

Evaluation of Traditional Chinese Medicine Service Capabilities in Primary Healthcare Institutions Using the Entropy-Weighted TOPSIS and RSR Methods: A Cross-Sectional Study

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Abstract: A comprehensive evaluation of the capacity for traditional Chinese medicine (TCM) services in primary healthcare institutions in Chongqing was conducted to provide a reference for enhancing service capacity and promoting balanced development across institutions. A combination of literature review and expert consultation was employed. Based on the ‘structure-process-outcome’ theoretical framework, four dimensions—TCM resource allocation, TCM services, TCM revenue and expenditure, and service efficiency—along with 15 indicators were identified to evaluate TCM service capacity. These were converted into a structured questionnaire, and on-site surveys were carried out at primary healthcare institutions in selected districts and counties between July and September 2024 using cluster sampling. The entropy-weighted TOPSIS method was used to comprehensively evaluate the TCM service capacity of the surveyed institutions. Using the non-parametric rank-sum and ratio method, the TCM service capacity of primary healthcare institutions was categorised into three tiers. Finally, multiple stepwise regression analysis was conducted to identify the influencing factors. The classification results showed that 17 institutions (15.6%), 74 institutions (67.9%), and 18 institutions (15.6%) were rated as having poor, moderate, and good TCM service capabilities, respectively. Regression analysis revealed the following factors influencing TCM service capacity: floor area allocated to TCM clinical services, number of TCM beds, total number of TCM medical techniques practised, number of patients receiving TCM preventive healthcare services, number of TCM outpatient visits, number of patients receiving TCM non-pharmacological therapies, and the rate of TCM health management for children aged 0–3 years. The overall level of TCM service capacity in primary healthcare institutions in Chongqing is not high, and further efforts are required to optimise resource allocation and enhance distinctive TCM services.

1. Introduction

Against a backdrop of accelerating global population ageing and a steadily rising prevalence of chronic diseases, healthcare systems worldwide are facing unprecedented pressure, driving a shift in healthcare delivery models away from traditional acute, episodic treatment towards a comprehensive, person-centred approach that places greater emphasis on prevention, long-term management and health promotion^[1]. Primary Health Care (PHC) is widely recognised by the international community as a key strategy for addressing this challenge. The World Health Organisation (WHO) has long advocated for the strengthening of community-based health service systems and has reiterated that primary health care is the cornerstone of building resilient and equitable health systems, and is essential for achieving universal health coverage and the Sustainable Development Goals^[2,3]. Traditional and complementary medicine (TCM), particularly traditional Chinese medicine, plays a vital role in disease prevention, chronic disease management and rehabilitation care due to its unique advantages of being ‘simple, convenient, effective and affordable’. As an integral part of strengthening primary healthcare, it is increasingly being incorporated into primary healthcare systems and has become one of the key strategies for achieving universal health coverage^[4]. In its Global Strategy on Traditional Medicine 2025–2034, the World Health Organisation clearly states that traditional medicine remains a vital means of accessing healthcare for billions of people worldwide, particularly in low- and middle-income countries. According to statistics, 170 WHO Member States (approximately 90% of the total) have reported that their populations use traditional medicine services, with between 40% and 90% of the population relying on traditional medicine as their primary source of healthcare^[5]. Although traditional medicine is widely practised worldwide, its integration into health systems continues to face significant challenges. A systematic review covering 19 countries identified 11 key domains influencing the integration of traditional medicine, with policy and funding, resource accessibility, and service quality and safety being the most frequently cited determining factors. The study further noted that simply expanding service coverage is insufficient to achieve the effective integration of traditional medicine; attention must also be paid to substantially enhancing service capacity^[6]. Therefore, establishing a scientific evaluation system for traditional medicine service capabilities is of crucial importance for accurately identifying weaknesses, optimising resource allocation and ensuring the effective implementation of policies.

As one of the most widely practised and comprehensive systems of traditional medicine in the world, traditional Chinese medicine (TCM) offers valuable insights into the development of primary healthcare systems in China. Following decades of policy support, China has established a network of primary TCM services covering both urban and rural areas. However, existing research indicates that primary TCM services generally face structural challenges, including the uneven distribution of TCM resources, a shortage of TCM personnel, and a limited range of TCM services^[7,8]. Particularly in western China, due to multiple constraints such as the level of economic development, geographical conditions and the ability to attract talent, there is a significant gap in the capacity of primary-level traditional Chinese medicine (TCM) services compared with the developed eastern regions. As the only directly administered municipality in western China, Chongqing faces particularly acute issues regarding the uneven distribution of healthcare resources between urban and rural areas and across different regions. Against this backdrop, a systematic evaluation of TCM service capacity in primary healthcare institutions in this region will not only help guide the targeted allocation of local healthcare resources and the optimisation of policies, but also provide valuable insights for other countries and regions facing similar challenges.

2. Subjects and methods

2.1. Subject

This study employed a stratified cluster sampling method. Based on the geographical location and economic distribution of Chongqing Municipality, one district or county was selected from each of the following regions—the central urban area, western Chongqing, north-eastern Chongqing and south-eastern Chongqing—to conduct the survey. Primary healthcare institutions in the selected districts and counties were designated as the survey subjects, with the survey taking place between July and September 2024. The primary healthcare facilities included in this study were mainly community health service centres and township health centres. A total of 120 primary healthcare facilities were surveyed, and following screening, valid data were obtained from 109 of them.

2.2. Methods for designing questionnaires

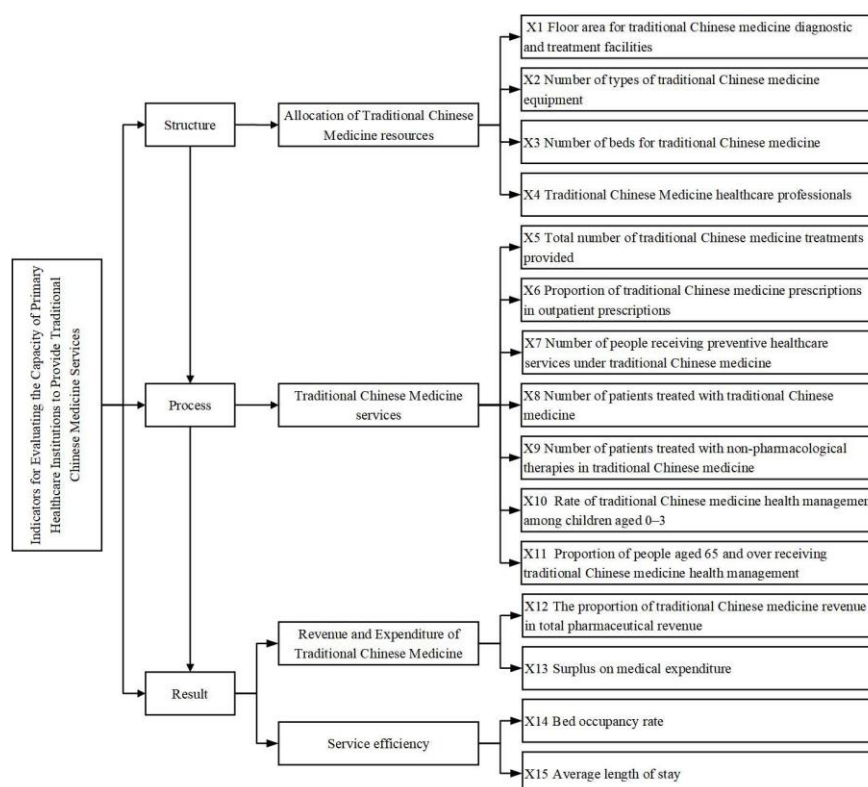


Figure 1: Evaluation Indicators for Traditional Chinese Medicine Service Capabilities in Primary Healthcare Institutions.

This study is based on the ‘Structure-Process-Outcome’ (SPO) quality evaluation model proposed by Donabedian, taking into account the functional role of primary healthcare institutions and the characteristics of traditional Chinese medicine services, whilst drawing on research into healthcare service capacity conducted by relevant scholars^[9-11], develop an evaluation framework for the capacity of primary healthcare institutions to provide traditional Chinese medicine services. Subsequently, following extensive discussions within the research team and consultation with experts—including practitioners of traditional Chinese medicine and administrators from primary healthcare institutions—four dimensions and 15 indicators were finally established, covering the allocation of traditional Chinese medicine resources, traditional Chinese medicine services, the financial performance of traditional Chinese medicine, and service efficiency, as shown in Figure 1.

The evaluation criteria were then converted into a structured questionnaire, with options for the basic characteristics of grassroots organisations added, to form a formal questionnaire.

2.3. Evaluation methods

2.3.1. Entropy-weighted TOPSIS method

The entropy weighting method is an approach that uses objective weighting principles to determine the weights of evaluation indicators; the degree of variation in these indicators reflects the amount of information provided by the evaluated object regarding that indicator. The greater the degree of variation in a particular evaluation indicator, the greater the amount of information provided by the evaluated object, and the higher the weighting proportion assigned to that indicator ^[12]. The calculation procedure is as follows:

The first step involves standardising the data for the 15 indicators used to assess the capacity of primary healthcare institutions to provide traditional Chinese medicine services, using the following formula:

$$x'_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \text{ (High-quality indicators)}, x'_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)} \text{ (Low-quality indicators)} \quad (1)$$

Step 2: Calculate the entropy values (e_j) and weights (W_j) based on the standardised indicators. The formula is:

$$P_{ij} = \frac{x_{ij}}{m_i}, e_j = -\frac{1}{\ln n} \sum_{i=1}^n P_{ij} \ln P_{ij}, W_j = \frac{1 - e_j}{\sum_{j=1}^m (1 - e_j)} \quad (2)$$

The TOPSIS method involves homogenising and normalising the data matrix to identify the optimal and worst-performing objectives among multiple criteria. It then calculates the Euclidean distance between the evaluated object and the optimal objective, thereby determining the relative proximity of each evaluation criterion to the ideal solution and ranking them accordingly, which serves as the basis for assessing the relative merits of the objectives ^[13]. The calculation procedure is as follows:

The first step involves aligning the evaluation indicators to the same trend and normalising them. As the average length of stay for discharged patients is the only indicator classified as ‘low-quality’, the reciprocal method is used in the calculations to standardise the direction of change across all indicators. The normalisation formula is:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}} \quad (3)$$

In the second step, calculate the Euclidean distances D_+ and D_- between the optimal scenario A_+ and the worst-case scenario A_- for each evaluation criterion, based on the normalised data. The optimal scenario A_+ corresponds to the maximum value for each criterion, whilst the worst-case scenario A_- corresponds to the minimum value for each criterion. The formula is:

$$D_i^+ = \sqrt{\sum_{j=1}^m [w_j(1 - z_{ij})]^2}, D_i^- = \sqrt{\sum_{j=1}^m [w_j(0 - z_{ij})]^2} \quad (4)$$

Step 3: Calculate the relative proximity C_i of each indicator to the optimal solution using the formula $C_i = \frac{D_i^-}{D_i^+ + D_i^-}$. A higher C_i value indicates a better evaluation indicator.

2.3.2. Group the scores of each primary healthcare facility using the non-integer rank-sum method (RSR)

The Relative Sum of Ranks (RSR) method is a comprehensive evaluation technique that involves constructing a matrix and performing rank transformations on various evaluation criteria to obtain the dimensionless statistical measure RSR; it then ranks and classifies the objects under evaluation based on their RSR values^[14].

First, the C_i values—which measure the degree of similarity among the various evaluation indicators of traditional Chinese medicine service capacity across 109 primary healthcare institutions—are ranked in ascending order. The group frequency f , cumulative frequency R , average rank \bar{R} , and the value of $\bar{R} \times 100/n$ are then calculated. These values are subsequently converted into corresponding probability units (Probit values) using the ‘Percentage-Probability Unit Conversion Table’.

Step 2: Using the corresponding logit values as the independent variables and the C_i values as the dependent variables, calculate the regression equation.

Step 3: Using the RSR method’s optimal categorisation principles and the table of reasonable category counts, the traditional Chinese medicine service capabilities of the 109 primary healthcare institutions were categorised, and the categories were subjected to a consistency test to ensure that the variance within each category passed the consistency test.

2.4. Statistical methods

Data from the questionnaires were entered using Epidata software, and the data were filtered, cleaned and subjected to statistical analysis using SPSS 26.0. All statistical tests were two-tailed, with a significance level of $\alpha = 0.05$.

3. Result

3.1. Evaluation results using the Entropy-TOPSIS method

The weights for each indicator were calculated using the entropy weighting method. Among the 15 indicators, X7 (the proportion of patients receiving preventive healthcare services in traditional Chinese medicine) has the highest weighting at 0.300, indicating that this indicator exhibits the greatest variability and exerts a significant influence on the capacity of primary healthcare institutions to provide traditional Chinese medicine services; X11 (the rate of traditional Chinese medicine health management for people aged 65 and over) has the lowest weighting at 0.003, indicating that this indicator exhibits the least variability and has a relatively minor impact on the capacity of primary healthcare institutions to provide traditional Chinese medicine services (See Table 1). The results of the evaluation of the TCM service capacity of 109 primary healthcare institutions were obtained using the TOPSIS model formula. As the tables containing the D_i^+ , D_i^- and C_i values for the 109 primary healthcare institutions would have taken up too much space, only a selection of data is presented here (see Table 2) to save space, and simple descriptive statistics have been provided (see Table 3). The TCM service capabilities of the 109 primary healthcare institutions were ranked according to the magnitude of their C_i values; the closer the C_i value is to 1, the better the service capability; the closer it is to 0, the poorer the service capability. The institution ranked first was D87, with a C_i value of 0.623, indicating that this institution had the highest level of TCM service provision; the institution ranked last was D10, with a C_i value of 0.036, indicating that this institution had the lowest level of TCM service provision.

Table 1 Calculation Results of Indicator Weights Based on the Entropy Weighting Method.

Variable	Indicators	Indicator properties	Entropy (e)	Difference (d)	Weighting (w)
X1	Floor area for traditional Chinese medicine diagnostic and treatment facilities	Forward	0.931	0.069	0.057
X2	Number of types of traditional Chinese medicine equipment	Forward	0.988	0.012	0.010
X3	Number of beds for traditional Chinese medicine	Forward	0.932	0.068	0.057
X4	Traditional Chinese Medicine healthcare professionals	Forward	0.913	0.087	0.073
X5	Total number of traditional Chinese medicine treatments provided	Forward	0.944	0.056	0.046
X6	Proportion of traditional Chinese medicine prescriptions in outpatient prescriptions	Forward	0.979	0.021	0.017
X7	Number of people receiving preventive healthcare services under traditional Chinese medicine	Forward	0.641	0.359	0.300
X8	Number of patients treated with traditional Chinese medicine	Forward	0.895	0.105	0.087
X9	Number of patients treated with non-pharmacological therapies in traditional Chinese medicine	Forward	0.730	0.270	0.226
X10	Rate of traditional Chinese medicine health management among children aged 0–3	Forward	0.927	0.073	0.061
X11	Proportion of people aged 65 and over receiving traditional Chinese medicine health management	Forward	0.997	0.003	0.003
X12	The proportion of traditional Chinese medicine revenue in total pharmaceutical revenue	Forward	0.968	0.032	0.027
X13	Surplus on medical expenditure	Forward	0.994	0.006	0.005
X14	Bed occupancy rate	Forward	0.982	0.018	0.015
X15	Average length of stay	Reverse	0.982	0.018	0.015

Table 2 Evaluation C_i Values and Ranking Results of Traditional Chinese Medicine Service Capability in 109 Primary Healthcare Institutions.

Name of organisation	D_i^+	D_i^-	C_i	Sort results
D1	0.404	0.021	0.049	101
D2	0.398	0.029	0.069	71
D3	0.401	0.022	0.053	95
D4	0.398	0.026	0.061	83
D5	0.406	0.018	0.042	108
D6	0.404	0.021	0.049	100
D7	0.380	0.068	0.151	21
D8	0.395	0.046	0.105	36
D9	0.402	0.026	0.060	87
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D107	0.391	0.055	0.124	29
D108	0.406	0.020	0.047	103
D109	0.403	0.024	0.055	92

Table 3 Comprehensive Evaluation Results of Traditional Chinese Medicine Service Capabilities in Primary Healthcare Institutions of Chongqing Municipality.

Variable	Min	Max	$M \pm SD$
Di+	0.175	0.406	0.381±0.042
Di-	0.015	0.304	0.054±0.054
Ci	0.036	0.623	0.120±0.110

3.2. Results of the non-integer rank-sum ratio (RSR) classification

Based on the formula and procedure for the RSR method, the following results were obtained: the

coefficient of determination $R^2 = 0.675$, indicating that the regression equation provides a moderate fit; $F = 145.290$, but $P < 0.001$, suggesting that the established regression equation is valid. The regression equation is: $C_i = -0.640 + 0.160 \times Probit$ ($t=12.054$, $P<0.001$), indicating that there is a significant linear correlation between the C_i values for the capacity of primary healthcare institutions to provide traditional Chinese medicine services and the Probit values.

By substituting the Probit values corresponding to each institution into the regression equation, the C_i cut-off values were obtained. In accordance with the optimal stratification principle of the RSR method, the TCM service capabilities of the 109 primary healthcare institutions were classified into three categories: low, medium and high. A normality K-S test was performed on the C_i cut-off values after stratification, yielding $P=0.200>0.05$, indicating that the data conform to a normal distribution. A test for homogeneity of variances was performed on the categorised C_i thresholds, yielding $P=0.116>0.05$, indicating that the variances of the data across the categories are homogeneous. A one-way analysis of variance was conducted, yielding $F=153.449$, $P<0.001$, indicating that the differences between groups across the three categories are statistically significant; it can therefore be concluded that dividing the data into three categories is reasonable. Among these, institutions with ‘high’ levels of TCM service capacity accounted for a small proportion, at 15.6%; those with ‘medium’ levels accounted for the largest proportion, at 67.9%; and those with ‘low’ levels accounted for the smallest proportion, at 15.6%, as shown in Table 4.

Table 4 Classification of Traditional Chinese Medicine Service Capabilities in Primary Healthcare Institutions in Chongqing Municipality.

Grade	Percentile Threshold	Probit threshold	C_i Threshold (Fitted value)	Number of sorting units	Proportion (%)
Low	<15.866	<4	<-0.000	17	15.6
Medium	15.866~	4~	-0.000~	74	67.9
High	84.134~	6~	0.320~	18	16.5

3.3. An analysis of factors influencing the C_i value of traditional Chinese medicine service capacity in primary healthcare institutions

Table 5 Results of a stepwise regression analysis of factors influencing the C_i value of traditional Chinese medicine service capacity in primary healthcare institutions.

Factors influencing	Non-standardisation coefficient		Standardisation coefficient	t	P
	B	standard error	Beta		
(constant)	0.023	0.003	-	8.040	<0.001
Floor area for traditional Chinese medicine diagnostic and treatment facilities	7.373E-05	<0.001	0.067	5.950	<0.001
Number of beds for traditional Chinese medicine	<0.001	<0.001	0.080	5.987	<0.001
Total number of traditional Chinese medicine treatments provided	0.001	<0.001	0.066	5.761	<0.001
Number of people receiving preventive healthcare services under traditional Chinese medicine	3.197E-05	<0.001	0.737	63.222	<0.001
Number of patients treated with traditional Chinese medicine	7.398E-07	<0.001	0.114	7.066	<0.001
Number of patients treated with non-pharmacological therapies in traditional Chinese medicine	3.553E-06	<0.001	0.230	16.527	<0.001
Rate of traditional Chinese medicine health management among children aged 0–3	0.143	0.019	0.079	7.569	<0.001

Note: ‘-’ indicates that the constant term has no standardised regression coefficient; the coefficient of determination R^2 is 0.990, and the adjusted R^2 is 0.989.

A multiple stepwise regression analysis was conducted, with the C_i value for traditional Chinese

medicine service capacity across 109 primary healthcare institutions as the dependent variable and 15 evaluation indicators as independent variables. The results indicate that seven indicators—floor area allocated to TCM diagnostic and treatment services, number of TCM beds, total number of TCM medical techniques practised, number of patients receiving TCM preventive healthcare services, number of TCM consultations, number of patients receiving TCM non-pharmacological therapies, and TCM health management coverage rate for children aged 0–3—are the primary factors influencing the TCM service capacity C_i value of primary healthcare institutions, as shown in Table 5.

4. Discussion

4.1. The overall standard of traditional Chinese medicine services at the grassroots level is not high, and there are marked disparities in development between different institutions

The results of this study's comprehensive evaluation of the traditional Chinese medicine service capacity of 109 primary healthcare institutions in Chongqing show that the average C_i value for the sample institutions was only 0.120, indicating an overall low level. The results of the RSR classification further reveal that the vast majority of institutions (67.9%) fall into the medium category, whilst those at the high and low ends account for a smaller proportion, presenting a typical spindle-shaped distribution characterised by a large middle and narrow ends. This distribution pattern is consistent with findings from global research on primary healthcare service capacity, which indicates that following a rapid expansion of service coverage driven by policy, the standardisation of service quality often becomes a major challenge^[15]. The variations in C_i scores among primary healthcare institutions further highlight the imbalance in resource allocation and service efficiency. This imbalance may stem from the interplay of multiple factors, including institutional management standards, the capacity of higher-level hospitals to provide support and guidance, and the level of regional economic backing. This suggests that future policy-making should move away from a 'one-size-fits-all' development model and instead implement differentiated capacity-building strategies, with a particular focus on strengthening support and supervision for 'lower-tier' institutions to promote coordinated development within the region^[16].

4.2. Service process and outcome indicators are key to distinguishing between high and low levels of service capability in traditional Chinese medicine

The results of the entropy weighting method indicate that the two indicators reflecting service delivery—namely, 'the number of patients receiving TCM preventive care' and 'the number of patients receiving TCM non-pharmacological treatments'—contribute most significantly to the overall evaluation results. This clearly demonstrates that, against a backdrop of widespread improvements in the basic infrastructure of primary healthcare institutions, the depth and distinctive features of service provision—particularly proactive prevention and the application of specialised techniques—have become key factors in assessing the quality of TCM service provision. This finding is fully consistent with the view in the Donabedian model that the 'process' dimension is the key link connecting 'structure' inputs and 'outcome' outputs^[17]. The WHO also advocates shifting the focus of traditional medicine from the treatment of individual diseases to health maintenance and disease prevention, in order to fully realise its value in managing health throughout the life course^[18]. Furthermore, it is worth noting the significant variation in the number of people receiving 'preventive healthcare' services across institutions, indicating that such services have not yet become a regular feature in most institutions, with only a few having implemented them on a large scale. This highlights the lag in the transformation of primary-level traditional Chinese medicine service models—the focus

of services remains on the diagnosis and treatment of diseases, whilst the preventive and health-preserving benefits inherent in the TCM theory of ‘preventive healthcare’ are far from being fully realised. Regression analysis revealed that indicators such as non-pharmacological TCM therapies and preventive healthcare services are significant factors influencing the capacity of primary healthcare institutions to provide TCM services. This suggests that future capacity-building efforts should shift from a focus on hardware investment to supporting innovation in service models. Through measures such as payment system reforms and technical training, primary healthcare institutions should be encouraged to actively develop distinctive TCM services, thereby achieving a transition from merely ‘providing services’ to delivering ‘high-quality services’ [19].

4.3. The synergy between structure, process and outcome

The results of the multiple stepwise regression analysis further reveal the contribution pathways of indicators from different dimensions to the C_i value in the comprehensive evaluation of primary-level TCM service capacity. Among the seven significant variables ultimately included in the regression equation, the floor area allocated to TCM clinical services and the number of TCM beds belong to the ‘structure’ dimension, whilst the total number of TCM medical techniques performed, the number of patients receiving TCM preventive healthcare services, the number of TCM consultations, the number of patients receiving TCM non-pharmacological therapies, and the rate of TCM health management for children aged 0–3 all belong to the ‘process’ dimension. It is worth noting that none of the four indicators in the ‘outcome’ dimension (X12 to X15) were included in the regression equation. This pattern of results reveals the key pathways underlying the development of grassroots TCM service capacity at the current stage: the level of service capacity is primarily determined by the adequacy of resource allocation and the actual implementation of service processes (particularly specialised services), whilst outcome indicators such as service efficiency and economic benefits do not yet have a significant independent explanatory power regarding overall capacity. This does not imply that the outcome dimension is unimportant, but may reflect the characteristics of the current stage of development—the service output of most institutions is still in a transitional phase from ‘having’ to ‘excellence’, and differences in operational efficiency between institutions have not yet become a key factor in distinguishing levels of capability.

5. Conclusion

The overall standard of TCM service provision in primary healthcare institutions in Chongqing remains to be improved, with significant disparities between institutions. The quality of service delivery—particularly ‘preventive healthcare’ and non-pharmacological TCM therapies—is a key indicator of current TCM service capacity. To promote high-quality and balanced development, policy focus should shift from physical infrastructure coverage to deepening and standardising service substance. Differentiated development strategies, targeted support for weaker institutions, innovative talent cultivation, and policy levers such as medical insurance reforms are recommended to guide primary institutions in expanding distinctive TCM services.

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