective quantitative policy evaluation was conducted using administrative procurement data from 36 centralized procurement batches implemented between 2019 and 2024. A coefficient-of-variation-weighted composite performance index was constructed using the Technique for Order Preference by Similarity to the Ideal Solution, and differences across national, provincial, and inter-provincial alliance procurement models were assessed using the Kruskal–Wallis test. Composite performance scores ranged from 0.340 to 0.889, indicating substantial heterogeneity across procurement batches. Provincial procurement showed the highest average performance, followed by national procurement, while inter-provincial alliances demonstrated lower scores; however, these differences were not statistically significant ($p = 0.199$). Indicator weights showed that overall performance was driven mainly by drug expenditure savings and utilization of bid-winning medicines, rather than price reductions alone. These findings suggest that centralized procurement success should not be evaluated solely by nominal price reductions, but by whether negotiated prices are translated into actual medicine uptake and system-level financial gains. Overall, the study highlights the need for more implementation-sensitive evaluations of pharmaceutical procurement reform, particularly in resource-constrained settings where local capacity, market conditions, and batch-specific execution may strongly shape policy outcomes.

Keywords: Centralized drug procurement, volume-based procurement, resource-constrained settings, pharmaceutical expenditure, implementation performance, TOPSIS, China

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1 Introduction

Pharmaceutical spending has become a major challenge for health systems worldwide, particularly in low- and middle-income countries where medicines may account for a substantial share of health expenditure[1, 2]. In response, centralized or pooled procurement has been increasingly used as a cost-containment strategy to leverage collective purchasing power, reduce prices, and maintain access to essential medicines[3]. To counter rising pharmaceutical expenditure, many countries have long employed measures such as direct price controls, external reference pricing, and reimbursement restrictions to contain costs[4]. While these measures may provide short-term savings, they have major limitations[5]. Pharmaceutical companies often avoid such controls through confidential discounts or delayed market entry, while price controls alone struggle to reshape fundamental market structures (for example, lack of competition or fragmented purchasing power)[5]. Therefore, policymakers are increasingly turning to centralized procurement or joint procurement, a strategic demand-side approach that achieves lower prices by consolidating buyers' bargaining power[5]. Centralized procurement, once primarily used in low- and middle-income countries for global health initiatives, is now increasingly adopted in high-income regions and often supported by multilateral actors like the WHO[5, 6]. This evolution lays the foundation for examining how such policies perform under different implementation conditions.

Recent empirical analyses consistently show that centralized drug procurement can dramatically lower medication prices[7]. The most significant price reductions typically occur during the initial implementation phase, with relatively limited cost savings achieved in subsequent phases[7]. However, evidence on broader outcomes is mixed. Some studies report notable decreases in overall pharmaceutical spending (around 10% in aggregate) following centralized purchasing[8], while others find minimal net changes, as initial savings gradually erode or are offset by increased drug usage[7]. Significant variations in effectiveness were observed across different drug categories and institutional settings. Multinational studies revealed that when supplier competition is insufficient, average price reductions amount to only about 15%[9], in contrast to highly competitive markets or specific therapies where substantial cost savings can be achieved[7]. The key point is that the effectiveness of centralized procurement depends on implementation capacity and specific circumstances. Successful projects require solid governance capabilities and must align with the local health system's conditions[7].

China’s National Centralized Drug Procurement (NCDP) programme represents the world's largest institutional experiment in centralized drug procurement. It is characterized by its unprecedented scale, extensive mandatory implementation scope, and rapid nationwide expansion[10, 11]. Empirical evaluations over the past five years consistently indicate that under the NCDP, target drug prices have experienced considerable declines in the short term (typically exceeding 50%), accompanied by corresponding changes in drug procurement volumes[11, 12]. Unlike earlier fragmented provincial tendering mechanisms, the NCDP aggregates demand across provinces and public hospitals through a centralized Joint Procurement Office led by the National Healthcare Security Administration (NHSA)[10, 11]. This institutional arrangement grants the

government a unique monopsony position, enabling it to negotiate deep price discounts by guaranteeing manufacturers a large share of the consolidated market[11]. Hospitals are required to submit projected demand estimates, which form the basis for contractually binding purchase volumes. This model is commonly referred to as "volume-for-price"[11].

Despite its strong institutional design and demonstrated price reductions, the implementation of NCDP occurs across highly heterogeneous environments[13]. Less developed regions often face distinct implementation barriers, including weaker local procurement capacity and bargaining power, fragmented logistics and drug supply chains (especially in remote areas) and limited market competition, that may undermine policy effectiveness[13, 14]. However, most published studies have focused on large urban hospitals or economically advanced regions, leaving limited empirical evidence on NCDP implementation in lower-capacity settings, particularly in northwestern China[15]. This evidence gap therefore underscores an urgent need for further subnational research on NCDP implementation in less developed provinces and autonomous regions of China. To address this gap, this study evaluates the implementation performance of centralized drug procurement in a resource-constrained province in northwestern China and examines variation across governance models.

2 Methods

2.1 Study Design

This study adopts a retrospective quantitative policy evaluation design to assess the implementation performance of China's NCDP policy in a resource-constrained province in northwestern China between 2019 and 2024. Multidimensional policy outcomes were synthesized using a Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS)-based weighted composite index to support cross-batch and cross-policy comparisons.

The study used de-identified administrative procurement records provided with permission by the relevant provincial healthcare security administration. The dataset contained procurement-level and medicine-level indicators but did not include individual patient information or personal health records. The province was anonymised primarily because the dataset was obtained under administrative permission and contained non-public procurement information. Anonymisation also reduced the risk that individual low-performing procurement batches could be linked to identifiable local administrative performance. As the study was based on secondary administrative data without individual-level personal information, formal ethics approval was not required. Data sharing is restricted because the original dataset was obtained under administrative permission and contains non-public procurement information.

2.2 Evaluation Objects and Indicator System

The evaluation covered 36 batches of centralized drug procurement projects implemented in the study province (national procurement programmes, inter-provincial alliance procurement initiatives, and provincial procurement projects) between December 2019 and July 2024. For each procurement batch, representative medicines were selected from the bid-winning drug list based on procurement expenditure. Specifically, the four drug products with the highest procurement expenditure within each procurement batch were selected as indicator medicines to represent the implementation performance of the procurement project. If fewer than four medicines were available, all medicines were included. Across the 36 procurement batches, 141 representative product specifications were included. Thirty-five batches contributed four representative products each, while one batch, Inter-provincial Alliance B, included only one eligible bid-winning product specification (see Table 1). Therefore, the number of representative products per batch ranged from one to four. For procurement projects with implementation periods shorter than one year as of July 2024, procurement quantities and expenditure were proportionally adjusted according to the actual number of implementation days to estimate one-year indicator values.

Based on policy objectives and prior empirical studies on drug procurement and health financing reforms[16-21], six key indicators were selected to reflect policy performance:

1. Price reduction rate of bid-winning drugs (%)
2. Drug expenditure savings from bid-winning drugs (CNY)
3. Utilization rate of bid-winning drugs (%)
4. Completion rate of contracted procurement volumes (%)
5. Change rate in the volume of alternative drugs (%)
6. Change rate in expenditure on alternative drugs (%)

Indicators (1) – (4) were defined as benefit-oriented indicators, where higher values indicate better policy performance. Indicators (5) and (6) were treated as cost-oriented indicators, as reductions in substitutable drug use reflect stronger policy compliance and substitution effects. For each procurement batch, indicator values were derived from representative products, using the median value across the selected products to reduce the influence of extreme observations. The median was preferred over the mean because several drug-level indicators, particularly expenditure savings and changes in alternative drug use, were highly skewed and sensitive to extreme values. This approach reduced the risk that a single high-volume or atypical product would dominate the batch-level performance estimate.

2.3 Data Processing and Index Construction

2.3.1 Data Normalization.

To ensure comparability across indicators with different units and scales, all indicator values were normalized using a linear min–max normalization method.

For benefit-oriented indicators:

$$r_{ik} = \frac{x_{ik} - min(x_k)}{max(x_k) - min(x_k)}$$

For cost-oriented indicators:

$$r_{ik} = \frac{max(x_k) - x_{ik}}{max(x_k) - min(x_k)}$$

where r_{ik} denotes the normalized value of batch i on indicator k.

2.3.2 Indicator Weighting.

Indicator weights were determined using the coefficient of variation (CV) method, an objective weighting approach that assigns greater weight to indicators with higher relative variability across evaluation objects. CV values were calculated across the 36 procurement batches using the normalised batch-level indicator values after direction alignment and min–max normalisation.

The weight for each indicator was calculated as:

$$w_k = \frac{CV_k}{\sum_{k=1}^{6} CV_k}$$

where $w_k$represents the weight of indicator k, and the sum of all weights equals one.

2.3.3 Composite Policy Performance Index.

Normalized indicator values were multiplied by their corresponding weights to generate a weighted normalized decision matrix.

An ideal performance vector (best observed values across all indicators) and an anti-ideal performance vector (worst observed values) were then defined.

For each procurement batch, the Euclidean distance to the ideal and anti-ideal solutions was calculated. Based on these distances, a composite policy performance index (Ci) was derived:

$$C_i = \frac{D_i^-}{D_i^- + D_i^+}$$

where $D_i^+$and D_i^-denote the distances to the ideal and anti-ideal solutions, respectively. The value of $C_i$ranges from 0 to 1, with higher values indicating better overall policy performance.

2.4 Comparative Analysis

The composite performance index was used to rank procurement batches and compare policy performance across governance levels, including national, provincial, and inter-provincial alliance procurement. Mean scores were examined to compare differences

across procurement models. Differences in composite performance scores across governance levels were further assessed using the Kruskal-Wallis non-parametric test, given the unequal group sizes and the non-normal distribution of Ci values. Effect size (η^2) was calculated to evaluate the magnitude of governance-level differences. This analysis was intended as a comparative rather than causal assessment.

3 Results

3.1 Overall Performance and Variation in Composite Performance Across Governance Level

Composite performance scores (Ci) varied substantially across the 36 procurement batches, ranging from 0.340 to 0.889, indicating marked variation in implementation effectiveness (**Table 1**). The highest-performing batch was XM17, with a Ci value of 0.889, followed by XM3 (Ci = 0.824) and XM32 (Ci = 0.801). In contrast, XM26 ranked lowest, with a Ci of 0.340, suggesting pronounced implementation challenges in this batch.

Overall, most batches clustered within a moderate performance range (Ci ≈ 0.55–0.75), while a smaller number of batches demonstrated either notably high or low composite scores. This wide dispersion of Ci values highlights considerable variation in procurement outcomes across different implementation rounds, despite operating under a broadly similar national policy framework.

Substantial heterogeneity was observed within each governance category. National procurement showed the widest range of composite scores, including both the highest-performing batch, XM17 (Ci = 0.889), and one of the lowest-performing batches, XM16 (Ci = 0.345). Inter-provincial alliances also varied considerably, with scores ranging from 0.340 to 0.759, while provincial procurement generally showed moderate-to-high performance despite some variation across rounds. These patterns suggest that performance differences were not confined to one governance model, but were also shaped by batch-level implementation conditions.

Table 1. Closeness Coefficients (Ci) and Ranking of Each Procurement Batch

Governance	Project ID	Procurement Batch	C_i	Rank
National	XM1	National Procurement – Round 1	0.643	11
	XM2	National Procurement – Round 1 (Second Round)	0.589	20
	XM3	National Procurement – Round 2	0.824	2
	XM4	National Procurement – Round 2 (Second Round)	0.561	26
	XM5	National Procurement – Round 2 (Third Round)	0.617	15
	XM6	National Procurement – Round 3	0.748	8
	XM7	National Procurement – Round 3 (Second Round)	0.605	18
	XM8	National Procurement – Round 3 (Third Round)	0.660	10

	XM9	National Procurement – Round 4	0.636	13
	XM10	National Procurement – Round 4 (Second Round)	0.632	14
	XM11	National Procurement – Round 4 (Third Round)	0.561	26
	XM12	National Procurement – Round 5	0.525	30
	XM13	National Procurement – Round 5 (Second Round)	0.800	4
	XM14	National Procurement – Round 5 (Third Round)	0.431	34
	XM15	National Procurement – Round 6	0.749	7
	XM16	National Procurement – Round 6 (Second Round)	0.345	35
	XM17	National Procurement – Round 7	0.889	1
	XM18	National Procurement – Round 7 (Second Round)	0.564	24
	XM19	National Procurement – Round 8	0.609	17
	XM20	National Procurement – Round 9	0.612	16
Inter-provincial alliances	XM21	Inter-provincial Alliance A	0.457	33
	XM22	Inter-provincial Alliance A (Second Round)	0.558	28
	XM23	Inter-provincial Alliance B	0.539	29
	XM24	Inter-provincial Alliance C	0.759	5
	XM25	Inter-provincial Alliance D	0.504	32
	XM26	Inter-provincial Alliance D (Second Round)	0.340	36
	XM27	Inter-provincial Alliance E	0.592	19
	XM28	Inter-provincial Alliance E (Second Round)	0.580	22
	XM29	Inter-provincial Alliance F	0.750	6
	XM30	Emergency & Shortage Medicines Alliance	0.564	24
	XM31	Interferon Alliance	0.587	21
Provincial	XM32	2022 Provincial Procurement	0.801	3
	XM33	2022 Provincial Procurement (Second Round)	0.576	23
	XM34	Continuation of National Rounds 2 & 4	0.723	9
	XM35	Continuation of National Rounds 2 & 4 (Second Round)	0.524	31
	XM36	2023 Volume-Linkage Procurement	0.639	12

3.2 Comparison of Performance by Governance Level

Descriptive differences in composite performance were observed across governance levels (**Figure 1 & Table 2**). Provincial procurement achieved the highest mean closeness coefficient (Ci = 0.653, SD = 0.111; n = 5), followed by national procurement (Ci = 0.630, SD = 0.128; n = 20), while inter-provincial alliances demonstrated the lowest average performance (Ci = 0.566, SD = 0.118, n = 11). The boxplot further illustrates

this pattern. Provincial procurement showed the highest central values, although interpretation should be cautious because only five provincial batches were included. National procurement displayed the widest dispersion in Ci values, reflecting substantial within-group heterogeneity and the presence of both high-performing and low-performing batches. Inter-provincial alliances were generally clustered around lower Ci values, although some alliance batches achieved relatively high performance. Overall, these descriptive patterns suggest possible performance differences across governance levels, while also indicating considerable variation within each governance model.

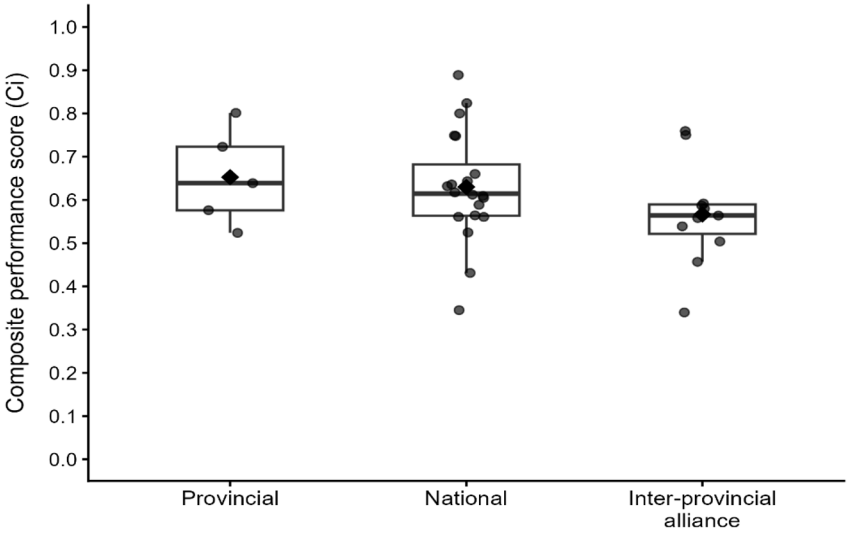


Fig. 1. Distribution of composite performance scores (Ci) by governance level

Notes: *Boxes represent interquartile ranges, horizontal lines indicate medians, diamonds denote means, and points represent individual procurement batches.*

Table 2. Composite performance by governance level

Governance level	Number of batches (n)	Mean Ci	SD
Provincial procurement	5	0.653	0.111
National procurement	20	0.630	0.128
Inter-provincial alliances	11	0.566	0.118

Although these descriptive patterns suggest potential differences across governance models, statistical testing did not indicate a significant difference in composite performance scores between governance levels. A Kruskal–Wallis test showed that the variation in Ci values across national procurement, inter-provincial alliances, and provincial procurement was not statistically significant ($\chi^2 = 3.228$, df = 2, $p = 0.199$). The estimated effect size was small ($\eta^2 = 0.037$), indicating that governance structure explained only a limited proportion of the variation in procurement performance.

3.3 Indicator Contributions to Policy Performance

Table 3. Indicator weights in the composite performance index

Indicator	Description	CV based on normalised values	W
W2	Drug expenditure savings from bid-winning drugs (CNY)	0.532	0.312
W3	Utilization rate of bid-winning drugs (%)	0.391	0.230
W1	Price reduction rate of bid-winning drugs (%)	0.236	0.139
W5	Change rate in the volume of alternative drugs (%)	0.200	0.118
W4	Completion rate of contracted procurement volume (%)	0.171	0.101
W6	Change rate in expenditure on alternative drugs (%)	0.172	0.101
Total		**1.702**	**1.000**

Notes: *Values may not sum exactly due to rounding.*

Indicator weighting results showed that composite performance scores were predominantly driven by financial savings and utilization outcomes (**Table 3**). Fund savings accounted for the largest proportion of total weight (0.312), followed by the utilization rate of bid-winning medicines (0.230). These two indicators contributed more than half of the total composite weight. In contrast, price reduction magnitude (0.139), completion rate (0.101), and substitution-related indicators, including changes in the volume (0.118) and expenditure (0.101) of alternative medicines, contributed relatively less to overall rankings. Higher Ci values were primarily associated with greater budgetary savings and higher levels of medicine uptake, while price reductions alone showed a more limited contribution to composite performance.

3.4 Sensitivity Analysis

To test the robustness of the TOPSIS composite index to the weighting structure, an equal-weight sensitivity analysis was conducted in which all six indicators were assigned the same weight. The equal-weight analysis produced broadly consistent batch-level rankings. XM17 and XM3 remained the two highest-performing batches, while XM26 and XM16 remained the two lowest-performing batches. The highest-ranking batches were largely the same as those identified in the main analysis, although some local rank changes were observed.

Governance-level conclusions were unchanged. Provincial procurement retained the highest mean composite score (mean Ci = 0.780, SD = 0.079), followed by national procurement (mean Ci = 0.751, SD = 0.094) and inter-provincial alliances (mean Ci = 0.698, SD = 0.104). The Kruskal-Wallis test remained non-significant ($\chi^2 = 3.005$, df = 2, $p = 0.223$), with a small effect size ($\eta^2 = 0.030$). These results indicate that the main governance-level conclusions were robust to the use of equal indicator weights.

4 Discussion

4.1 Principal Findings

Using a weighted TOPSIS framework, we found substantial variation in procurement performance across batches, with descriptive differences across governance models. However, the wide variation within governance categories suggests that procurement outcomes were shaped not only by governance structure, but also by batch-specific implementation conditions and local execution capacity.

Importantly, indicator contribution analysis showed that overall procurement performance was driven primarily by fund savings and utilization of bid-winning medicines, rather than price reductions alone. Together, financial savings and medicine uptake accounted for more than half of the composite score, highlighting that procurement effectiveness depends not only on negotiated price cuts but also on downstream implementation and budgetary impact within local health systems.

4.2 Governance, Implementation Capacity, and Performance Drivers

Our findings suggest that centralized procurement performance is shaped by both governance arrangements and downstream implementation capacity. Although provincial procurement showed the highest average composite performance and inter-provincial alliances showed lower average scores, the non-significant between-group test indicates that governance level alone explained only a limited share of overall variation. The wide dispersion of scores within governance categories, particularly among national procurement batches, suggests that batch-specific conditions and local execution capacity may be more important than procurement category itself. This reflects a key tension in centralized procurement: while large-scale national programmes can generate bargaining power and economies of scale, their effectiveness depends on whether local health systems can ensure reliable supply, hospital uptake, prescribing alignment, and procurement completion[11, 18]. Inter-provincial alliances may face additional coordination challenges because they require alignment across regions with different institutional capacities, reimbursement arrangements, and distribution systems[17, 22].

Importantly, the indicator contribution analysis further shows that procurement performance was driven primarily by financial savings and utilization of bid-winning medicines, rather than price reductions alone. This finding challenges an overly price-centred understanding of procurement success[11, 23]. Negotiated price reductions do not automatically translate into system-level savings if bid-winning medicines are not consistently supplied, prescribed, and used[11, 24]. Conversely, moderate price reductions may generate stronger budgetary impact when accompanied by high uptake and effective implementation. Therefore, evaluation of centralized drug procurement should move beyond headline price cuts and incorporate implementation-sensitive indicators that capture medicine use, financial realization, and local system capacity.

4.3 Strengths and Limitations

This study has several important strengths. First, it addresses a notable evidence gap by examining the implementation performance of centralized drug procurement in a resource-constrained provincial setting in China, an area that has received comparatively limited empirical attention in previous research. Moreover, the study adopts a multidimensional evaluation framework that goes beyond headline price reductions and incorporates financial savings, medicine utilization, procurement completion, and substitution-related indicators, providing a more implementation-sensitive assessment of procurement performance. Finally, by comparing procurement batches across national, provincial, and inter-provincial alliance models, this study offers a cross-level perspective on how different governance arrangements are associated with variation in procurement outcomes.

However, several limitations should be acknowledged. First, this study adopts a composite performance evaluation approach rather than causal inference, and results should be interpreted as comparative assessments rather than estimates of policy impact. Second, this analysis focuses on a single resource-constrained northwestern province, which may limit generalizability. The findings are likely to be most relevant to other resource-constrained settings in central and western China, where procurement capacity, medicine distribution systems, hospital uptake, and local administrative implementation may similarly affect policy performance. They should be applied more cautiously to economically developed coastal provinces or large metropolitan health systems, where supply chains, provider incentives, and market competition may differ substantially. Third, the selection of representative medicines may have introduced selection bias. For each procurement batch, the analysis included one to four product specifications with the highest procurement expenditure. This approach was used to capture medicines with the greatest budgetary relevance within each batch and to ensure comparability across heterogeneous procurement projects. However, high-expenditure medicines are often high-volume or routinely used products with more stable demand, stronger hospital uptake, and more mature supply arrangements. As a result, the analysis may overrepresent medicines with relatively established implementation pathways and underrepresent lower-volume, specialty, or clinically narrower medicines, which may face different challenges in supply continuity, prescriber acceptance, and substitution behaviour. Therefore, the findings should be interpreted as reflecting the implementation performance of major representative products within each batch, rather than the performance of all bid-winning medicines. Another limitation is the absence of qualitative evidence from policymakers or healthcare providers to contextualize the quantitative findings. Without qualitative triangulation, the mechanisms underlying variations in procurement performance across batches cannot be fully explored. Despite these limitations, this study provides a systematic framework for assessing centralized drug procurement across governance models and offers empirical evidence from an under-studied setting. By integrating financial and utilization dimensions, it contributes to a more implementation-sensitive understanding of procurement performance and highlights the critical role of downstream execution in realizing the full benefits of centralized purchasing reforms.

4.4 Policy Implications

From a policy perspective, these findings indicate that centralized procurement effectiveness depends not only on purchasing scale, but also on downstream implementation capacity. For national procurement, substantial bargaining advantages need to be matched by stronger local execution, including administrative readiness, demand forecasting, hospital engagement, supply continuity, and monitoring of prescribing behaviour. For provincial procurement, relatively stronger performance suggests that locally coordinated models may better align procurement design with local service delivery conditions, although this advantage should be supported by standardized monitoring and accountability mechanisms. For inter-provincial alliances, lower and more clustered performance highlights the need for stronger cross-jurisdictional coordination, including harmonized reimbursement policies, clearer accountability mechanisms, and greater flexibility in procurement design.

More specifically, resource-constrained settings may require targeted support to convert negotiated prices into realized system-level savings. Such support could include dedicated financial support for distribution and last-mile delivery, targeted subsidies or contingency funds to stabilize medicine supply in remote areas, strengthened forecasting and inventory management systems, and incentives to promote hospital uptake of bid-winning medicines. These implications extend beyond China to countries adopting pooled or centralized procurement, particularly low- and middle-income countries and decentralized health systems, where weak provider incentives, fragmented supply chains, and limited administrative capacity may constrain the translation of negotiated prices into effective access and fiscal savings[7, 11, 22]. Procurement reforms in such settings should therefore be accompanied by complementary measures that strengthen provider engagement, align reimbursement incentives, and ensure supply continuity, rather than relying on price negotiation alone[7].

5 Conclusion

This study shows that variation in centralized drug procurement performance in a resource-constrained province was driven more by differences between individual procurement batches than by governance level alone. Although provincial procurement had the highest average composite score, governance level explained only a limited share of the observed variation, indicating that batch-specific implementation conditions matter more than procurement category itself. The findings further suggest that procurement success cannot be judged by price reductions alone. Financial savings and the uptake of bid-winning medicines were more important for overall performance. The main policy implication is that centralized procurement reforms should be supported not only by price negotiation, but also by stronger hospital uptake mechanisms, prescriber incentive alignment, better demand forecasting, and more reliable supply chains, especially in resource-constrained settings. Future research should test the robustness of these findings in other provinces, examine how specific implementation arrangements shape batch-level performance, and incorporate qualitative evidence to better explain why some procurement rounds perform substantially better than others.

Authors' Contributions

YL conceived the study, designed the analytical framework, conducted the data analysis, interpreted the findings, and drafted and revised the manuscript. The author read and approved the final manuscript.

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