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Assessing the institutional provision of maternal nutrition services in antenatal clinics in Beijing

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ABSTRACT

Objective: To evaluate the availability, quality, and delivery of maternal nutrition services in antenatal clinics across Beijing, focusing on service types, provider qualifications, resource adequacy, and barriers to effective service delivery. The study also aims to identify factors influencing service availability and institutional variation and propose a framework for improving maternal nutrition care in urban China.

Methods: A cross-sectional study was conducted across 110 antenatal clinics in Beijing, using structured surveys targeting institutional characteristics, service coverage, personnel qualifications, and service delivery methods, supplemented by qualitative insights from open-ended responses.

Results: Among 104 valid responses, 56% of institutions offered prenatal nutrition education classes. Provision varied descriptively by facility type (e.g. 12.5% in private hospitals vs ~55-57% in other facility types), but the facility-type comparison was not statistically significant (chi-square = 5.72, df = 3, p=0.13). While 76% of institutions reported having personnel with formal nutrition qualifications, gaps in training and reliance on non-specialized staff were common. Resource constraints (e.g. space, equipment, and limited digital support) were frequently reported as barriers. Institutional respondents reported high perceived patient satisfaction and the presence of feedback systems, but no patient-level outcomes were measured.

Conclusion: This city-wide institutional survey suggests that maternal nutrition services in Beijing antenatal clinics are broadly available but heterogeneous in delivery, staffing, and resources. Observed contrasts across facility types should be interpreted as descriptive patters rather than confirmed group differences. Future work should evaluate whether standardization, workforce development, infrastructure strengthening, and digital support improve service quality and equity, using patient-level and implementation indicators.

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Maternal nutrition; antenatal care; pregnancy; health care providers; nutrition education; health education

Introduction

Prenatal nutrition support is widely recognized as important for maternal health, but the present study focuses on institutional service capacity and delivery rather than measuring downstream maternal or infant outcomes. Nutrition problems during pregnancy can lead to complications such as low or high birth weight, preterm births, and maternal health problems, all of which can have lasting effects on both the mother and child [1–3]. As a global healthcare challenge, the integration of effective nutrition services into routine antenatal care (ANC) is essential. In Beijing, a major healthcare hub and China's capital, the issue of maternal nutrition is particularly significant due to its diverse population, socio-economic disparities, and rapid urbanization [4]. Although Beijing has implemented

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various nutrition interventions and policies [5], the delivery of these services often faces challenges such as inconsistent implementation, variable provider expertise, and resource disparities across districts [6]. Unlike previous studies that have focused on low-resource settings where access is the primary issue [7–9], this study investigates maternal nutrition in Beijing's high-resource yet socio-economically stratified urban context, where disparities are shaped by factors beyond mere resource availability. Existing research has pointed to a lack of targeted interventions to improve maternal nutrition, particularly in urban settings like Beijing [10–12]. Rapid urbanization, socio-economic inequalities, and challenges related to healthcare access and quality further complicate the delivery of adequate nutritional care [13]. Past studies on maternal nutrition services have predominantly focused on subjective measures such as maternal satisfaction and pregnancy outcomes, particularly in evaluating prenatal nutrition education (PNE) programs [14,15]. These evaluations often rely on feedback from pregnant women, assessing their satisfaction with nutrition services and how these services correlate with pregnancy outcomes like birth weight and complications [16]. However, such evaluations are typically limited to individual perceptions and health results, rather than taking a comprehensive approach to assess the overall quality and delivery of nutrition services from an institutional perspective. Furthermore, most research has concentrated on measuring the knowledge of pregnant women, often using quantitative methods such as surveys [17]. What remains lacking is a systematic, institution-wide assessment framework that evaluates the effectiveness and quality of nutrition services. A clear and comprehensive set of guidelines for evaluating maternal nutrition education programs is needed, one that not only considers outcomes but also the institutional capacity to deliver effective services [18].

This study is informed by Donabedian's structure–process–outcome model and the WHO Health Systems Framework. By examining the structural characteristics of antenatal clinics, the processes of service delivery, and perceived adequacy of nutrition services, we position maternal nutrition within a systems-level evaluation framework. This approach allows us to assess institutional capacity for delivering standardized nutrition care in urban China.

This study aims to fill this gap by systematically assessing the availability, quality, and delivery of maternal nutrition services across ANC clinics in Beijing. While previous studies have explored individual-level experiences or provider perceptions in isolation, our study offers a systematic, city-wide mapping of service availability, provider qualifications, and delivery mechanisms across both public and private antenatal clinics in a high-resource, urban setting. Rather than claiming novelty in addressing institutional perspectives per se, our contribution lies in the comprehensiveness and granularity of institutional analysis within a metropolitan healthcare system like Beijing. While primarily quantitative, the study also incorporates qualitative insights from open-ended responses to highlight frontline institutional perspectives. It seeks to map existing services such as nutrition counseling, assessments, and education programs while evaluating their coverage, effectiveness, and alignment with clinical standards. The research also investigates key factors affecting service quality, including healthcare infrastructure, provider training, and program design, while identifying barriers such as resource constraints and enablers like supportive policies and well-trained staff. A key objective is to develop a comprehensive evaluation framework for maternal nutrition services, addressing both service outcomes and institutional capacity. The study will propose evidence-based strategies to enhance nutrition interventions, provider training, and resource allocation, ultimately improving maternal and child health outcomes. Beijing's unique socio-economic and healthcare context provides a dynamic setting for addressing critical gaps in urban maternal nutrition care. Findings from this study will guide policy reforms and inform stakeholders, including government agencies, NGOs, and public health institutions on designing targeted maternal nutrition programs and optimizing resource use. By addressing disparities in service delivery and proposing practical strategies, this research aims to improve maternal nutrition care in Beijing and other urban settings in China, contributing to better health outcomes for mothers and children.

This study is guided by Donabedian's structure–process–outcome (SPO) model and the WHO health system building blocks. We operationalized structure as infrastructure, equipment and workforce (qualifications/training); process as service delivery (nutrition classes, counseling frequency, curriculum scope) and information systems (digital tools); and outcomes as institution-level perceived performance

indicators (e.g. internal satisfaction summaries), not patient outcomes. WHO workforce, service delivery, and information systems map respectively to our staffing, class/counseling delivery, and IT domains; medical products/technologies map to equipment. We organize our Results and interpret our Discussion through these constructs.

Methods

Framework mapping

Survey domains were mapped to SPO/WHO as follows: Structure (workforce qualifications/training; infrastructure/equipment); Process (class availability, content breadth, counseling frequency; digital tools); Outcomes (institution-reported perceptions only; no validated patient outcomes). A summary mapping is provided in Supplementary Table S1.

Study design

A cross-sectional study was conducted to evaluate the availability, quality, and delivery of maternal nutrition services in antenatal clinics across Beijing, China. Data was collected *via* a structured questionnaire distributed to 110 obstetric institutions across the city. The survey sought to assess facility characteristics, service coverage, personnel qualifications on the delivery of maternal nutrition services. This manuscript adheres to the STROBE guidelines for cross-sectional studies. A completed STROBE checklist is provided in Supplementary File 2.

Sample and data collection

Data collection was carried out across 110 obstetric institutions in Beijing. The sample included a mix of public and private healthcare facilities across the city's 16 districts. Institutional representatives (e.g. obstetricians, nurses, or administrators) completed the questionnaire on behalf of their clinic as part of the routine institutional evaluation. Out of 110 distributed questionnaires, 106 institutions responded, and 104 valid responses were collected, yielding a response rate of 98.11%. Two institutions did not provide any responses, and four institutions submitted partial responses. The final dataset represented a diverse range of antenatal clinics across Beijing, with respondents from both urban and suburban areas, ensuring a comprehensive assessment of service delivery.

Questionnaire content

The questionnaire was designed to collect both quantitative and qualitative data on several dimensions of maternal nutrition services, including questions on institutional characteristics, the availability of prenatal nutrition classes, healthcare personnel qualifications, service frequency, and the use of digital tools for managing maternal nutrition services. A combination of both closed-ended and open-ended questions allowed for quantitative analysis and qualitative insights [1]: **Facility Characteristics**: Information was gathered about the type of healthcare facility, infrastructure, the availability of nutrition-related resources (e.g. educational materials, dietary supplements), and the clinic environment [2]. **Service Coverage**: The survey assessed the range of maternal nutrition services offered at the clinic, including nutrition counseling, nutritional assessments, and prenatal nutrition education programs [3]. **Personnel Qualifications**: This section captured data on the qualifications of healthcare providers, including training, certifications, professional roles, and the frequency of professional development in maternal nutrition [4]. **Service Delivery**: The questionnaire also inquired about the frequency and consistency of service offerings, such as the delivery of nutrition classes and counseling sessions, and the use of digital tools or resources to support nutrition service delivery.

Data Collection procedure

Data was collected using a combination of on-site survey distribution and electronic submission for healthcare providers in remote or under-resourced areas. In-person surveys were administered directly to healthcare providers in the participating clinics, while electronic surveys were made available to respondents in institutions that preferred digital submission. Data on patient satisfaction were not collected directly from pregnant women. Instead, institutional respondents were asked to report on perceived patient satisfaction based on internal evaluations or routine feedback systems within their clinics. To ensure a representative sample from various districts, data collection spanned three months, from July to September 2024, allowing for adequate time to reach a broad cross-section of healthcare facilities. The survey instrument was designed collaboratively by the research team and public health officials from the municipal health bureau, drawing on national guidelines for maternal nutrition services and previous institutional assessment tools. It included both structured and open-ended questions covering five domains: service availability, staffing, content and delivery of nutrition education, digital infrastructure, and perceived barriers. The questionnaire was pilot-tested in two antenatal clinics for clarity and relevance, with minor revisions made accordingly, such as changes to some wording. The revised questionnaire consists of 2 parts, namely service coverage (including 8 items) and staffing (including 5 items). Three subject-matter experts (obstetrics, nutrition, public health) reviewed item relevance using a 4-point scale (mean CVI = 0.89). The draft questionnaire also underwent content validation through adaptation from municipal service evaluation tools and national maternal nutrition guidelines. It was piloted in two antenatal clinics ($n = 12$ institutional respondents). Based on feedback, items on digital tool use and service barriers were clarified. Cronbach's alpha was calculated for two multi-item domains, yielding values of 0.78 (service coverage) and 0.81 (staffing adequacy), indicating acceptable reliability. No items were removed following pilot testing, and all item-total correlations exceeded 0.40, indicating satisfactory convergent validity. A copy of the full questionnaire is provided as Supplementary File 1.

The municipal health bureau conducts an ongoing, city-wide institutional evaluation program that annually collects standardized data on antenatal service capacity, staffing, and infrastructure across Beijing. Our project was embedded in this established evaluation framework and therefore operated under the same annual ethical oversight process. For research purposes, a brief supplementary module (barriers, digital tool use, and open-ended prompts) was added to the existing evaluation form. The study was reviewed and approved under the continuing ethics review mechanism of the Peking Union Medical College Hospital Institutional Review Board (Approval No. I-25PJ1827), which covers the ongoing series of institutional assessment studies. This approval reconfirmed that the project involves minimal risk and analyzes only institutional-level data collected within a public health service evaluation. Institutional representatives (department heads or senior clinicians) completed the questionnaire in their professional capacity; no patient data or identifiable personal information were involved. Participation was voluntary, and returning the questionnaire indicated implied consent. Facilities included tertiary, general, specialty/MCH, and private institutions providing ANC; community clinics without ANC and non-obstetric departments were excluded.

Data analysis

Given the descriptive design and sample size constraints, we present primarily descriptive statistics (frequencies, percentages) with limited inferential testing. Descriptive statistics were used to summarize the characteristics of the institutions, including the distribution of nutrition services and the qualifications of healthcare personnel. Frequency distributions, means, and percentages were calculated for categorical and continuous variables. Chi-square or Fisher's exact tests were used for selected comparisons; effect sizes (Cramér's V or odds ratios with 95% confidence intervals) are reported where appropriate to indicate magnitude, however, non-significant findings preclude inferential interpretation. We used a two-sided $\alpha = 0.05$ without multiplicity adjustments, and treat inferential outputs as exploratory. Open-ended responses were analyzed thematically to provide supplementary insights into institutional experiences. Two researchers independently reviewed all textual responses and performed

initial inductive coding. A preliminary code list was iteratively refined through discussion until consensus was reached. Three major thematic categories emerged [1]: infrastructure and resource constraints [2], personnel qualifications and training gaps, and [3] enabling factors such as leadership support and innovative service delivery models. To enhance reliability, approximately 20% of responses were double-coded, yielding over 80% agreement between coders. Disagreements were resolved through consensus discussion; when consensus could not be reached, a senior team member adjudicated. The coding framework was iteratively refined during early coding rounds before being applied to the full dataset. Data saturation was considered achieved when no new categories emerged from the last five responses. Representative quotations were selected to illustrate these themes, not as frequency counts.

Results

Structure: Workforce and infrastructure

Clinic characteristics and service coverage & delivery

The survey results, drawn from 104 valid responses across various healthcare institutions in Beijing, underscore the heterogeneity in the provision of prenatal nutrition services. In addition to structured survey results, a small number of open-ended responses provided useful context to interpret institutional differences. While not subjected to formal coding, these remarks helped surface concerns related to staffing, space, and service delivery constraints. This service was predominantly provided by tertiary hospitals and maternal and child health centers, which are generally better resourced. Descriptively, the proportion of institutions offering prenatal nutrition classes differed across facility types (e.g. 12.5% vs ~57%). However, the facility-type comparison did not reach statistical significance ($p = 0.13$), so these contrasts should be treated as exploratory patters rather than evidence of systematic disparities. All institutions surveyed reported having designated prenatal nutrition clinics[1]. Of these, 87% considered the facilities adequate for daily operations, reflecting generally positive infrastructure. However, some institutions, due to limitations such as inadequate space (12%), outdated equipment (8%), and other factors, had not established dedicated prenatal nutrition clinics. These institutions instead relied on nutrition education courses and established referral mechanisms with higher-tier medical institutions' nutrition departments to provide prenatal nutrition management services to pregnant women in need. The infrastructure gaps, such as limited space and aging equipment, have restricted the ability to conduct hands-on prenatal nutrition classes. These gaps highlight a need for investment in both physical and technological resources to ensure that the facilities can meet the growing demand for maternal nutrition services and keep up with evolving best practices (see Table 1). Chi-square tests were conducted to compare the provision of maternal nutrition services across facility types (tertiary, general, specialty/MCH centers, private). Cramér's V is provided only to indicate magnitude; however, non-significant findings preclude inferential interpretation. Fisher's exact test was used where expected cell counts were <5. A significance threshold of $p < 0.05$ was applied. As shown in Table 1, the provision of prenatal nutrition education ranged from 12.5% in private institutions (95% CI: 2.2–47.1%) to over 55% in tertiary, general, and specialty hospitals. No statistically significant differences were detected across facility types ($\chi^2 = 5.72$, df = 3, $p = 0.13$). Therefore, no group differences were inferred. Descriptive percentages are presented as exploratory patterns only. In terms of equipment, computers, weighing scales, food models, food pyramid models, food exchange portion models, and bulletin boards are standard configurations for most prenatal nutrition clinics, supporting daily nutrition

Table 1. Provision of prenatal nutrition education across facility types with 95% confidence intervals and chi-square test results.

Facility type	Total (*N*)	Offered (*n*)	Percentages (*n/N*)	Proportion	95% CI (Lower)	95% CI (Upper)
Tertiary	35	20	57.14%	0.571	0.409	0.720
General	40	22	55%	0.550	0.398	0.693
Specialty/MCH	21	12	57.14%	0.571	0.365	0.755
Private	8	1	12.5%	0.125	0.022	0.471

*Chi-square test: $\chi^2 = 5.72$, df = 3, $p = 0.13$.
*Descriptive results are presented as exploratory patterns.
*Percentages (*n/N*) are shown; error bars represent ± 1 SE.

guidance and health education activities. However, only 20 institutions had equipped their prenatal nutrition clinics with body composition analyzers, indicating that there is still room for improvement in the provision of precise nutritional assessments during pregnancy. This infrastructure gap has made it difficult for some institutions to conduct group nutrition sessions. As one respondent described, *"We only have one shared classroom, so nutrition classes are often cancelled if other departments need the space."* Another agreed, stating that *"the lack of a dedicated teaching room makes group sessions difficult,"* even though basic infrastructure needs were otherwise met.

Healthcare personnel qualifications and training

The personnel composition within prenatal nutrition services reveals a critical area for improvement. While a majority of institutions employed obstetricians (56 institutions), nutritionists (35 institutions), and nurses (38 institutions) in their nutrition education programs, the overall availability of qualified nutrition professionals was limited. On average, institutions employed 2.3 full-time and 1.8 part-time nutrition counselors, which suggests that while the workforce is relatively stable, many institutions had fewer than three dedicated nutrition staff members (24%). The absence of full-time, specialized nutrition professionals in certain institutions may result in suboptimal delivery of prenatal nutrition education, particularly in areas where nutrition counseling is essential for managing pregnancy-related conditions such as gestational diabetes or anemia. Furthermore, the qualification of healthcare providers in nutrition was a major concern. Only 76% of institutions reported that their personnel had formal qualifications in nutrition (e.g. degree or certification in nutrition science, dietetics, or public health nutrition). The lack of specialized nutrition training among healthcare providers, particularly in obstetric and nursing staff, may compromise the quality of nutrition counseling provided to pregnant women (see Figure 1). Regular internal training was reported by 60% of institutions, but only 40% participated in external certification programs. This suggests a significant gap in the professional development of staff, which could limit their ability to stay current with the latest research and best practices in maternal nutrition care. The lack of specialized nutrition training among healthcare providers may compromise the quality of counseling. The shortage of dual-trained personnel was noted by several institutions. One explained, *"None of our current staff have dual training in nutrition and patient education. We rely on general nurses,"* while another added, *"Our obstetricians are too overloaded to also serve as regular nutrition educators."*

Reported barriers such as staffing shortages and infrastructure constraints were derived from open-ended responses and are presented as respondent-attributed explanations rather than author-inferred causes.

Process: Service delivery and information systems

Prenatal nutrition education class availability and content

The variability in prenatal nutrition education class availability and content across institutions underscores the fragmented nature of nutrition services. While 56% of institutions (58 institutions) offered

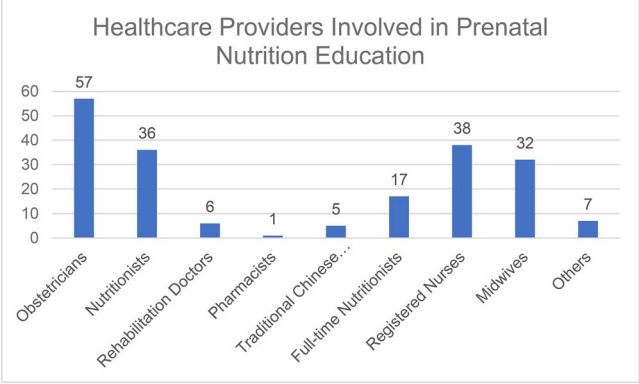

Figure 1. Healthcare providers involved in prenatal nutrition education.

prenatal nutrition education classes, the range and depth of content varied widely. The classes covered essential topics, such as gestational weight management (56 institutions), gestational diabetes management (54 institutions), and anemia management (44 institutions). However, the curriculum's inconsistency presents a challenge. Some institutions offered comprehensive classes covering all recommended nutrition topics, while others focused on a limited number of issues, failing to address the full spectrum of nutritional needs outlined in national guidelines.

This inconsistency in content delivery reflects a significant gap in the standardization of prenatal nutrition education. While pregnant women generally expressed high satisfaction with the courses (over 95%), the frequency and accessibility of these classes varied significantly. Some institutions offered classes only once a month, limiting pregnant women's opportunities to access education. Additionally, there were reports that many classes were only available during weekdays, which posed barriers for women working or living in rural areas. The lack of evening or weekend sessions points to a broader issue of accessibility, particularly for women in lower socio-economic groups who may have limited flexibility in their schedules. This uneven availability underscores the need for more flexible delivery models, such as digital health interventions or more frequent class offerings (see Figure 2). This inconsistency, driven largely by staffing limitations and the absence of a standardized curriculum, presents a major challenge to ensuring equitable and effective care. As one institution noted, "*We only offer one class per month, and the topics are chosen based on staff availability, not patient needs.*" Another remarked, "*There is no unified curriculum, so each instructor teaches what they know best—this causes inconsistency.*"

Management of prenatal nutrition clinics and digital health integration

The integration of prenatal nutrition services with obstetrics departments was widely reported, with most institutions adopting a multi-disciplinary approach to care. Institutions reported that nutrition services were often integrated with obstetric care and supported by multidisciplinary collaboration. Respondents also reported perceived improvements in nutrition-related outcomes; these perceptions are included to reflect routine institutional monitoring but do not constitute validated patient-level outcomes. While these reports are based on internal institutional assessments and not independently verified outcome data, they suggest a perceived benefit of structured nutrition services. Accordingly, statements about impact on pregnancy outcomes are not inferred from these data. However, while the integration of services has been successful, the use of digital tools to manage and track nutrition services remains limited. Less than 50% of institutions utilized electronic health records or nutritional analysis software to monitor and assess prenatal nutrition interventions. The lack of digital tools and integrated data management systems indicates a missed opportunity to deliver personalized care. As one provider reported, "*We use electronic health records, but we don't have any nutrition-specific tracking or education tools.*" Another echoed, "*Data input is still manual. Without proper software, we can't track patient nutrition progress over time.*"

Moreover, information technology (IT) support has provided a solid foundation for managing prenatal nutrition programs, though its development remains uneven. While most institutions have implemented

Figure 2. Prenatal nutrition education class availability and content.

electronic health record systems for the screening and management of high-risk pregnancies, the application of dynamic management and data analytics is still insufficient, with fewer than half of institutions using these tools effectively. Notably, district-level maternal and child health centers tend to have lower levels of IT support. For example, some district hospitals can identify high-risk pregnancies but have not yet implemented dynamic management or assessment functions. Meanwhile, other institutions are exploring data-driven, refined management models, such as dynamic grouping and patient management through online platforms. However, the limitations of manual data input continue to affect efficiency. It is worth noting that some higher-tech institutions are improving their management efficiency by integrating their systems. For instance, one hospital's HIS (Hospital Information System) supports networking across three branches, enabling high-risk screening, dynamic management, and data storage. Despite these advances, the widespread application of IT support remains in its early stages. Future development should focus on balancing the application of digital tools across institutions, strengthening data analysis capabilities, and promoting dynamic management functions to upgrade prenatal nutrition services comprehensively. As expressed in an open-ended response: *"We use electronic health records, but we don't have any nutrition-specific tracking or education tools." "Data input is still manual. Without proper software, we can't track patient nutrition progress over time."*

Institution-Reported perceptions (non-validated outcomes)

Institutions commonly reported high satisfaction among service users and perceived improvements in nutrition-related outcomes (e.g. anemia and low birth weight), although these were not independently validated. Findings in this domain should therefore be interpreted as institution-reported perceptions, not as objective outcome measures.

Discussion

This discussion interprets the findings through the Donabedian structure–process–outcome (SPO) framework and the WHO health-system building blocks. This study provides a comprehensive, institution-level snapshot of maternal nutrition services in Beijing. Reported services were broadly available, with heterogeneity in staffing, training opportunities, infrastructure, and digital support. As patient outcomes and implementation fidelity were not measured, findings should be interpreted as descriptive evidence of service capacity and delivery patterns.

Principal findings

This study provides important insights into the availability, quality, and delivery of maternal nutrition services in antenatal clinics across Beijing. The findings reveal significant variability in prenatal nutrition education coverage and content, gaps in healthcare provider training and qualifications, and challenges related to infrastructure and resource constraints. While interdisciplinary collaboration and high patient satisfaction highlight strengths, limited use of digital health tools indicates missed opportunities for innovation and efficiency in service delivery.

Interpretation of key findings

Variability in service coverage and content

One of the most significant findings of this study is the wide variability in the coverage and content of prenatal nutrition education across different institutions. While 56% of the institutions offered prenatal nutrition education classes, the range of topics covered was inconsistent, with some institutions addressing only limited aspects of maternal nutrition, such as gestational weight management or gestational diabetes, while others failed to provide education on key topics like anemia and dyslipidemia. This finding aligns with previous studies that have reported inconsistencies in prenatal nutrition education, particularly in urban settings [19,20]. observed that many urban hospitals in

China focus primarily on high-risk pregnancies and neglect to address basic nutritional needs for all pregnant women, resulting in fragmented service delivery. The lack of a unified curriculum across institutions in this study reflects the absence of standardized guidelines for maternal nutrition education in urban China. This issue has been highlighted in previous research by Nankumbi et al. [9], who pointed out that while some clinics have integrated nutrition education into routine ANC visits, the curriculum remains variable, which affects the consistency of care across institutions. Such variability can lead to disparities in the knowledge and care received by pregnant women, with potentially detrimental effects on maternal and child health outcomes. We observed descriptive heterogeneity in service coverage; however, hypothesis testing did not reach statistical significance and the study was not powered to detect modest between-group differences. Findings should therefore be interpreted as exploratory and hypothesis-generating. While descriptive trends were observed, private institutions were less likely to provide prenatal nutrition education. While our study did not directly measure clinical outcomes, institutional respondents commonly perceived improvements in maternal nutrition and associated pregnancy indicators, such as reduced rates of anemia and low birth weight, but these observations lack objective verification. These observations should be interpreted with caution and verified through future outcome-based research. A national framework for standardizing prenatal nutrition education should be developed, similar to the guidelines established by the World Health Organization (WHO) for maternal health services (WHO, 2023) [21]. This framework should include clear guidelines on the topics to be covered, the frequency of classes, and the duration of each session to ensure consistency and comprehensiveness.

Gaps in healthcare provider training and qualifications

The study found that a significant number of healthcare providers in Beijing's antenatal clinics lacked the specialized qualifications in maternal nutrition. 76% of institutions reported that their personnel had formal qualifications in nutrition, but many institutions relied heavily on general healthcare providers—such as obstetricians and nurses—for nutrition counseling, instead of employing specialized nutritionists. This finding echoes concerns raised by previous studies, such as those by [22,23], who also identified inadequate training in nutrition among healthcare providers as a key barrier to effective prenatal nutrition education While obstetricians and nurses play essential roles in managing maternal health, their limited expertise in nutrition can result in suboptimal counseling and a lack of tailored nutrition interventions. This is particularly concerning given the rising prevalence of gestational diabetes and hypertension in urban populations, where specialized nutrition care is needed to effectively manage these conditions [24]. In terms of optimal staffing ratios, there is no universal standard for the ideal number of nutritionists per pregnant woman. However, studies and guidelines suggest that a certain ratio of specialized professionals is necessary to ensure effective prenatal nutrition education. Research shows that the involvement of nutritionists can significantly improve maternal dietary behaviors and nutrition quality. For instance, Rasmussen et al. [25] found that the guidance of professional nutritionists during pregnancy markedly improved maternal nutrition and weight management. Such interventions often require nutritionists to have ample time for one-on-one consultations and to provide personalized advice. According to Beulen's research [26], when prenatal nutrition interventions are effective, it is recommended that each nutritionist supports a manageable number of pregnant women to ensure sufficient interaction and tailored guidance. The reliance on non-specialized staff for delivering nutrition education has been shown to lead to inconsistent counseling and lack of follow-up, undermining the potential impact of nutrition services on pregnancy outcomes. It is critical to expand the role of specialized nutritionists in maternal care and provide continuous professional development for all healthcare providers involved in nutrition education. Programs similar to those implemented in high-income countries, where multidisciplinary teams are the norm, like the UK's National Health Service, should be considered to ensure that all pregnant women receive personalized, evidence-based nutrition counseling.

Infrastructure and resource constraints

Another significant barrier identified in this study was the infrastructure limitations faced by many institutions, including space constraints and outdated equipment. 12% of institutions reported that

space limitations hindered their ability to offer nutrition education to larger groups, and 8% cited the need for modern equipment to better facilitate nutrition counseling. These findings are consistent with those of previous studies [27,28], which highlighted that resource limitations in urban clinics often affect the quality and accessibility of public health services. Similar challenges have been observed in other parts of the world, including in suburban and rural settings, where infrastructure deficiencies are a key impediment to service delivery [29]. The lack of adequate infrastructure (defined as availability of space for nutrition counseling and basic equipment such as scales and projectors), particularly in smaller or private clinics, may contribute to inequalities in service delivery, as larger hospitals or maternal and child health centers are often better equipped to offer comprehensive prenatal nutrition services. These disparities are particularly problematic in low-income urban areas, where access to quality maternal care may be more limited. Potential areas for strengthening service delivery, which could include expanding clinic space, upgrading equipment, and integrating digital tools for nutrition tracking and patient management, similar to models implemented in developed countries [30], require further evaluation before prescriptive recommendations can be made.

Digital health integration and data management gaps

A major opportunity for improvement identified in the study was the limited use of digital health tools to manage and track maternal nutrition services. Less than 50% of institutions utilized electronic health records or nutritional software to monitor and assess the effectiveness of nutrition interventions. This finding is consistent with the results of similar studies in urban healthcare settings in China [31], which have emphasized the need for data-driven approaches to improve service delivery and track patient outcomes more effectively. In contrast, studies from high-income countries have demonstrated that digital health integration can significantly enhance service delivery and patient outcomes by providing real-time data for providers and enabling more personalized care. The lack of such systems in Beijing's antenatal clinics suggests a missed opportunity to improve both the quality of care and the efficiency of maternal nutrition services. Digital health tools, such as electronic health records systems and nutritional tracking software, should be integrated into routine care to enhance the management and evaluation of maternal nutrition services. By adopting these technologies, healthcare providers can offer more personalized and effective care while ensuring continuous monitoring of patient progress.

Clinical implications

The proposed four-pillar framework provides a preliminary conceptual model for improving service quality, developed from the patterns observed in this institutional survey. Its practical feasibility and effectiveness remain to be explored through stakeholder consultation, co-design workshops, and pilot testing. Therefore, the framework should be viewed as a guiding hypothesis rather than prescriptive policy advice. The findings suggest potential directions for strengthening maternal nutrition services, such as developing standardized curricula for prenatal nutrition education, enhancing the role of qualified nutritionists, and improving continuing professional training. Similarly, investment in infrastructure and digital tools may help improve accessibility and service quality. These insights are intended to inform future evidence-based initiatives rather than to prescribe specific reforms.

Research implications

Future research should evaluate the impact of standardized nutrition education on maternal and child health outcomes, particularly in urban settings. Longitudinal studies are needed to assess the long-term effects of improved services. Exploring the role of digital health tools in enhancing efficiency and engagement, as well as the influence of socio-economic factors on service access, is crucial. Additionally, scalable training models for healthcare providers should be investigated to promote widespread adoption of best practices.

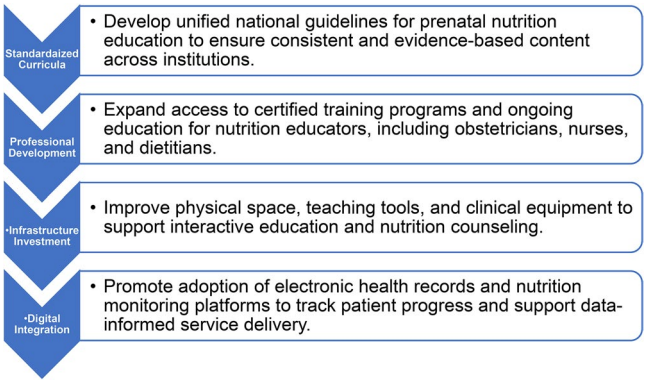

Figure 3. A preliminary four-pillar synthesis for organizing institutional elements relevant to maternal nutrition service provision (workforce development, infrastructure support, and digital integration).
*The figure is conceptual and should be interpreted as hypothesis-generating rather than directive.

Strengths and limitations

This study provides a comprehensive, city-wide institutional overview of maternal nutrition service provision across public and private antenatal clinics in Beijing, capturing trends in service models, staffing, and infrastructure. However, it did not involve direct engagement with pregnant women or families during survey development or interpretation; thus, findings reflect institutional perspectives rather than patient experiences. Several potential sources of bias should be noted. The high response rate (98.1%) likely reflects the official endorsement of the project by municipal health authorities and its integration into routine service evaluation, which may have encouraged greater participation from institutions already engaged in quality improvement. At the same time, this endorsement and the involvement of facility leadership in completing the survey may have produced social desirability bias, leading respondents to overstate service adequacy, training coverage, or patient satisfaction and to under-report barriers or resource gaps. Given the municipal endorsement of this evaluation and the involvement of facility leadership in completing the forms, responses may be subject to social desirability and leadership influence. Institutional representatives could overstate service availability, workforce readiness, or patient satisfaction to align with perceived policy priorities or internal performance targets. The likely direction of bias is overestimation of adequacy and underreporting of constraints, which may attenuate observed differences across facility types. To mitigate interpretive risk, we (i) frame our findings as descriptive, (ii) avoid causal language, and (iii) recommend independent audits and direct patient-reported outcomes in future studies to validate institutional reports. In addition, self-reported institutional data may be limited by recall errors and internal reporting standards. Generalizability is further constrained by Beijing's distinctive healthcare landscape greater investment, advanced infrastructure, and a high density of tertiary hospitals, which may not reflect less-resourced urban or rural areas. Despite these limitations, the institutional insights obtained provide a valuable foundation for policy refinement and for designing future evaluations that incorporate patient and public involvement to enhance validity and inclusivity.

Proposed framework for improving maternal nutrition services

We proposed a framework consisting of four interrelated pillars, which is presented as a structured synthesis aligned with established health systems concepts (e.g. Donabedian and WHO service capacity domains), to improve the quality and equity of maternal nutrition services in urban China (See Figure 3). These pillars should be embedded within institutional planning and supported by municipal and national health policies.

Conclusions

This study provides a comprehensive, institution-level snapshot of maternal nutrition service provision in Beijing antenatal clinics. Across institutions, services were reported as broadly available, with heterogeneity

in delivery, staffing, resources, and digital support. Because the study did not measure patient outcomes or implementation fidelity, findings should be interpreted as descriptive evidence of service capacity and delivery patters. Further adequately powered studies are needed if inferential comparisons are intended. Future research should examine how proposed improvement areas can be implemented and whether they influence service quality, equity, and clinical outcomes alongside implementation measures.

Note

1. In this study, the term "nutrition clinics" includes both standalone units and embedded services within obstetrics or maternal health departments.

Author contributions

CRediT: **Yini Li**: Software, Writing – original draft, Writing – review & editing; **Xi Wang**: Methodology, Visualization; **Dongjun Wang**: Data curation; **Suhan Zhang**: Supervision; **Ye Li**: Software, Writing – original draft, Writing – review & editing; **Mingyue Hu**: Supervision; **Yin Sun**: Writing – review & editing; **Liangkun Ma**: Writing – review & editing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Condensation

Maternal nutrition services in Beijing's antenatal clinics show foundational availability but face challenges in quality, training gaps, and service standardization.

Consent to participate

This study does not involve consent to participate.

Consent to publish

This study does not involve consent to publish.

Ethical approval

This study was reviewed and approved by the Institutional Review Board of Peking Union Medical College Hospital (Annual Review Approval No. 1-25PJ1827).

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Data availability statement

All the data generated and analyzed in this study have been included in this article and can be provided separately as needed.

References

[1] Black RE, Alderman H, Bhutta ZA, et al. Maternal and child nutrition: building momentum for impact. The Lancet. 2013;382(9890):372–375. doi:10.1016/S0140-6736(13)60988-5.

[2] Abu-Saad K, Fraser D. Maternal nutrition and birth outcomes. Epidemiol Rev. 2010;32(1):5–25. doi:10.1093/epirev/mxq001.

[3] Maternal nutrition. | UNICEF [Internet]. [cited 2024 Nov 29]. Available from: https://www.unicef.org/nutrition/maternal.

[4] Lu C, Zhang Z, Lan X. Impact of China's referral reform on the equity and spatial accessibility of healthcare resources: a case study of Beijing. Soc Sci Med. 2019;235:112386. doi:10.1016/j.socscimed.2019.112386.

[5] Huang X, Yang B, Liu Q, et al. Improving maternal and child nutrition in China: an analysis of nutrition policies and programs initiated during the 2000–2015 Millennium Development Goals era and implications for achieving the Sustainable Development Goals. J Health Popul Nutr. 2020;39(1):12. doi:10.1186/s41043-020-00221-y.

[6] Li X, Song J, Lin T, et al. Urbanization and health in China, thinking at the national, local and individual levels. Environ Health. 2016;15(S1):S32. doi:10.1186/s12940-016-0104-5.

[7] Salmuth V V, Brennan E, Kerac M, et al. Maternal-focused interventions to improve infant growth and nutritional status in low-middle income countries: a systematic review of reviews. PLoS One. 2021;16(8):e0256188.

[8] Saronga N, Burrows TL, Collins CE, et al. Nutrition services offered to pregnant women attending antenatal clinics in Dar es Salaam, Tanzania: a qualitative study. Midwifery. 2020;89:102783. doi:10.1016/j.midw.2020.102783.

[9] Nankumbi J, Ngabirano TD, Nalwadda G. Maternal nutrition education provided by midwives: a qualitative study in an Antenatal Clinic, Uganda. J Nutr Metab. 2018;2018(1):3987396–3987397. doi:10.1155/2018/3987396.

[10] Liu N, Mao L, Sun X, et al. The effect of health and nutrition education intervention on women's postpartum beliefs and practices: a randomized controlled trial. BMC Public Health. 2009;9(1):45. doi:10.1186/1471-2458-9-45.

[11] Li C, Tang L, Yang M, et al. A study to evaluate the efficacy of different interventions for improving quality of maternal health care service in China. Telemed J E Health. 2020;26(10):1291–1300. doi:10.1089/tmj.2019.0230.

[12] Song J, Zhang J, Fawzi W, et al. Double burden of malnutrition among chinese women of reproductive age and their social determinants. Nutrients. 2020;12(10):3102. doi:10.3390/nu12103102.

[13] Rahaman MA, Kalam A, Al-Mamun M. Unplanned urbanization and health risks of Dhaka City in Bangladesh: uncovering the associations between urban environment and public health. Front Public Health. 2023;11:1269362. doi:10.3389/fpubh.2023.1269362.

[14] Boyd NR, Windsor RA. A formative evaluation in maternal and child health practice: the partners for life nutrition education program for pregnant women. Matern Child Health J. 2003;7(2):137–143. doi:10.1023/a:1023873112024.

[15] Goodarzi-Khoigani M, Baghiani Moghadam MH, Nadjarzadeh A, et al. Impact of nutrition education in improving dietary pattern during pregnancy based on pender's health promotion model: a randomized clinical trial. Iran J Nurs Midwifery Res. 2018;23(1):18–25. Available from: doi:10.4103/ijnmr.IJNMR_198_16.

[16] Dewidar O, John J, Baqar A, et al. Effectiveness of nutrition counseling for pregnant women in low- and middle-income countries to improve maternal and infant behavioral, nutritional, and health outcomes: a systematic review. Campbell Syst Rev. 2023;19(4):e1361. doi:10.1002/cl2.1361.

[17] Bashir S, Ansari AH, Sultana A. Knowledge, attitude, and practice on antenatal care among pregnant women and its association with sociodemographic factors: a hospital-based study. J Patient Exp. 2023;10:23743735231183578. doi:10.1177/23743735231183578.

[18] Hanson L, VandeVusse L, Roberts J, et al. A critical appraisal of guidelines for antenatal care: components of care and priorities in prenatal education. J Midwifery Womens Health. 2009;54(6):458–468. doi:10.1016/j.jmwh.2009.08.002.

[19] Rizk J, Andreou E, Hileti D, et al. Assessing health care providers' knowledge and practices of nutrition during pregnancy in lebanon: a cross-sectional study. Medicina (B Aires). 2023;59(8):1471. doi:10.3390/medicina59081471.

[20] Li Q, Piaseu N, Phumonsakul S, et al. Effects of a comprehensive dietary intervention program, promoting nutrition literacy, eating behavior, dietary quality, and gestational weight gain in chinese urban women with normal body mass index during pregnancy. Nutrients. 2024;16(2):217. doi:10.3390/nu16020217.

[21] Nutrition counselling during pregnancy. 2024. https://www.who.int/tools/elena/interventions/nutrition-counselling-pregnancy

[22] Kris-Etherton PM, Akabas SR, Bales CW, et al. The need to advance nutrition education in the training of health care professionals and recommended research to evaluate implementation and effectiveness. Am J Clin Nutr. 2014;99(5 Suppl):1153S–1166S. doi:10.3945/ajcn.113.073502.

[23] Lee A, Newton M, Radcliffe J, et al. Pregnancy nutrition knowledge and experiences of pregnant women and antenatal care clinicians: a mixed methods approach. Women Birth. 2018;31(4):269–277. doi:10.1016/j.wombi.2017.10.010.

[24] Rasmussen L, Poulsen CW, Kampmann U, et al. Diet and healthy lifestyle in the management of gestational diabetes mellitus. Nutrients. 2020;12(10):3050. doi:10.3390/nu12103050.
[25] Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. Weight Gain during pregnancy: reexamining the guidelines [Internet]. Rasmussen KM, Yaktine AL, editors. Washington (DC): national Academies Press (US); 2009. [cited 2025 Jan 13]. (The National Academies Collection: reports funded by National Institutes of Health). http://www.ncbi.nlm.nih.gov/books/NBK32813/
[26] Beulen YH, Super S, de Vries JHM, et al. Dietary interventions for healthy pregnant women: a systematic review of tools to promote a healthy antenatal dietary intake. Nutrients. 2020;12(7):1981. doi:10.3390/nu12071981.
[27] Guagliardo MF. Spatial accessibility of primary care: concepts, methods and challenges. Int J Health Geogr. 2004;3(1):3. doi:10.1186/1476-072X-3-3.
[28] Wang F. Measurement, optimization, and impact of health care accessibility: a methodological review. Ann Assoc Am Geogr. 2012;102(5):1104–1112. doi:10.1080/00045608.2012.657146.
[29] Weinhold I, Gurtner S. Understanding shortages of sufficient health care in rural areas. Health Policy. 2014;118(2):201–214. doi:10.1016/j.healthpol.2014.07.018.
[30] Haddad SM, Souza RT, Cecatti JG. Mobile technology in health (mHealth) and antenatal care–Searching for apps and available solutions: a systematic review. Int J Med Inform. 2019;127:1–8. doi:10.1016/j.ijmedinf.2019.04.008.
[31] Shi H, Chen L, Wei Y, et al. Improving maternal healthcare further in China at a time of low maternal mortality. BMJ. 2024;386:e078640. doi:10.1136/bmj-2023-078640.