Quality of antenatal care in Primary Health Care in Brazil: A Latent Class Analysis

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Abstract

Background

Adequate antenatal care (ANC) is fundamental in preventing maternal and neonatal mortality. Developing indicators for assessing the ANC quality in Primary Health Care (PHC) is essential.

Objective

To characterize subgroups of quality of care with respect to ANC at the PHC level in Brazil.

Methods

We conducted a cross-sectional study with data from the first Brazil's National Program for Improving Primary Care Access and Quality (PMAQ-AB) cycle (2012). 16,566 PHC teams participated in the first cycle of the PMAQ-AB, corresponding to 49.6% of the teams active across Brazil, distributed across 69.3% of Brazilian municipalities. To evaluate the ANC quality, six indicators were elaborated: "Medicines", "Protocols and patient flows", "Record keeping practices", "ANC routine tests", "Protocols for early detection of pregnant women and ANC provision", and "Identification and ANC of Low/High-risk pregnancies". Latent Class Analysis (LCA) was carried out to characterize the quality of care provided by PHC teams according to these six indicators.

Results

"Identification and ANC of Low/High-risk pregnancies" indicator had the highest percentage of teams providing adequate care (39.5%), while "ANC routine tests" had the lowest percentage (16.8%). The LCA identified three classes, and 20.5% of PHC teams had the probability of belonging to the class denominated "High adequacy".

Conclusion

Using a dataset from a survey carried out with health professionals at the PHC level allowed us to select indicators and characterize PHC teams in terms of the adequacy of ANC provided. This approach can guide global initiatives to evaluate the quality of ANC.

Introduction

The provision of maternal and child care is an international concern and a focus of the United Nations Sustainable Development Goals. ¹ Antenatal care (ANC) systematizes a set of practices and guidelines
directed towards pregnant women, and, according to Brazilian legislation, it should be predominantly provided at the Primary Health Care (PHC) level.

ANC aims to ensure a healthy pregnancy and appropriate development of the fetus, preventing adverse health outcomes for the mother and her future infant. Thus, ANC contemplates promoting maternal and fetal health, diagnosing and treating complications, and reducing the risk of gestational complications during labor and postpartum. Regular ANC visits have been shown to benefit babies by improving intrauterine growth and reducing the risk of infection, thereby increasing infant survival rates. These visits also provide the opportunity to assess maternal nutritional status and provide counselling, screen for potential pregnancy complications, treat infections, and carry out early management of newborn illness. These interventions are essential for reducing maternal, neonatal, and infant morbimortality, as well as improving birth weight.

However, for ANC to be effective, it is recommended to initiate it early in pregnancy and to ensure it comprises a set of actions established by care protocols informed by scientific evidence. These may vary slightly depending on the institution that develops them, although they always maintain some common traits. For example, the World Health Organization (WHO) recommends that pregnant women receive at least eight antenatal care visits, with the first ideally taking place within the first 12 weeks of gestation, followed by additional visits at 20, 26, 30, 34, 36, 38, and 40 weeks of gestation. On the other hand, the Brazilian Ministry of Health recommends a minimum of six consultations, also identifying the need to preferably receive the first one in the first trimester, followed by two in the second trimester, and also recommends a greater frequency (three visits) in the third trimester of pregnancy.

In addition to visit frequency, essential elements of ANC interventions have been emphasized to ensure the quality of care. Quality includes care provision and experience from a health systems perspective. ANC actions in Brazil are guided by the quality and effectiveness criteria elaborated by the Rede Cegonha initiative. Nevertheless, existing literature indicates concerns about the subpar quality of ANC in primary care settings and persistent regional and sociodemographic inequalities in terms of access and outcomes.

Overall, the quality of ANC is determined by resource availability, normal development, adherence to technical-scientific standards, and timely access. However, assessing its adequacy in detail poses a significant challenge and demands the development of appropriate indicators that assess ANC quality in PHC. To address the issue of monitoring and evaluation of PHC services, including ANC, in 2011 the Federal Government launched the National Program for Improving Primary Health Care Access and Quality (PMAQ-AB) as a strategy to assess and enhance the quality of PHC facilities and services provided.

Therefore, this study characterizes subgroups of quality of care with respect to the provision of ANC at the PHC level in Brazil, using data from the PMAQ-AB's first cycle.
Methods

Study design, population, and data

This cross-sectional study utilized data from modules I (structure of PHC facility) and II (PHC team's work processes) of the PMAQ-AB, collected during the program's first cycle, between 2011 and 2012.

Our study sample comprised 16,566 PHC teams that joined the PMAQ-AB. These represented 49.6% of the teams active in 2012, distribute across 69.3% of Brazilian municipalities. 20

Latent Class indicators

To identify in the PMAQ-AB questionnaire the variables that pertained to ANC, we used criteria and standards derived from Brazilian legislation, guidelines, protocols, existing scientific evidence, and consultation with PHC experts. Subsequently, the selected questions were grouped into six different ANC indicators (Tables 1 and 2), which were in turn classified as adequate or inadequate to represent the quality of care at the PHC level. 3,5
Table 1
Frequency of PHC teams providing adequate care, in terms of each variable of the six indicators composing Antenatal Care (ANC). PMAQ-AB, Brazil. 2012.

<table>
<thead>
<tr>
<th>1. Medicines</th>
<th>% of PHC teams providing adequate care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analgesic</td>
<td>75.5</td>
</tr>
<tr>
<td>Antidiabetics</td>
<td>47.7</td>
</tr>
<tr>
<td>Antibacterials</td>
<td>75.4</td>
</tr>
<tr>
<td>Antihypertensive or cardiovascular action</td>
<td>78.8</td>
</tr>
<tr>
<td>Antiparasitic</td>
<td>71.2</td>
</tr>
<tr>
<td>Antiasthmatics</td>
<td>73.3</td>
</tr>
<tr>
<td>Antiacids and Antiemetics</td>
<td>64.7</td>
</tr>
<tr>
<td>Vitamins, multivitamins, minerals</td>
<td>75.6</td>
</tr>
<tr>
<td>The application of benzathine penicillin G is performed at the facility</td>
<td>50.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Protocols and patient flows</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Defined referral protocols and patient flows: Delivery (maternity ward)</td>
<td>48.3</td>
</tr>
<tr>
<td>Defined referral protocols and patient flows: Serological examination for syphilis (VDRL) in pregnant women</td>
<td>50.4</td>
</tr>
<tr>
<td>Defined referral protocols and patient flows: Serological examination for HIV in pregnant women</td>
<td>50.7</td>
</tr>
<tr>
<td>Defined referral protocols and patient flows: Glicose exam</td>
<td>49.4</td>
</tr>
<tr>
<td>Defined referral protocols and patient flows: Uroculture or urine summary (type I urine)</td>
<td>48.7</td>
</tr>
<tr>
<td>Defined referral protocols and patient flows: Ultrasound exam for pregnant women</td>
<td>50.9</td>
</tr>
<tr>
<td>Pregnant women accompanied by the team has a defined maternity for delivery</td>
<td>82.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Record keeping practices</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>In the monitoring of pregnant women, there is a record of: the professional responsible for monitoring the pregnancy</td>
<td>91.9</td>
</tr>
<tr>
<td>In the monitoring of pregnant women, there is a record of: dental consultation</td>
<td>55.9</td>
</tr>
<tr>
<td>In the monitoring of pregnant women, there is a record of: collection of cytopathological examination</td>
<td>73.9</td>
</tr>
<tr>
<td>There is a copy/record of the pregnant women's booklet, or another form with equivalent information, in the PHC facility</td>
<td>77.4</td>
</tr>
</tbody>
</table>
1. Medicines

The PHC team uses the pregnant women's booklet to monitor pregnant women. There is a document to prove it

<table>
<thead>
<tr>
<th>% of PHC teams providing adequate care</th>
</tr>
</thead>
<tbody>
<tr>
<td>92.0</td>
</tr>
</tbody>
</table>

4. Antenatal care routine tests

- Syphilis serology (VDRL) tests are performed for antenatal care
- Fasting glucose tests are performed for antenatal care
- HIV serology are performed for antenatal care
- Hemoglobin and hematocrit tests are performed for antenatal care
- Urine culture or urinalysis tests are performed for antenatal care
- Serology tests for hepatitis B are performed for antenatal care
- Serological examinations for toxoplasmosis are performed for antenatal care
- The PHC team gets the results of pregnant women examinations in time for the necessary interventions
- Rapid syphilis test
- Rapid HIV test
- Rapid pregnancy test

<table>
<thead>
<tr>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>98.0</td>
</tr>
<tr>
<td>97.7</td>
</tr>
<tr>
<td>97.7</td>
</tr>
<tr>
<td>97.0</td>
</tr>
<tr>
<td>95.4</td>
</tr>
<tr>
<td>94.4</td>
</tr>
<tr>
<td>92.8</td>
</tr>
<tr>
<td>73.3</td>
</tr>
<tr>
<td>3.1</td>
</tr>
<tr>
<td>19.3</td>
</tr>
<tr>
<td>6.4</td>
</tr>
</tbody>
</table>

5. Protocols for early detection of pregnant women and antenatal care provision

- The protocol for accepting spontaneous demand considers early enrollment of pregnant women
- The PHC team has defined protocols and therapeutic guidelines for antenatal care

<table>
<thead>
<tr>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.3</td>
</tr>
<tr>
<td>74.9</td>
</tr>
</tbody>
</table>

6. Identification and antenatal care of Low/High-risk pregnancies

- The PHC team organizes the service offers and referrals (consultations and tests) of pregnant women based on the assessment and classification of risk and vulnerability. There is a document to prove it
- The PHC team has a record of the number of high-risk pregnant women in the territory. There is a document to prove it
- The PHC team attends to the complications or emergencies of the high-risk pregnant woman. There is a document to prove it
- Antenatal care is among the services provided to special interest groups
- During home visits, the CHW carries out community outreach to identify pregnant women that have missed appointments

<table>
<thead>
<tr>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>67.5</td>
</tr>
<tr>
<td>52.3</td>
</tr>
<tr>
<td>47.8</td>
</tr>
<tr>
<td>84.3</td>
</tr>
<tr>
<td>93.6</td>
</tr>
</tbody>
</table>
### Table 2
Development of the six Antenatal Care (ANC) indicators.

<table>
<thead>
<tr>
<th>ANC indicator</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicines</td>
<td>This indicator was composed of eight groups of essential medicines for the care of pregnant women: analgesics, antidiabetics, antibacterials, antihypertensives or cardiovascular agents, antiparasitics, antiasthmatics, antacids, and antiemetics, as well as multivitamins. For each group, the PHC facility should have at least one medicine to be considered adequate. Additionally, the PHC team should have answered &quot;yes&quot; to the question about the administration of benzathine penicillin G to pregnant women in the facility.</td>
</tr>
<tr>
<td>Protocols and patient flows</td>
<td>For this indicator, the PHC team needed to have documents containing referral protocols and patient flows for pregnant women for several situations such as delivery (maternity ward), serological examination for syphilis (VDRL) and HIV, glucose exam, uroculture, and ultrasound. If the team answered &quot;yes&quot; to all questions and had defined the maternity ward for delivery, the indicator was considered adequate.</td>
</tr>
<tr>
<td>Record keeping practices</td>
<td>It was asked whether the professional responsible for monitoring the pregnant woman had records of dental consultation and collection of cytopathological examination. When the answers were positive, and there was also a record of the pregnant women's booklet proving this, the indicator was considered adequate.</td>
</tr>
<tr>
<td>Antenatal care routine tests</td>
<td>This indicator consisted of ten questions about the antenatal tests performed by the PHC team, including syphilis serology (VDRL), fasting glucose, HIV serology, hemoglobin and hematocrit, urine culture, serology test for hepatitis B and toxoplasmosis, and three rapid tests for syphilis, HIV, and pregnancy. If the PHC team answered positively to all questions and could obtain the results of the pregnant women's examinations in time for necessary interventions, the indicator was considered adequate.</td>
</tr>
<tr>
<td>Protocols for early detection of pregnant women and antenatal care provision</td>
<td>This indicator was based on two questions. The first question asked whether the PHC team considered the early enrollment of pregnant women in the protocol for accepting spontaneous demand. The second question asked whether the team had defined protocols and therapeutic guidelines for prenatal care. To be considered adequate, the health professional should have answered &quot;yes&quot; to both questions.</td>
</tr>
<tr>
<td>Identification and antenatal care of Low/High-risk pregnancies</td>
<td>The PHC team was required to answer &quot;yes&quot; to three questions regarding pregnant women with some level of risk or vulnerability: (1) organizing service offerings and referrals based on the risk classification, (2) keeping a record of the number of high-risk pregnant women in the area, and (3) attending to the complications or emergencies of these women. To prove these activities, the PHC team should always have a document available. Additionally, the team was asked if they offered a program aimed at antenatal care and if the community health worker identified pregnant women who missed appointments during home visits. To consider this indicator adequate, the health professional should have answered positively to each question.</td>
</tr>
</tbody>
</table>

### Statistical analysis

Initially, descriptive analyses were carried out to identify the frequencies of PHC teams providing adequate ANC, in terms of each variable of the six indicators composing antenatal care.
Subsequently, we applied Latent Class Analysis (LCA) to characterize the adequacy of ANC provided by PHC teams. LCA is a multivariate statistical method that uses conditional and unconditional probabilities to describe categorical constructs based on a set of categorical indicators. The resulting models were assessed using AIC, BIC, entropy, and the Vuong-Lo-Mendell-Rubin likelihood ratio test. The interpretation of the latent classes was used as an additional model selection criteria, and the local independence assumption of LCA was evaluated through the analysis of standardized bivariate residuals. A maximum percentage of 10% of residuals was deemed acceptable. The latent classes according to the response patterns on the LCA indicators and their posterior probabilities are also presented.

The descriptive analysis and the LCA were performed with Stata 15.0 and Mplus 8.6, respectively.

As this study used secondary data from publicly available databases provided by the Brazilian Ministry of Health, submission to the Research Ethics Committee was not required.

Results

The variables composing each of the six indicators of ANC quality and their respective frequencies are presented in Table 1.

Figure 1 displays the frequencies of PHC teams providing adequate care in relation to each of the six indicators of the ANC quality component. The indicator "Identification and ANC of Low/High-risk pregnancies" had the highest frequency of teams providing adequate care (39.5%), while the indicator "ANC routine tests" had the lowest frequency (16.8%).

Table 3 presents the model fit statistics for different latent class models with varying numbers of classes. Despite the lowest AIC (111460.0) and BIC (111668.3) values for the LCA model with four classes, the model with three classes was chosen because of its greater interpretability. Moreover, the classification quality of this latter model is also superior (entropy = 0.529).
Table 3
Comparison of model fit statistics for different latent class models for Antenatal Care (ANC) quality.
Brazil. 2012.

<table>
<thead>
<tr>
<th>Number of classes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of estimated parameters</td>
<td>6</td>
<td>13</td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td>AIC</td>
<td>119237.5</td>
<td>112138.5</td>
<td>111614.4</td>
<td>111460.0</td>
</tr>
<tr>
<td>BIC</td>
<td>119283.8</td>
<td>112238.8</td>
<td>111768.7</td>
<td>111668.3</td>
</tr>
<tr>
<td>Entropy</td>
<td>-</td>
<td>0.623</td>
<td>0.529</td>
<td>0.472</td>
</tr>
<tr>
<td>Vuong-Lo-Mendell-Rubin likelihood ratio test</td>
<td>-</td>
<td>1 vs 2 classes</td>
<td>2 vs 3 classes</td>
<td>3 vs 4 classes</td>
</tr>
</tbody>
</table>

Figure 2 presents the three latent classes selected as our final model: 20.5% of PHC teams were characterized as having a "High adequacy" of care, 23.9% as having an "Intermediate adequacy" of care, and 55.6% as having a "Low adequacy" of care.

The "High adequacy" class had the highest probabilities of adequacy across all six indicators. PHC teams in this class had a 68.1% probability of reporting adequacy for medicines, 72.6% for protocols and patient flows, 67.7% for record-keeping practices, 53.3% for ANC routine tests, 67.2% for protocols for early detection of pregnant women and ANC provision, and 67.7% for identification and ANC of Low/High-risk pregnancies (Fig. 2 and Table 1S). In the class labelled as "Intermediate", the indicator with the highest probability of adequacy was the "Identification and ANC of Low/High-risk pregnancies" (63.8%). Meanwhile, in the class labelled as "Low adequacy", the indicator with the highest probability of adequacy was "Record keeping practices" (17.6%) (Fig. 2 and Table 1S).

When comparing the three classes, it is worth highlighting the two indicators with the greatest percentage point difference for the conditional probabilities. Between the "High adequacy" and "Intermediate adequacy" classes, the indicator "Medicines" had a difference of 54.8 p.p. On the other hand, the indicator "Protocols for early detection of pregnant women and ANC provision" had the greatest percentage point difference (59.1) when comparing the "High adequacy" with the "Low adequacy" class.

Table 2S displays the response patterns for the six indicators of ANC quality. The most frequent response pattern indicated inadequacy across all six indicators (24.3%), with a 95.4% probability of belonging to the "Low adequacy" class. Additionally, within the "Low adequacy" class, the maximum number of "adequate" indicators observed was two. Conversely, the response pattern featuring all six indicators
classified as adequate accounted for 2.2% of the PHC teams and had a 99.3% probability of belonging to the "High adequacy" class. This pattern exhibited at least four adequate indicators.

Discussion

Statement of principal findings

Our study used LCA and real-world data from the PMAQ-AB external evaluation dataset to identify subgroups of quality of care related to ANC at the PHC level in Brazil.

To ensure comprehensive and effective ANC for pregnant women in PHC, facilities must have the necessary infrastructure, and healthcare professionals must perform procedures, tests, and provide guidance to promote their health. "Identification and ANC of Low/High-risk pregnancies" was the indicator of the ANC component that showed the highest percentage of adequacy in terms of availability and quality.

Interpretation within the context of the wider literature

Compared to the recommended amount, in low-resource settings a reduced number of ANC visits increases the risk of perinatal mortality. Thus, many LMICs have adopted CHW programs to strengthen PHC systems and extend care to vulnerable groups. CHWs play a vital role in improving the quality of maternal and child health care, access to PHC services, and reducing maternal, newborn, and infant morbimortality. In Brazil, CHWs are required members of the basic PHC team, and their main function is to carry out home visits and community outreach for vulnerable groups, or those with greater health needs. Through these visits, they monitor child development, promote health, and prevent diseases. CHWs, who are community members with training in the health area, are considered a link between the community and the health facility, helping pregnant women meet the desired number of antenatal consultations and fostering vaccination of pregnant women and children through outreach initiatives. Their presence is associated with better PHC practices, including those related to children's and women's health.

The Brazilian Ministry of Health has implemented several strategies to enhance the quality of healthcare services, including rapid tests and examinations for diagnosing pregnancy complications, HIV infection, and screening for syphilis and viral hepatitis in PHC. On-site testing for maternal syphilis can be particularly useful in improving ANC quality and reducing perinatal mortality in areas where laboratory facilities are not available. Repeating HIV tests in pregnant women during the third trimester or during breastfeeding, as well as reviewing the urgent results of critically ill children, could help prevent a significant number of deaths in children under-5 years of age. However, the lack of medicines and rapid diagnostic tests remains a well-known problem in the public PHC system, especially prior to the implementation of PMAQ-AB. Vanderlei and Navarrete (2013) found that the constant lack of
medication and regulatory mechanisms could contribute to post-neonatal infant deaths, while the shortage of resources, training, staff, and overcrowding have been noted as contributors to reducing the efficiency of healthcare. In a study conducted by Droti et al. (2019) in eight Sub-Saharan African countries, the availability of priority medicines recommended by WHO for pregnant women and children was found to be unacceptably low in most of them.

To ensure high-quality ANC, it is crucial for health facilities to have a well-structured system that provides comprehensive care, including the availability of rapid tests and medications. Additionally, outreach, home visits, and bonding with the healthcare team are important aspects of quality ANC. However, according to Luz et al. (2018), the majority of PHC facilities in Brazil do not meet the standards established in national protocols in terms of structure and processes required for adequate ANC. ANC's managerial and care dimensions were found to be of low quality, with very few teams having the necessary resources to provide adequate care. These findings are consistent with other studies in the literature that have identified inadequate medications, difficulties in performing tests, and low application of HIV and syphilis tests. Furthermore, a high percentage of facilities had expired materials, there was a lack of protocols, patient flows agreed upon with municipal management, and various structures in the facilities investigated in a local study. Therefore, there is a need for improvements in the infrastructure and processes of ANC in PHC facilities to ensure high-quality care for pregnant women.

In Brazil, specifically, low quality of ANC has been commonly discussed. In Mexico, low referral of pregnant women to educational activities was evidenced. In Europe, a systematic review showed that, although maternal care systems are well implemented in the continent, inequalities persist in Central and Eastern European countries, which suffer from barriers to access for maternal care, outdated material resources, lack of medication, and inadequate and outdated protocols, among others. A study carried out in a more populous and developed region of Asia highlighted that the quality of ANC was extremely inadequate, mainly due to inadequacy and low coverage in managerial and healthcare levels, distance from the units, deficiency of facilities and working hours, and availability of human resources.

The greatest percentage point difference for the conditional probabilities when comparing "High adequacy" and "Low adequacy" for protocols for early detection of pregnant women and ANC provision is worth noting. PHC, as the gateway to the health system, has presented important shortcomings, such as limited opening hours or health network fragmentation. Initiatives such as extended hours and advanced access are relevant but still incipient. Protocols and guidelines can help guide evidence-based practices to prevent maternal deaths. ANC in PHC units should include routine exams with timely results. Based on the clinical examination and the results of these tests, the pregnancy may be identified as high-risk, and referral to specialized services should be ensured. However, the PHC team must continue to follow up with the pregnant woman to maintain the bond and provide comprehensive care to her and her family, as recommended by the principles that guide the Brazilian health system.

**Strengths and limitations**
The strengths of this study include the following: (i) the inclusion of many questions in the PMAQ-AB questionnaire that required documentation as proof, providing a significant layer of security to ensure the robustness of our data; (ii) the robustness of the employed ANC quality model, considering an indicator of structure and work process; and (iii) the use of LCA to measure the ANC component, which has several advantages, such as the possibility of identifying subgroups within a population based on response patterns of the observed variables (indicators), no distributional assumptions about the indicators, and easy characterization of categories through conditional and unconditional probabilities. Additionally, LCA can be easily implemented in several statistical software.

Regarding the limitations of this study, it is important to acknowledge that participation in the PMAQ-AB was voluntary, which may have led to non-participation of some PHC facilities and teams with poorer performance, especially in the first cycle, which covered about 60% of PHC teams distributed across roughly 70% of Brazilian municipalities. Despite this limitation, significant variations in the quality and distribution of PHC teams evaluated across the country were observed in the first cycle. Furthermore, the data used to develop the indicators and component in this study were collected through interviews with health professionals and direct observation by interviewers, without contemplating the user's perception of quality/performance.

Implications for policy, practice and research

To support the enhancement of PHC, it is advisable to undertake studies that evaluate the quality of ANC in more detail. Such initiatives can contribute to ensuring that expectant mothers receive the highest standard of ANC, leading to better health outcomes for both mothers and babies.

Conclusions

The study's findings underscore the importance of the ANC dimension, which offers valuable guidance for worldwide efforts to assess maternal care at the PHC level, ultimately contributing to its improvement. It also highlights the need for governments and international organizations to invest in robust data systems and provide adequate resources to promote research in this field. Nonetheless, it is worth pointing out that it is crucial to deliver high-quality health services while addressing socioeconomic disparities that affect health outcomes.

Declarations

Contributorship

NO drafted the initial manuscript, reviewed, and revised the manuscript. EPP-J acquired data and funding and supervised the study process. NO, EPP-J, and MdPF-Q were responsible for study conception. LDAFA, RA, APGFV-M, JRA, MPVDP, MdPF-Q, LAL, and YHSS were responsible for data analysis and interpretation. EPP-J, VM, EFA, AMPL, RA, LDAFA, APGFV-M, LAL, MLB, and MYTI critically reviewed and
revised the manuscript for important intellectual content. All authors participated in preparing and approving the final manuscript as submitted and agree to be accountable for all aspects of the work.

**Ethics and other permissions**

As this study used secondary data from publicly available databases provided by the Brazilian Ministry of Health, submission to the Research Ethics Committee was not required.

**Funding**

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**Conflict of interest**

The authors have no conflicts of interest to disclose.

**Acknowledgements**

Not applicable.

**Data Availability Statement**

Data are available in a public, open access repository: https://aps.saude.gov.br

**References**


Figures

**Figure 1**

Percentage of adequacy for the Antenatal Care (ANC) quality indicators.
**Figure 2**

Latent class membership of PHC units in relation to PMAQ-AB indicators for Antenatal Care (ANC) quality. PMAQ-AB, Brazil. 2012.

**Supplementary Files**

This is a list of supplementary files associated with this preprint. Click to download.

- 4.Supplementarydata.docx