

# Analysis of the Follow-up and Diagnosis of Pregnant Women and Newborns with Suspected Zika Virus Infection in Espírito Santo, Brazil: Strengths and Areas for Improvement in Future Epidemics

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## Abstract

Zika virus (ZIKV) infection gained prominence in 2015 following a marked increase in cases of microcephaly and other congenital abnormalities among newborns of women infected during pregnancy, ultimately leading to the recognition of Congenital Zika Syndrome (CZS). This longitudinal descriptive study aimed to analyze changes in epidemiological surveillance, diagnostic methods, and the classification of suspected CZS cases in the state of Espírito Santo, Brazil, using data from the unified RESP-Microcephaly/DATA-SUS database from 2015 to 2024. Case incidence and temporal trends were analyzed, as well as associations between maternal infection, vertical transmission, clinical manifestations, diagnostic methods, and neonatal outcomes, using chi-square tests, odds ratios (OR), and binomial logistic regression. A total of 851 suspected cases of ZIKV infection during pregnancy were analyzed, according to data availability for each variable. The number of investigated cases peaked in 2016, followed by a progressive decline in notifications in subsequent years. Newborns of mothers with confirmed ZIKV infection had higher odds of CZS confirmation (OR = 5.1; 95% CI: 2.28–11.4; \* $p < 0.001$ ), supporting the occurrence of vertical transmission. Maternal clinical manifestations were significantly associated with confirmed infection, whereas the clinical characteristics evaluated in newborns were not. Among newborns, only IgM serology and PCR were significantly associated with diagnosis, although these were the least frequently used tests, whereas imaging examinations, which were more commonly performed, showed no significant

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association with case confirmation. In addition, maternal signs and symptoms showed greater diagnostic discrimination than the clinical characteristics assessed in newborns. These findings suggest limitations in the diagnostic strategy adopted for newborns and a possible underestimation of infection incidence, highlighting the need to strengthen prenatal follow-up, expand access to more informative laboratory diagnostic methods, and improve epidemiological investigation, thereby contributing to more effective responses to future epidemics.

**KEYWORDS:** Zika virus; Vertical transmission; Epidemiology; Espírito Santo.

## Introduction

The emergence of Zika virus (ZIKV) in Brazil in 2015 and the subsequent establishment of a causal relationship between infection and severe neurological abnormalities resulted in an unprecedented public health emergency and ultimately led to the recognition of Congenital Zika Syndrome (CZS). Given the dynamic nature of the epidemic, epidemiological surveillance systems required continuous improvement as scientific knowledge advanced, with successive updates to guidelines and case definitions aimed at increasing the specificity of case notifications.

Initially recognized as an arboviral infection with a predominantly mild clinical course, ZIKV infection gained international attention following the identification of a marked increase in cases of microcephaly and other congenital abnormalities among newborns of mothers exposed to the virus during pregnancy. Epidemiological and pathological studies conducted during the Brazilian epidemic demonstrated a consistent association between congenital ZIKV infection and fetal neurological abnormalities, establishing CZS as a new clinical and epidemiological entity (FRANÇA *et al.*, 2016; MARTINES *et al.*, 2016).

In response to the rapid increase in suspected cases and the need for systematic monitoring of the epidemiological situation, the Brazilian Ministry of Health implemented specific surveillance strategies for CZS, including investigation protocols, diagnostic criteria, and the establishment of the Public Health Event Registry for Microcephaly (RESP-Microcephaly). This system became the main repository for reporting and monitoring suspected cases of microcephaly and other central nervous system abnormalities potentially associated with congenital ZIKV infection. In addition to diagnostic confirmation, surveillance activities included detailed clinical investigation, laboratory and imaging examinations, assessment of epidemiological links, and final case classification (MARINHO *et al.*, 2016).

The consolidation of RESP-Microcephaly enabled epidemiological studies addressing the spatial distribution, clinical profile, and temporal trends of CZS cases in Brazil. However, several authors have emphasized that data from this surveillance system should be interpreted with caution because of successive changes in case definitions, heterogeneity in the investigative capacity of healthcare services, and regional differences in the completeness of case notifications (ARAÚJO *et al.*, 2018; MARTELLI *et al.*, 2024).

Investigating changes in the surveillance of suspected CZS cases in the state of Espírito Santo may help identify temporal patterns in case reporting, the geographic distribution of records, and the consistency of final case classifications throughout the epidemic and post-epidemic periods. In addition to supporting assessments of surveillance system quality, this type of analysis may provide relevant evidence for health authorities and researchers regarding the strengths and limitations of RESP-Microcephaly as a source of epidemiological data, particularly for retrospective studies of congenital ZIKV infection.

Therefore, this study aimed to analyze changes in the surveillance and classification of suspected CZS cases in Espírito Santo using the unified RESP-Microcephaly database from 2015 to 2024. We hypothesized that the main clinical manifestations associated with ZIKV infection would be significantly associated with confirmed diagnoses and that newborns of infected mothers would have a higher likelihood of CZS confirmation, supporting the occurrence of vertical transmission.

## Methods

A longitudinal descriptive study was conducted using publicly available secondary data from individual records compiled into annual RESP-Microcephaly/DATASUS datasets. The study included suspected cases of Congenital Zika Syndrome (CZS) reported in the state of Espírito Santo, Brazil, between 2015 and 2024 (SINAN – Brazilian Ministry of Health), comprising a total of 851 investigated cases.

The incidence of confirmed cases relative to both the total population and the number of tests performed in each municipality of Espírito Santo was calculated, and municipalities with the highest proportional incidence were represented using bar charts. In addition, temporal trends in investigated and confirmed cases of maternal infection, as well as confirmed cases among newborns, were presented using line graphs according to the notification years included in the study.

Associations between categorical variables were assessed using contingency tables, chi-square tests, and odds ratios (ORs) with their respective 95% confidence intervals (95% CIs). These analyses were used to investigate the association between confirmed maternal infection and infection in the newborn as an indicator of vertical transmission. In addition, the

effect of gestational age at the time of maternal infection diagnosis on the occurrence of infection in the newborn was evaluated using binary logistic regression.

Signs and symptoms recorded in the RESP-Microcephaly/DATASUS dataset for suspected CZS cases in Espírito Santo and classically associated with maternal ZIKV infection were also evaluated in relation to confirmed infection. These included fever, rash, pruritus, conjunctivitis, arthralgia, myalgia, edema, headache, lymphadenopathy, and neurological abnormalities. Among newborns, associations between confirmed infection and the presence of microcephaly, visual impairment, hearing impairment, and neurological impairment were assessed.

Regarding diagnostic methods used in pregnant women, the results of IgG and IgM serology, IgG and IgM rapid tests, and molecular detection of viral RNA were evaluated, as well as their associations with confirmed maternal infection using contingency tables, chi-square tests, ORs, and 95% CIs. The same analytical approach was used to investigate the associations between diagnostic methods applied to newborns and infection confirmation, including IgM serology, polymerase chain reaction (PCR), prenatal ultrasonography, nuchal translucency assessment, computed tomography (CT), and magnetic resonance imaging (MRI).

A significance level of 5% ( $p = 0.05$ ) was adopted for all statistical analyses. Data processing and statistical analyses were performed using Jamovi. Because this study was based exclusively on publicly available secondary data with no personally identifiable information, ethics committee review was not required, in accordance with Resolution No. 510/2016 of the Brazilian National Health Council.

## Results

Between 2015 and 2024, 851 suspected cases of Congenital Zika Syndrome (CZS) were investigated in Espírito Santo, as recorded in RESP-Microcephaly. The municipalities with the highest absolute numbers of confirmed cases were Vila Velha, Cariacica, Vitória, Serra, and Guarapari. These municipalities were also among those with the highest numbers of diagnostic tests performed, together with Linhares, where more tests were conducted than in Guarapari (**Figure 1**). In contrast, the municipalities with the highest infection rates relative to their total populations were São José da Calçada, Baixo Guandu, Rio Bananal, Afonso Cláudio, and Aracruz. Despite the low absolute numbers of tests performed, these municipalities tested a larger proportion of their populations (**Figure 2**).

**Figure 1.** Highest absolute numbers of tests performed and confirmed Zika virus infection cases in municipalities of Espírito Santo, Brazil, between 2015 and 2024.

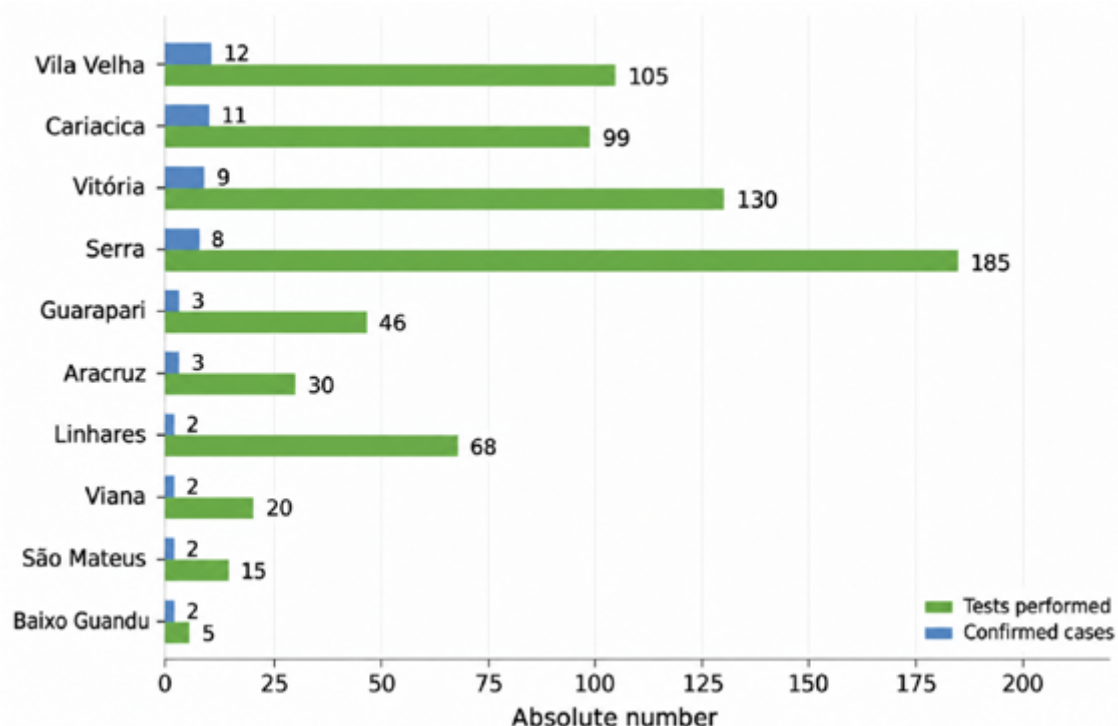
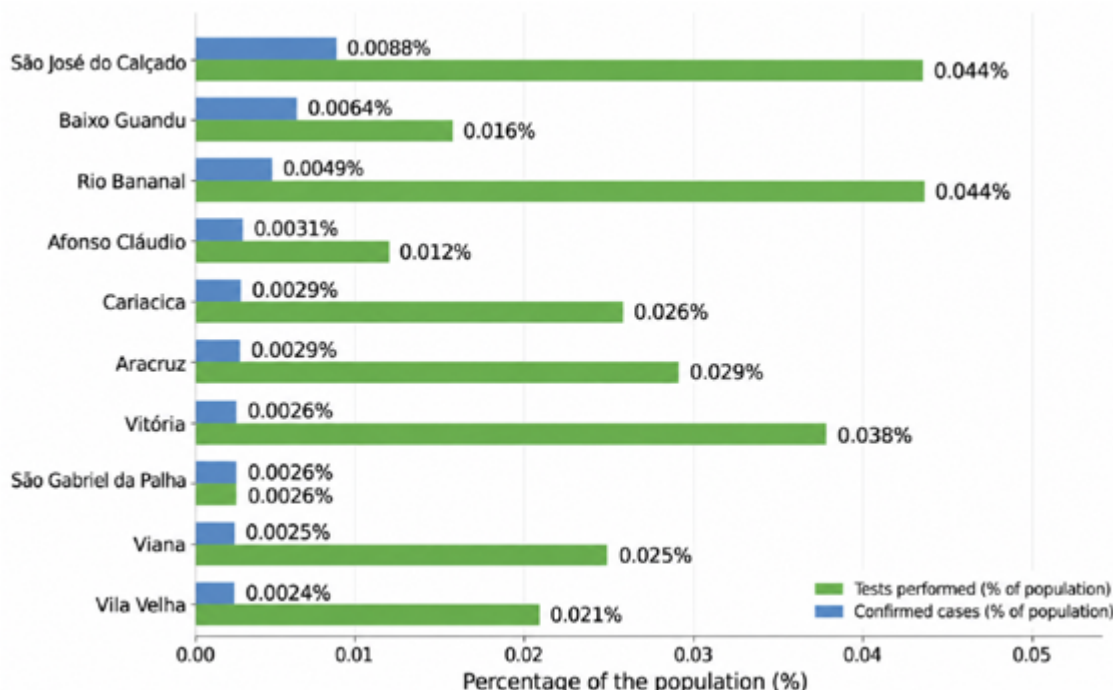


**Figure 2.** Highest percentages of tests performed and confirmed Zika virus infection cases relative to the total population of each municipality in Espírito Santo, Brazil, between 2015 and 2024.



The temporal distribution showed an epidemic pattern, with the number of investigated cases peaking in 2016 (236 cases), followed by a progressive decline in subsequent years. The number of mothers with confirmed infection followed a similar pattern to the number of cases investigated, also peaking in 2016 ( $n = 25$ ) and progressively decreasing to near-zero levels by 2024 in Espírito Santo. In contrast, the number of confirmed cases among newborns did not follow the same temporal pattern. Peaks occurred later than those observed among mothers, in 2020 ( $n = 11$ ) and 2022 ( $n = 8$ ) (**Figure 3**).

A statistically significant association was observed between confirmed maternal ZIKV infection and confirmed CZS in newborns ( $\chi^2 = 19$ ;  $p < 0.001$ ;  $N = 851$ ) (**Table 1**). Among mothers with confirmed ZIKV infection ( $n = 59$ ), 9 (15.3%) had newborns with confirmed CZS, whereas among mothers with a negative result ( $n = 792$ ), only 27 (3.4%) had newborns with confir-

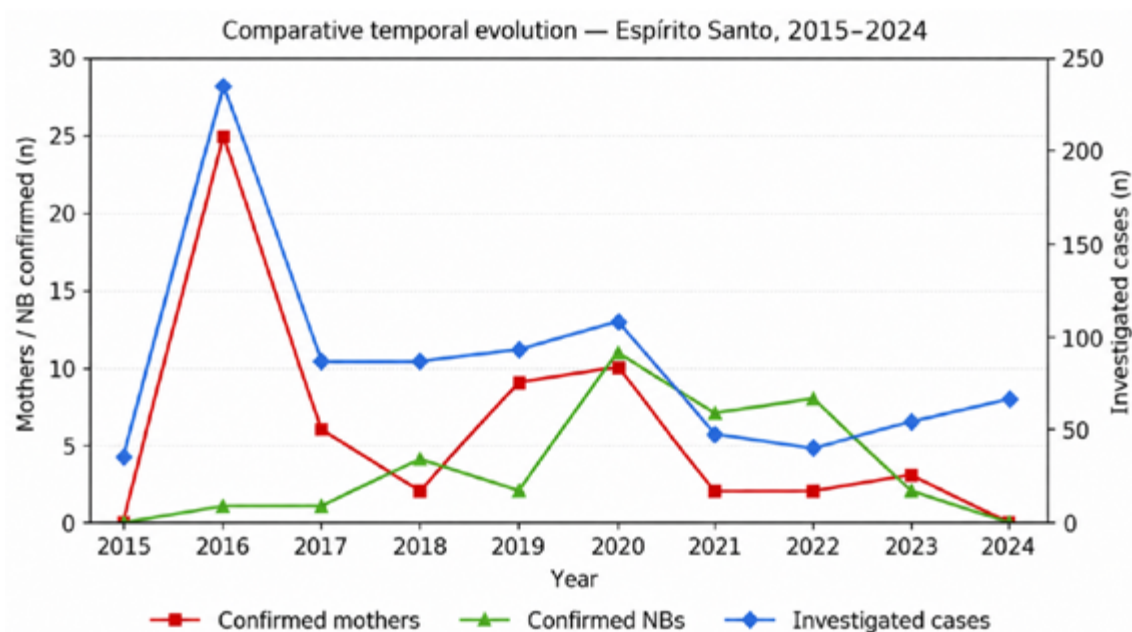
med CZS. The OR was 5.1 (95% CI: 2.28–11.4), indicating that newborns of mothers with confirmed ZIKV infection had approximately fivefold higher odds of CZS confirmation.

**Table 1.** Contingency table of maternal and newborn (NB) CZS diagnoses.

| Maternal diagnoses | NB negative | NB positive | Total |
|--------------------|-------------|-------------|-------|
| Negative           | 765         | 27          | 792   |
| Positive           | 50          | 9           | 59    |
| Total              | 815         | 36          | 851   |

$$\chi^2 = 19; df = 1; p < 0,001; N = 851. Odds ratio = 5,1 (IC 95\%: 2,28-11,4).$$

**Figure 3.** Comparative temporal trends in investigated cases, mothers with confirmed ZIKV infection, and newborns (NBs) with confirmed Congenital Zika Syndrome in Espírito Santo, Brazil, between 2015 and 2024.



Binary logistic regression was performed to assess the predictive effect of gestational age at the time of confirmed maternal infection on the likelihood of CZS confirmation in the newborn (**Table 2**). The model showed very limited fit (Deviance = 231; AIC = 235; McFadden's  $R^2 = 0.00384$ ). The estimated coefficient for gestational age at maternal diagno-

sis was 0.0238 (SE = 0.0252; Z = 0.947;  $p = 0.344$ ) and was not statistically significant. Thus, gestational age at the time of maternal diagnosis, when considered independently, was not a significant predictor of CZS confirmation in the newborn.

**Table 2.** Binary logistic regression assessing gestational age at maternal diagnosis as a predictor of confirmed CZS in the newborn.

| Predictor                 | Estimate | SE     | Z      | p       |
|---------------------------|----------|--------|--------|---------|
| Intercept                 | -3.8342  | 0.7865 | -4.875 | < 0.001 |
| Age at maternal diagnosis | 0.0238   | 0.0252 | 0.947  | 0.344   |

Model adjustment: Deviance = 231; AIC = 235;  $R^2McF = 0.00384$ . Estimates as log odds of NB positive vs. negative. N = 851.

Of the ten maternal symptoms evaluated, nine were significantly associated with confirmed ZIKV infection; neurological abnormalities were the only exception ( $\chi^2 = 0.375$ ;  $p = 0.54$ ). Based on effect size, as measured by the odds ratio, the symptoms most strongly associated with confirmed infection were lymphadenopathy (OR = 40.6), edema (OR = 13.9), fever during pregnancy and myalgia (OR = 9.85 each), and conjunctivitis (OR = 9.23). In terms of statistical evidence, as indicated by the chi-square statistic, the strongest associations were observed for fever during pregnancy ( $\chi^2 = 67.1$ ), myalgia ( $\chi^2 = 44.7$ ), headache ( $\chi^2 = 38.1$ ), and rash during pregnancy ( $\chi^2 = 32.4$ ). These two criteria did not fully coincide because they reflect different aspects of the association: effect size and strength of statistical evidence, respectively, although both consistently identified symptoms associated with confirmed maternal infection (**Figure 4**). In contrast, confirmed CZS in newborns was not significantly associated with any of the evaluated clinical characteristics, including microcephaly, neurological impairment, hearing impairment, or visual impairment ( $p > 0.05$ ) (**Figure 5**).

**Figure 4.** Association between maternal symptoms and confirmed Zika virus infection, expressed as the natural logarithm of the odds ratio [ln(OR)] and 95% confidence intervals.

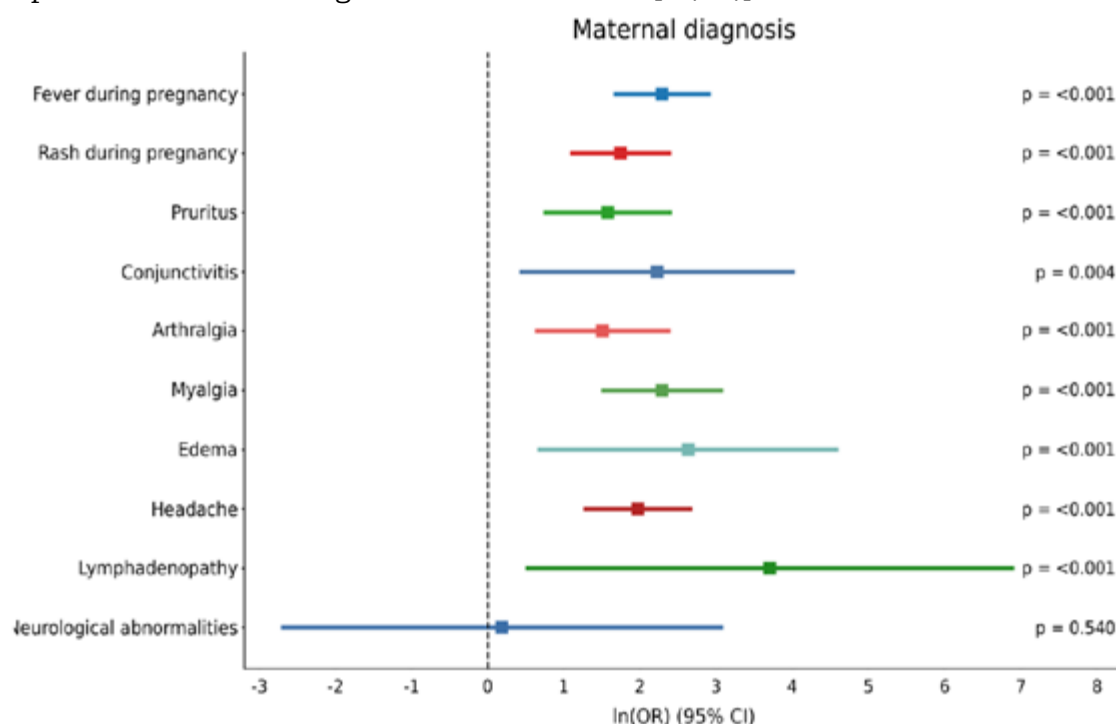
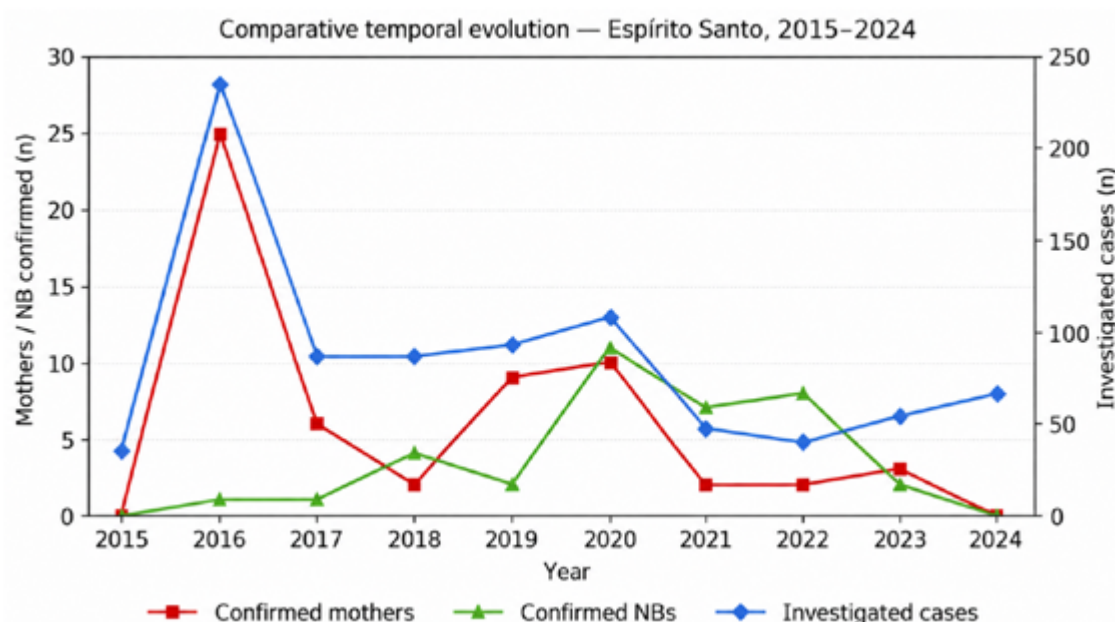


**Figure 5.** Association between clinical manifestations in newborns and confirmed Zika virus infection, expressed as odds ratios (ORs).



Diagnostic tests showed distinct patterns between mothers and newborns (**Tables 3 and 4**). Among mothers, all five tests evaluated—IgG serology, IgM serology, IgG rapid test, IgM rapid test, and PCR—were significantly associated with confirmed ZIKV infection ( $p < 0.001$  for all tests). These tests were performed in similar numbers of suspected maternal ZIKV cases, ranging from 340 to 359 tests (**Table 3**). Among newborns, only IgM serology ( $\chi^2 = 31$ ;  $p < 0.001$ ) and PCR ( $\chi^2 = 9.87$ ;  $p = 0.002$ ) were significantly associated with confirmed CZS. Imaging examinations, including ultrasonography, fetal nuchal translucency assessment, computed tomography (CT), and magnetic resonance imaging (MRI), showed no statistically significant association with case confirmation ( $p \geq 0.05$  for all) (**Table 4**).

Paradoxically, IgM serology and PCR, the most informative diagnostic tests in newborns, were also the least frequently used in this population, with 226 and 260 newborns tested, respectively. In contrast, imaging examinations, which showed no significant association with diagnostic confirmation, were the most frequently performed, with 433 to 474 newborns undergoing these assessments. This pattern differed from that observed among mothers, in whom the most informative tests were used at frequencies comparable to those of the other diagnostic methods throughout the study period (**Tables 3 and 4**).

**Table 3.** Maternal diagnostic tests associated with confirmed Zika virus infection.

| Test            | N tested | N positive | $\chi^2$ | p       |
|-----------------|----------|------------|----------|---------|
| IgG serology    | 351      | 18         | 189      | < 0.001 |
| IgM serology    | 357      | 19         | 204      | < 0.001 |
| IgG rapid test  | 345      | 2          | 21.9     | < 0.001 |
| IgM rapid test  | 340      | 2          | 24.3     | < 0.001 |
| PCR (viral RNA) | 359      | 8          | 80.8     | < 0.001 |

*N tested = Number of mothers with available test results; N positive = number of mothers with a positive test result.*

**Table 4.** Diagnostic tests in newborns (NBs) associated with confirmed Zika virus infection.

| Test                             | N tested | N positive | $\chi^2$ | p       |
|----------------------------------|----------|------------|----------|---------|
| IgM serology                     | 226      | 5          | 31       | < 0.001 |
| PCR (viral RNA detection)        | 260      | 1          | 9.87     | 0.002   |
| Ultrasonography                  | 447      | 167        | 0.849    | 0.357   |
| Fetal nuchal translucency        | 474      | 131        | 0.00959  | 0.922   |
| Computed tomography (CT)         | 466      | 29         | 0.0805   | 0.777   |
| Magnetic resonance imaging (MRI) | 433      | 2          | 0.0821   | 0.774   |

*N tested = number of newborns with available test results; N positive = number of newborns with a positive test result. IgM serology and PCR, the tests most strongly associated with diagnostic confirmation, had the lowest N tested among newborns.*

## Discussion

Of the two hypotheses proposed in this study, the hypothesis that the main clinical manifestations associated with the disease would be significantly associated with confirmed diagnoses was only partially supported by our data, as this pattern was observed among mothers with suspected ZIKV infection but not among newborns. In contrast, the hypothesis that newborns of infected mothers would have a greater likelihood of a positive diagnosis was supported by the patterns described here, highlighting the importance of vertical transmission in congenital ZIKV infection.

The municipalities with the highest infection rates relative to their total populations indicate that areas farther from the main political and economic centers of the state were more vulnerable to ZIKV infection, despite not necessarily presenting the highest testing volumes. This pattern suggests underascertainment of the overall number of infections, since greater testing efforts in areas with higher infection rates would be expected to identify additional cases. Municipalities with more limited

healthcare infrastructure tend to be more vulnerable to the effects of epidemics and pandemics and may also experience greater underreporting of cases (ARAÚJO & FERREIRA, 2024; PAIXÃO *et al.*, 2021). A descriptive study of the SINAN, SINASC, and RESP-Microcephaly surveillance systems covering the period from 2016 to 2023 found that only 25.32% of pregnant women reported with suspected infection underwent laboratory investigation and that only 13.67% of confirmed cases were confirmed based on laboratory criteria (PEREIRA *et al.*, 2025). Similarly, a nationwide cohort study based on RESP-Microcephaly that followed 11,850 suspected CZS cases between 2015 and 2018 found that only 28.3% were ultimately confirmed, whereas 9.3% remained inconclusive and 62.4% were never confirmed (PAIXÃO *et al.*, 2022). Therefore, broader and more effective testing could provide a more accurate representation of disease distribution, which is essential for appropriate public health decision-making during epidemic events.

In the present study, the temporal variation in confirmed maternal cases followed the overall pattern of diagnostic testing. This may be explained by the relatively frequent use of tests that were more strongly associated with final diagnostic confirmation, including IgG and IgM serology, IgG and IgM rapid tests, and viral RNA detection by PCR. In contrast, this relationship between confirmed cases and testing effort was not observed among newborns. This may be partly explained by differences in the diagnostic performance and use of the methods applied in this group, including IgM serology, viral RNA detection by PCR, ultrasonography, fetal nuchal translucency assessment, computed tomography, and magnetic resonance imaging. IgG serology in newborns, in particular, may produce misleading positive results because maternally derived IgG antibodies can cross the placenta and be detected in the newborn (SINGH *et al.*, 2019).

Cohort studies have shown that, even when congenital ZIKV infection is clinically suspected, laboratory confirmation in newborns is particularly challenging, with a substantial proportion of cases remaining classified only as “possible” because of limitations related to the viral detection window and serological cross-reactivity (MULKEY *et al.*, 2023). Moreover, the complexity of and low adherence to postnatal follow-up protocols, which require multiple specialized assessments, represent practical barriers that may contribute to the underdetection of both infection and associated sequelae in newborns. This supports the hypothesis that limited diagnostic investigation in this population is a recurring pattern across different healthcare settings (CDC, 2024).

In addition, our results reinforce that maternal clinical manifestations were more strongly associated with confirmed ZIKV infection than the clinical manifestations observed in newborns were with confirmed CZS. This finding suggests that, during the epidemic period, epidemiological surveillance was more effective in identifying and confirming ZIKV infection among pregnant women than CZS among newborns during the neonatal period. This difference may be largely related to the inherent difficulties in diagnosing congenital infection. The short viral detection window and the possibility of absent or subtle clinical manifestations at birth may reduce diagnostic sensitivity and hinder case confirmation (MOORE *et al.*, 2017; ADEBANJO *et al.*, 2017).

Similar findings were reported by PACHECO *et al.* (2016) in a study conducted in Colombia, in which a large number of pregnant women with suspected ZIKV infection were identified, whereas infection was confirmed in a smaller proportion of newborns. The authors attributed this pattern to the short period during which laboratory tests remain positive and to the variability of clinical manifestations of congenital infection, both of which complicate diagnostic confirmation during the neonatal period.

Confirmation of suspected cases should therefore consider the combination of the child's clinical findings, maternal epidemiological and obstetric history, laboratory test results, and imaging findings, as recommended by CZS surveillance protocols (ADEBANJO *et al.*, 2017). Such an integrated approach may improve case classification and generate more reliable epidemiological information, which is essential for disease surveillance and for planning healthcare and public health interventions.

The findings of the present study showed that newborns of mothers with confirmed ZIKV infection had greater odds of confirmed infection, supporting vertical transmission as the primary route of congenital ZIKV infection. The causal basis of this route is supported by the detection of viral RNA and antigens in amniotic fluid, placental tissue, and brain tissue from affected newborns and fetuses, demonstrating the ability of ZIKV to cross the placental barrier and its marked neurotropism (NORONHA *et al.*, 2016; TEIXEIRA *et al.*, 2020).

The finding that this association was not related to gestational age at maternal diagnosis is also consistent with follow-up studies of pregnant women with laboratory-confirmed infection. A cohort of pregnant women presenting with rash in the metropolitan region of Belém, Pará, across different gestational ages identified laboratory-confirmed ZIKV infection by molecular and/or serological methods, indicating that maternal exposure to the virus is not restricted to a specific gestational window during pregnancy (OLIVEIRA *et al.*, 2016). This lack of a strict temporal restriction is also compatible with the mechanisms of transplacental transfer. In a cohort of pregnant women from Vitória, Espírito Santo, maternal-to-fetal IgG transfer occurred efficiently regardless of the gestational period in which maternal infection occurred (SINGH *et al.*, 2019). This finding is consistent with the hypothesis that the likelihood of vertical transmission

is not restricted to a specific stage of pregnancy but is instead related to the occurrence of maternal infection itself.

## Conclusions

The findings presented here suggest that more comprehensive and efficient surveillance, particularly in municipalities in the interior of Espírito Santo, could have revealed a higher incidence of ZIKV infection between 2015 and 2024, especially among pregnant women, for whom the diagnostic tests used showed strong associations with final case confirmation. In addition, our results reinforce the risk associated with vertical transmission during pregnancy, highlighting the importance of public health policies aimed at strengthening prenatal follow-up and improving family education and preventive measures to reduce the risk of maternal infection during future outbreaks.

## Author contributions

**Conceptualization:** AAL / AAM / ACBO / BHL / YDI / BFMC

**Data curation:** ACMPL / ACD

**Formal analysis:** CBR / ALGP

**Investigation:** CBR / ALGP

**Methodology:** ACMPL / ACD

**Validation:** ACMPL / ACD

**Visualization:** CBR / ALGP

**Writing – original draft:** AAL / AAM / ACBO / BHL / YDI / BFMC

**Writing – review and editing:** CMM / JFPW / MAGF

## Conflict of Interest

The authors declare no conflicts of interest related to this study. This work was conducted independently, without influence from institutions, organizations, or sponsors that could affect the results or the interpretation of the data presented.

## Data Availability

The authors declare that the data supporting the results of this study are available in the article. Derived data supporting the study's conclusions that are not found in the article may be requested from the corresponding author.

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## References

ADEBANJO, Titilope *et al.* Update: Interim Guidance for the Diagnosis, Evaluation, and Management of Infants with Possible Congenital Zika Virus Infection — United States, October 2017. Morbidity and Mortality Weekly Report (MMWR), Atlanta, v. 66, n. 41, p. 1089-1099, 2017. DOI: 10.15585/mmwr.mm6641a1.

ARAÚJO, J. M. D., & FERREIRA, M. A. M. (2024). State capacity impact on COVID-19 mortality in Brazil. *Cadernos de Saúde Pública*, 40, e00171523.

ARAÚJO, Tania Maria Varejão Barbosa de *et al.* Association between microcephaly, Zika virus infection, and other risk factors in Brazil: final report of a case-control study. *The Lancet Infectious Diseases*, Londres, v. 18, n. 3, p. 328-336, 2018. Disponível em: <https://www.sciencedirect.com/science/article/abs/pii/S1473309917307272>.

Associação Médica Brasileira (AMB) / Conselho Federal de Medicina (CFM). Zika Vírus e Gravidez. Disponível em: <https://amb.org.br/wp-content/uploads/2021/08/ZIKA-VIRUS-GRAVIDEZ-FINAL-2016.pdf>

Pereira, A. C. N., de Castro, P. H. M., Romeiro, R. V., de Aquino, A. C. O., Silveira, F. A., & Seixas, J. A. (2025). Avaliação da correlação entre casos de infecção pelo Zika vírus em gestantes e a síndrome congênita associada à infecção pelo vírus

Zika no Brasil. Revista Saber Digital, 18(3), e20251809-e20251809.

BRASIL. Ministério da Saúde. **Manual de Gestão de Alto Risco**. Brasília: Ministério da Saúde, 2022. (Série A. Normas e Manuais Técnicos).

BRASIL. Ministério da Saúde. **Protocolo de vigilância e resposta à ocorrência de microcefalia relacionada à infecção pelo vírus Zika**. Brasília: Ministério da Saúde, 2016.

CDC (Centers for Disease Control and Prevention). Pediatric Evaluation & Follow-up Tool for Infants with Possible Congenital Zika Virus Exposure. Atlanta: CDC, 2024.

FLEURY MEDICINA E SAÚDE. Diagnóstico de infecções na gestação. Disponível em: <https://www.fleury.com.br/medico/artigos-cientificos/diagnostico-de-infeccoes-na-gestacao>

FORTIN O, MULKEY SB. Neurodevelopmental outcomes in congenital and perinatal infections. Curr Opin Infect Dis. 2023 Oct 1;36(5):405-413. doi: 10.1097/QCO.0000000000000946. Epub 2023 Jul 19. PMID: 37466092; PMCID: PMC10530333.

FRANÇA, Giovanny Vinícius Araújo *et al.* Congenital Zika virus syndrome in Brazil: a case series of the first 1501 livebirths with complete investigation. The Lancet, Londres, v. 388, n. 10047, p. 891-897, 2016. Disponível em: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(16\)30902-3/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)30902-3/fulltext).

MARINHO, Fatima *et al.* Microcephaly in Brazil: prevalence and characterization of cases from the Information System on Live Births (Sinasc), 2000-2015. Epidemiologia e Serviços de Saúde, Brasília, v. 25, n. 4, p. 701-712, 2016. Disponível em: <https://www.scielo.br/j/ress/a/nwGLZsdg3K5Ff7Zxn4cwkYh/?format=html&lang=en>

MARTELLI, Celina Maria Turchi *et al.* Clinical spectrum of congenital Zika virus infection in Brazil. Revista da Sociedade Brasileira de Medicina Tropical, Uberaba, v. 57, e00931-2024, 2024. Disponível em: <https://www.scielo.br/j/rsbmt/a/t7gzpR-VmMb5h88f3DDHqfNK/?lang=en>

MARTINES, Rodrigo Barbosa *et al.* Pathology of congenital Zika syndrome in Brazil: a case series. The Lancet, Londres, v. 388, n. 10047, p. 898-904, 2016. Disponível em: <https://pubmed.ncbi.nlm.nih.gov/27372395/>

MOORE, Cynthia A. *et al.* Characterizing the Pattern of Anomalies in Congenital Zika Syndrome for Pediatric Clinicians. JAMA Pediatrics, Chicago, v. 171, n. 3, p. 288-295, 2017. DOI: 10.1001/jamapediatrics.2016.3982.

MULKEY, S. B. *et al.* Complexities of Zika Diagnosis and Evaluation in a U.S. Congenital Zika Program. *Journal of the Pediatric Infectious Diseases Society*, 2023.

MUSSO, Didier; KO, Albert I.; BAUD, David. Zika Virus Infection — After the Pandemic. *The New England Journal of Medicine*, Boston, v. 381, n. 15, p. 1444-1457, 2019. DOI: 10.1056/NEJMra1808246.

NORONHA L, ZANLUCA C, AZEVEDO MLV, LUZ KG, DUARTE DOS SANTOS CN. Zika virus damages the human placental barrier and presents marked fetal neurotropism. *Memórias do Instituto Oswaldo Cruz*, 2016. DOI: 10.1590/0074-02760160085. Disponível em: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4878297/>

OLIVEIRA CS, MATOS HJ, RAMOS FLP, PINTO AYN, ALMEIDA MPS, GUIMARÃES VPR, *et al.* Acompanhamento de gestantes com confirmação laboratorial de infecção pelo vírus Zika na região metropolitana de Belém, Estado do Pará, Brasil: dados preliminares. *Revista Pan-Amazônica de Saúde*, 2016;7(Esp). Disponível em: [http://scielo.iec.gov.br/scielo.php?script=sci\\_arttext&pid=S2176-62232016000500209](http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S2176-62232016000500209)

PACHECO, Oscar *et al.* Zika virus disease in Colombia: preliminary report. *The New England Journal of Medicine*, Boston, 2016. DOI: 10.1056/NEJMoa1604037.

PAIXÃO ES, RODRIGUES LC, COSTA MCN, *et al.* Population-based surveillance for congenital zika virus syndrome: a latent class analysis of recorded cases from 2015–2018. *BMC Pregnancy and Childbirth*, 2022. Disponível em: <https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-022-04860-3>

PAIXÃO, B., BARONI, L., PEDROSO, M., SALLES, R., ESCOBAR, L., DE SOUSA, C., ... & OGASAWARA, E. (2021). Estimation of COVID-19 under-reporting in the Brazilian states through SARI. *New Generation Computing*, 39(3), 623-645.

RANÇA *et al.* Síndrome congênita associada à infecção pelo vírus Zika em nascidos vivos no Brasil: descrição da distribuição dos casos notificados e confirmados em 2015-2016. **Epidemiologia e Serviços de Saúde**, Brasília, v. 27, n. 2, e2017473, 2018. Disponível em: <https://www.scielo.br/j/ress/a/nvpwC7jVqpBg6Y5Z4zRJwzd/?lang=pt>. Acesso em: 19 mai. 2026.

RODRIGUES, Fernanda Mariano Garcia de Souza. **Diversidade genética do Zika vírus no Estado do Espírito Santo**. 2018. 73 f. Dissertação (Mestrado em Biotecnologia) – Centro de Ciências da Saúde, Universidade Federal do Espírito Santo, Vitória, 2018. Disponível em: <https://repositorio.ufes.br/items/1203dda1-699d-49ae-a-c17-32cc44dba873>. Acesso em: 19 mai. 2026.

SINGH T, LOPEZ CA, GIUBERTI C, DENNIS ML, ITELL HL, HEIMSATH HJ, *et al.*

Efficient transplacental IgG transfer in women infected with Zika virus during pregnancy. *PLoS Neglected Tropical Diseases*, 2019;13(8):e0007648. DOI: 10.1371/journal.pntd.0007648. Disponível em: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6730934/>

TEIXEIRA GA, DANTAS DNA, CARVALHO GAF, SILVA AN, LIRA ALB, ENDERS BC. Análise do conceito síndrome congênita pelo Zika vírus. *Ciência & Saúde Coletiva*, 2020;25(2):567-574. DOI: 10.1590/1413-81232020252.30002017. Disponível em: <https://www.scielo.br/j/csc/a/Hw7b8hsPTbJncZkwWCmj8Cq/>

TEIXEIRA, MARIA GLÓRIA *et al.* Evidências da vigilância epidemiológica para o avanço do conhecimento sobre a epidemia pelo vírus Zika no Brasil. **Epidemiologia e Serviços de Saúde**, Brasília, v. 27, n. 4, e2018230, 2018. Disponível em: <https://www.scielo.br/j/ress/a/G3vDx8ZdX7VrzmFctRxG58p/?lang=pt>. Acesso em: 19 mai. 2026.

TEIXEIRA, MARIA GLÓRIA *et al.* Vigilância em Saúde no SUS: construção, efeitos e perspectivas. **Ciência & Saúde Coletiva**, Rio de Janeiro, v. 23, n. 6, p. 1811-1818, jun. 2018. Disponível em: <https://www.scielo.br/j/csc/a/FxcSJBQq8G7CNSxhTyT7Qb-n/?lang=pt>. Acesso em: 19 mai. 2026.

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