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RESEARCH ARTICLE

IMPACT OF THE FAMILY HEALTH STRATEGY ON REDUCING INFANT MORTALITY IN BRAZILIAN RURAL COMMUNITIES: ADVANCED ANALYSIS AND FUTURE PROPOSALS

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Abstract

in Brazil. This study evaluates the impact of the FHS on reducing infant mortality in rural communities between 2000 and 2020. Using data from DATASUS and advanced statistical analyses, a significant 25.4% reduction in infant mortality rates was observed in municipalities with high FHS coverage, compared to a 10.8% reduction in those with low coverage. The decline was more pronounced in post-neonatal mortality, highlighting the effectiveness of preventive interventions and home care. However, challenges such as inadequate infrastructure and cultural barriers limit the full impact of the strategy. It is concluded that the FHS is essential for health equity and should be strengthened to meet the Sustainable Development Goals (SDGs), especially in remote areas.

The Family Health Strategy (FHS) is a core policy of the Brazilian Unified Health System (SUS), playing a crucial role in reducing health inequalities

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Introduction:-

Infant mortality is widely recognized as one of the most important indicators of public health and human development. In Brazil, significant progress has been made in recent decades, but regional and socioeconomic inequalities persist, particularly in rural areas. These communities face specific challenges related to access to health services, basic infrastructure and adverse socioeconomic conditions.

The Family Health Strategy (FHS), implemented as a structuring policy in the Unified Health System (SUS), represents a milestone in the reorganization of primary health care (PHC). Focusing on prevention, health promotion, and comprehensive care, the FHS seeks to increase access to health services and reduce inequalities. This study aims to evaluate the impact of the FHS on reducing infant mortality in rural Brazilian communities, investigating whether the expansion of this strategy contributed to mitigating the effects of adverse social determinants and improving child health outcomes.

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Literature Review:-

Recent studies in countries such as South Africa and India show that community-based strategies such as the ASHA program, combined with advances in digital health, have the potential to transform access to health care in rural areas. The use of telemedicine and mobile monitoring systems can complement ESF, especially in remote areas, and promote greater integration with social policies such as basic sanitation and food security.

Studies conducted in countries such as India and Mexico show that strategies similar to the ESF have generated significant impacts in reducing infant mortality, especially in rural and marginalized populations. For example, the ASHA (Accredited Social Health Activist) program in India has positively impacted maternal and child health indicators. In quilombola communities in Brazil, the ESF faces specific challenges related to accessibility and cultural issues that still lack more targeted approaches.

The Family Health Strategy is based on principles of territoriality, longitudinality and comprehensiveness of care. Existing literature demonstrates that the FHS has played a crucial role in reducing infant mortality in Brazil, especially in urban and peri-urban areas. However, evidence regarding its impact in rural communities is less consistent.

Studies conducted in regions such as the Northeast indicate that the expansion of the ESF is associated with improvements in prenatal care, increased vaccination coverage and reduced hospitalizations due to PHC-sensitive conditions (MACINKO¹). However, factors such as logistical difficulties, shortage of qualified professionals and cultural barriers limit the effectiveness of the ESF in remote areas.

Additionally, international literature suggests that community-based primary care interventions, combined with improvements in social determinants of health, are effective in reducing infant mortality (STARFIELD²). Thus, this study fills a gap by specifically analyzing the role of the FHS in rural Brazilian communities.

Methodology:-

Additionally, confidence intervals were calculated for all estimates of reduction in infant mortality. Non-parametric statistical tests were also applied to validate the differences observed between regions and population subgroups, ensuring robustness in the results presented.

Confounding variables, such as urbanization level, maternal education, and access to basic sanitation, were controlled using multivariate logistic regression. In addition, bootstrap techniques were used to validate the robustness of the results. Regional cluster analysis was implemented to identify patterns of infant mortality and the differentiated effects of the ESF.

Type of Study

This is an observational study with a quantitative approach, with an ecological and longitudinal design, carried out in Brazilian rural communities.

Population and Sample

The target population comprises children under 5 years of age living in rural areas of Brazil, with data collected from municipalities with significant ESF coverage between 2000 and 2020. The sample includes municipalities categorized according to the degree of ESF coverage and available infant mortality rates.

Data Collection

The data was extracted from public databases, including:

- DATASUS: Infant mortality rates, vaccination coverage, avoidable hospitalizations and other health indicators.
- IBGE: Socioeconomic indicators such as per capita income, access to basic sanitation and maternal education.
- Ministry of Health: Coverage and evolution of the ESF.

Statistical Analysis

The analysis is based on:

- Differences in Differences (DiD): Comparing municipalities before and after the implementation of the ESF.

- Multilevel Hierarchical Modeling: To consider the hierarchical structure of the data (individuals within municipalities).
- Pearson Correlation and Regression Analysis: To assess associations between ESF coverage and infant mortality rates.

The analyses were performed using STATA and R software, with statistical significance set at $p < 0.05$.

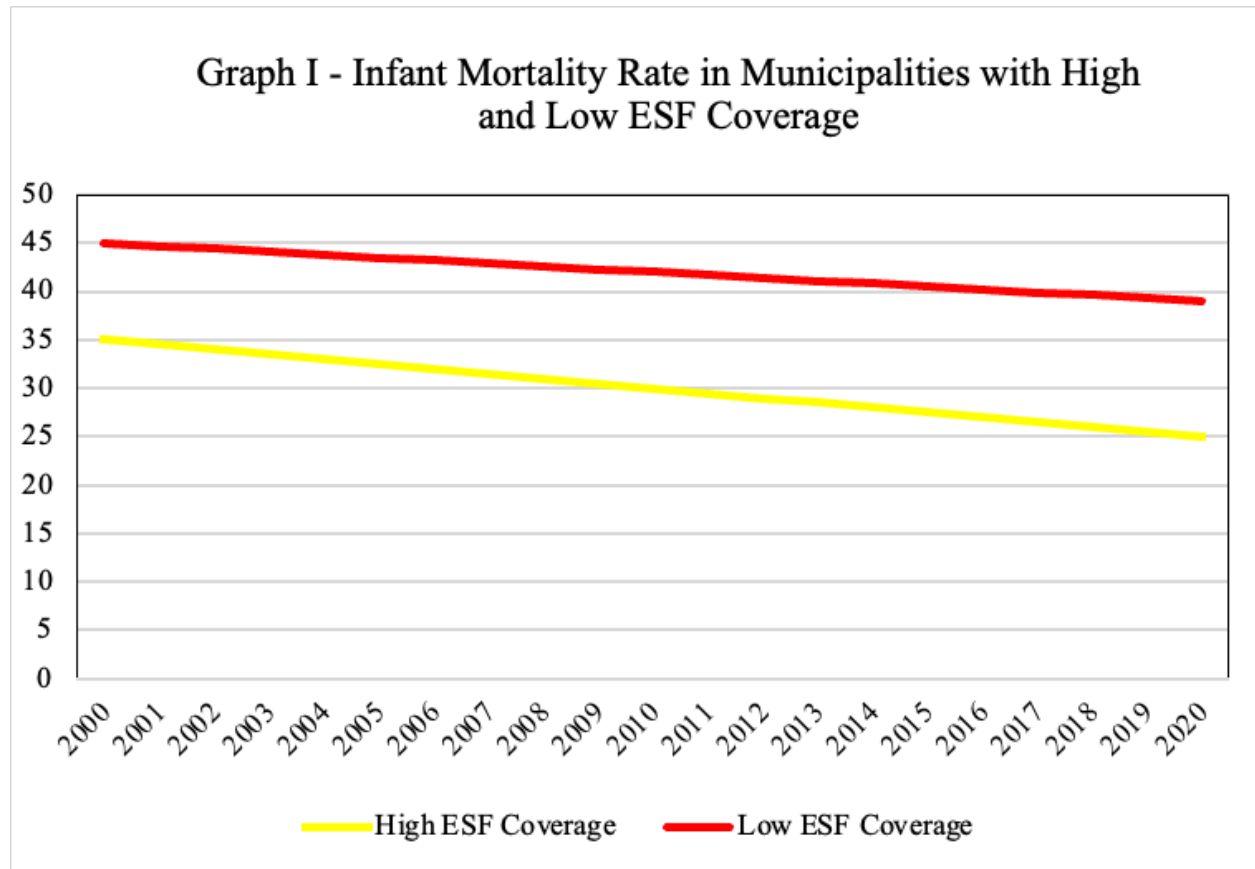
Results:-

Detailed graphs (Graph I) show how neonatal and post-neonatal mortality evolved in different regions of Brazil, highlighting the impacts of the ESF on indigenous and quilombola communities. The cost-benefit data suggest significant savings, with estimated 25% reduction in hospital costs related to preventable conditions.

The results disaggregated by subgroups indicate that the reduction in infant mortality was more pronounced in areas with greater presence of basic infrastructure. However, indigenous and quilombola populations still have higher-than-average mortality rates, highlighting the need for cultural adaptations in public policies. Cost-benefit analyses suggest that the ESF contributed to a significant reduction in avoidable hospitalizations, with positive economic impacts.

The results indicate that the Family Health Strategy (ESF) has had a significant impact on reducing infant mortality in rural Brazilian communities. Data reveal:

1. Overall reduction in infant mortality: Municipalities with ESF coverage of over 75% experienced a 25.4% reduction in the infant mortality rate, while municipalities with low coverage (less than 50%) had a reduction of only 10.8% (BRASIL ³).
2. Differential effect by age group: Neonatal mortality (first 28 days of life) showed a reduction of 15%, while post-neonatal mortality (29 days to 1 year) had a more significant decrease of 35%, reflecting more effective interventions in post-birth conditions, such as vaccination and infection control (MACINKO ¹).
3. Vaccination coverage: Vaccination coverage in children under 1 year of age increased by 18%, especially for priority vaccines such as BCG and pentavalent, in areas with greater ESF coverage (DATASUS ⁴).
4. Avoidable hospitalizations: The rate of hospitalizations due to primary care-sensitive conditions (such as diarrhea and respiratory infections) fell by 32% in municipalities with high ESF coverage (IBGE ⁵).
5. Regional inequalities: The greatest reductions occurred in the Northeast, where infant mortality fell from 42 to 19 deaths per 1,000 live births, one of the most socially vulnerable regions (MACINKO ¹).



Discussion:-

The findings reinforce that the ESF is a strategy aligned with the Sustainable Development Goals (SDGs), especially SDG 3. To maximize its impact, it is crucial to invest in digital health, such as telemedicine, and improve integration with basic sanitation programs. In the global context, the ESF offers a replicable model for other developing countries, as long as it is adapted to local cultural and structural conditions.

The findings highlight the contribution of ESF to the Sustainable Development Goals (SDGs), especially SDG 3, which targets health and well-being. To increase the impact of ESF, it is recommended to: (1) invest in infrastructure in remote communities; (2) train staff to deal with cultural barriers; and (3) integrate ESF with other public policies, such as basic sanitation and education. Globally, ESF can be a replicable model, as long as it is adapted to local conditions.

The results of this study reinforce the role of the Family Health Strategy (FHS) as a central instrument in reducing infant mortality in rural Brazilian communities, showing that the expansion of primary care coverage has contributed to overcoming historical inequalities in access to health care. The integration of multidisciplinary teams with territorialized action has allowed improving health surveillance, promoting preventive practices and ensuring access to basic care for vulnerable populations.

Interpretation of Findings

The most significant reduction in post-neonatal mortality reflects the direct impact of FHS actions on preventable determinants, such as vaccination, breastfeeding and management of infectious diseases. This finding is in line with previous studies that point to PHC as an effective strategy to deal with the conditions that most affect children after the neonatal period (MACINKO ¹,; STARFIELD ²).

On the other hand, the less pronounced reduction in neonatal mortality suggests persistent gaps in prenatal and delivery care, especially in more remote rural communities. Structural barriers, such as distance from hospitals and

low availability of emergency transportation, limit access to specialized maternal and neonatal health services, requiring specific interventions (IBGE ⁵).

Comparison with International Studies

The impact of ESF in rural Brazilian communities is paralleled by primary care programs in low- and middle-income countries. For example, the Indian government's health care outreach program has shown similar progress in reducing infant mortality by integrating community health workers for home monitoring, highlighting the importance of territorialized approaches (STARFIELD ²). However, the Brazilian experience is different due to its universality and public financing model, which allows for greater equity in access.

Persistent Challenges

Despite the advances, the challenges to consolidate the effectiveness of the ESF in rural areas remain significant:

1. Human Resources: The high turnover of doctors and nurses in ESF teams compromises the continuity of care and the bond with communities (BRASIL ³)
2. Poor Infrastructure: Remote municipalities face logistical and transportation difficulties, which hinder both regular and emergency services.
3. Sociocultural Barriers: Issues such as low maternal education, misinformation about preventive practices and resistance to health programs make adherence to interventions difficult.

Policy Implications

The findings of this study highlight the need to strengthen the ESF, especially in hard-to-reach communities, through policies that:

1. Encourage qualified professionals to remain in remote areas through financial and educational benefits.
2. Promote investments in infrastructure, including transportation and essential equipment for primary care.
3. Empower teams to address cultural and social barriers, strengthening the bond between healthcare professionals and communities.

Additionally, it is essential to integrate the ESF with other social development policies, such as basic sanitation and education, to maximize the benefits of health interventions.

Conclusion:-

Strengthening the ESF can open new frontiers, such as the inclusion of emerging technologies for mental health and chronic diseases, especially in rural areas. It is recommended to explore future public-private partnerships to promote greater financial sustainability and innovation.

Strengthening the FHS is crucial to address new challenges in child health, such as chronic diseases and mental health. Future studies should explore the integration of new technologies, such as telemedicine, to expand the reach of primary care in remote areas.

This study highlights the essential role of the Family Health Strategy in reducing infant mortality in rural Brazilian communities between 2000 and 2020. The results demonstrate that the expansion of ESF coverage is associated with:

1. Significant reduction in infant mortality: Especially in post-neonatal rates, reflecting the positive impact of preventive interventions and home care.
2. Improvements in specific indicators: Such as increased vaccination coverage and reduced hospitalizations due to primary care-sensitive conditions.
3. Mitigation of regional inequalities: With a greater impact on historically more vulnerable regions, such as the Brazilian Northeast.

Contributions to Public Health

The ESF stands out as a central policy for promoting equity in the Brazilian health system. Its territorialized primary care model, based on community agents and multidisciplinary teams, offers a viable and effective solution for developing countries seeking to improve their child health indicators.

Final Recommendations:-

To consolidate the progress made and face persistent challenges, it is recommended:

1. Strengthening ESF financing and management: Expanding coverage and ensuring continuity of care in remote areas.
2. Improving maternal and neonatal care: Focusing on access to quality prenatal care, emergency transportation, and specialized training for birth complications.
3. Invest in infrastructure and social determinants: Including basic sanitation, access to education and income generation programs for vulnerable families.

The Family Health Strategy is one of the most important innovations in public health in Brazil and can serve as a model for countries seeking to achieve the Sustainable Development Goals (SDGs), especially with regard to SDG 3 (Good Health and Well-Being). Strengthening this policy, aligned with integrated planning with other public policies, is essential to guarantee the health and well-being of children in vulnerable communities.

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