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Depressive Symptoms and Care Demands Among Primary Caregivers of Young Children with Evidence of Congenital Zika Virus Infection in Brazil

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Abstract

Objective—Evidence suggests that caring for a child with special health care needs can affect many domains of family life, including caregiver mental health. However, few studies have examined these outcomes among families impacted by the Zika virus (ZIKV). This study examines depressive symptom severity and care demands among primary caregivers of children, aged 15 to 26 months, with evidence of congenital Zika virus infection (ZVI).

Methods—A sample of primary caregivers of children with evidence of congenital ZVI in northeastern Brazil (n = 150) reported on depressive symptoms, care demands, and their children's development. Children were categorized into groups according to their developmental delay status. Bivariate analyses were run to test for differences between groups. A path analysis model was used to examine the indirect effects of developmental delay on depressive symptoms through economic challenges and time spent providing health care at home and whether these associations varied by child care support.

Results—Compared to primary caregivers of children without developmental delay, primary caregivers of children with developmental delay had higher depression scores ($p = 0.002$), reported more economic ($p < 0.001$) and child care ($p < 0.001$) challenges, and spent more time providing health care at home ($p < 0.001$). Among primary caregivers who did not have child care support, developmental delay had a significant indirect effect on depressive symptoms through economic challenges but not through time spent providing health care at home.

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Conclusion—For families impacted by the ZIKV outbreak in Brazil, economic and child care challenges may be associated with primary caregiver mental health.

Thousands of young children in Brazil are living with challenges linked to congenital Zika virus infection (ZVI) after the 2015 Zika virus (ZIKV) outbreak.[1] Some of these children face a number of serious co-occurring outcomes, such as microcephaly, seizures, severe motor impairment, and vision abnormalities,[2] while others present subtle or no early indications of delay.[3] Though the long-term consequences of congenital ZVI are still unknown, many of the affected children may require ongoing, specialized care, not only from clinicians but also from their primary caregivers.[2,5] Existing research suggests that caring for a child with special health care needs (CSHCN) can impact the health, economic, and social domains of family life.[6,7] However, there is limited information about how families are faring when children with congenital ZVI reach toddlerhood.[1] Understanding the effects of having a child with congenital ZVI on family life and, in particular, primary caregiver mental health can inform comprehensive, targeted supports and services for children affected by ZIKV and their families.

Parenting is a rewarding albeit demanding role that requires time, access to resources, and responsiveness to a child's individual needs.[8] Parents caring for CSHCN may face even greater demands, as their responsibilities often extend to providing specialized daily care at home and coordinating outside services and supports.[6] Qualitative studies have captured these parents' perspectives, in which they attribute declines in their own mental and physical health to playing multiple, labor-intensive roles, lacking time for other parts of their lives, and frequently worrying about their children.[6,7] Specifically, parents caring for CSHCN are more likely to have depressive symptoms and to meet criteria for clinically depressed mood than parents of typically developing children.[9,10]

However, the relationship between parental mental health and child health is likely bidirectional, as parental depression has been associated with negative parenting practices and risk for child behavior problems.[11,12] Therefore, prevention and treatment of parental depression could help in achieving optimal child health and development outcomes.

Although many studies describe the association between caring for CSHCN and parental depression,[9,10] family life is multifaceted, and other factors besides the child's special needs might attenuate or contribute to this relationship. One multidimensional model of caregiver health posits indirect and direct effects of factors on caregiver health, including socioeconomic status, caregiving demands, and social support.[13] Caregivers of CSHCN commonly report having financial difficulties, having to cut down on work hours or stop work completely to care for their child, and losing opportunities to engage in social and recreational activities.[6,14] The financial burden of having CSHCN has been associated with large out-of-pocket costs for medical care and transportation, particularly for children with more severe conditions.[14,15] Furthermore, this multidimensional model posits a relationship between socioeconomic status and psychological health.[13]

In contrast, social support can be a protective factor for caregiver mental health. Both instrumental (e.g., having help with child care) and emotional (e.g., having someone who

will listen to you) support can promote psychological well-being and quality of life among parents and family members caring for CSHCN.[16,17] For example, 1 study found that perceived availability of social support was inversely associated with parental depressive symptomology.[16]

Recent reports call for solutions that support families and address the social and economic impact of congenital ZVI.[4,5] Bailey and Ventura[4] suggest that family supports are critical given the severe and complex outcomes in ZVI affected children and related care needs, the uncertainty about long-term ZVI outcomes, the lack of specialized professional knowledge about the disease and its treatment, and the risk for social isolation and stigma. Further, the United Nations Development Programme reports that the ZIKV outbreak disproportionately affected the poorest communities and is expected to strain existing services and social protection systems as many low-income caregivers leave their jobs or formal education to care for their children and face growing care-related costs.[5]

Very limited outcomes data are available to inform strategies to better support families and children affected by ZVI. To date, few studies have reported on caregiver mental health in the context of the ZIKV outbreak. The available studies have been limited by small sample sizes and a specific focus on children with microcephaly.[18,19] A Brazilian study of 9 mothers of children aged 5 to 12 months with ZIKV-related microcephaly found that microcephaly was associated with high levels of maternal anxiety and low maternal quality of life.[18] Another Brazilian study assessed mental health among 86 parents of children aged 1 to 20 months diagnosed with congenital Zika syndrome. These researchers found that higher levels of fatigue, negative emotions, and lower levels of life satisfaction predicted worse parental mental health.[19]

The aim of the current study (the Zika Outcomes and Development in Infants and Children [ZODIAC] investigation) was to examine depressive symptoms and care demands among a sample of primary caregivers of children, aged 15 to 26 months, with evidence of congenital ZVI in northeastern Brazil. This study is unique in its focus on primary caregivers of children through 26 months of age with and without evidence of developmental delay, defined independently of microcephaly status. Two hypotheses were tested. First, primary caregivers of children with developmental delay will report significantly more severe depressive symptoms and social and economic challenges than primary caregivers of children without developmental delay. Second, child developmental delay will have a significant indirect effect on primary caregiver depressive symptoms through economic challenges and hours spent on home health care; however, relationships will differ by the presence of instrumental support (i.e., help with child care). The findings from this study will contribute new information to an emerging literature on the impact of congenital ZVI on families.

METHODS

Study Design

The Zika Outcomes and Development in Infants and Children (ZODIAC) investigation sought to describe child and family outcomes among primary caregivers and their children,

15 to 26 months old, with evidence of congenital Zika virus infection (ZVI). ZODIAC data were collected from August to October 2017 in 2 states in northeastern Brazil, Paraíba and Ceará. In Paraíba, ZODIAC served as a follow-up to a 2016 retrospective case-control investigation that assessed the association of microcephaly and Zika virus (ZIKV) among children aged 1 to 7 months.[20] The ZODIAC investigation was a collaboration between the Brazilian Ministry of Health, the State Health Secretariats of Paraíba and Ceará, and the US Centers for Disease Control and Prevention and was reviewed and approved by the Brazil National Commission on Ethics in Research.

Sample

All children enrolled in the ZODIAC investigation had laboratory (confirmed or probable) and/or clinical evidence of congenital ZVI, were 15 to 26 months old at the time of assessment, and lived in Paraíba or Ceará.

Confirmed laboratory evidence was indicated by a positive Zika virus-specific IgM antibody capture enzyme-linked immunosorbent assay (MAC-ELISA) result on infant cerebrospinal fluid or serum and positive plaque reduction neutralization testing (PRNT). Probable laboratory evidence was indicated by serologic evidence without PRNT confirmation.[2] Clinical evidence was defined by head circumference and length measurements that indicated microcephaly (head circumference less than the third percentile for gestational age and sex), small size, or disproportionate size for gestational age and sex.[20]

In Paraíba, all children recruited for ZODIAC had participated in the 2016 case-control investigation, which classified them as having laboratory and/or clinical evidence of congenital ZVI based on blood specimens and head circumference and length measurements taken at age 1 to 7 months.[20] In Ceará, ZODIAC followed up on a case series of children who had been reported to Brazil's national microcephaly registry and had a specimen collected at birth available for ZIKV testing or laboratory evidence of congenital ZVI. In both states, the child's primary caregiver also participated in the investigation.

Data Collection and Procedures

Investigation staff recruited families in stages. Staff made at least 3 phone calls and 1 home visit attempt, if needed, to contact families before concluding recruitment activities. Successfully contacted families were provided an overview of the investigation, and the child's primary caregiver was invited to accompany her/his child to 1 or 2 assessment visits at a participating health facility. A second visit was only necessary when the child's assessment results and/or medical history indicated the need for an audiologic and/or neurologic examination. Families were offered information about preventing mosquito-borne diseases and other health information, regardless of whether they enrolled in ZODIAC. Transportation to and from the health facilities was provided. Prior to data collection, primary caregivers signed the consent form for their own and their child's participation.

Data collection teams consisted of Brazilian Portuguese-speaking pediatricians, neurologists, ophthalmologists, epidemiologists, data clerks, a data manager, and

administrative support staff, all overseen by a field supervisor appointed by the State Health Secretariat. Team members received training on how to administer the assessment tools.

Multidisciplinary field teams evaluated the children and their primary caregivers. ZODIAC data were collected through clinical evaluations, primary caregiver interviews, and medical record review. Interviewers read questions to primary caregivers in Brazilian Portuguese to address variability in participant reading level. Within the data collection team, 1 data clerk asked the questions and another entered the responses in REDCap, a secure web application used to capture all ZODIAC data.

Measures

Developmental Delay

The Ages and Stages Questionnaire-3 (ASQ-3) was used to screen children for developmental delay. The ASQ-3 is a series of 21 questionnaires ("intervals") designed to screen the developmental progress of children aged 1 to 66 months in 5 domains: communication, gross motor skills, fine motor skills, problem solving, and personal-social skills.[21] For each question, caregivers are given 3 choices for answering whether the child is demonstrating the skill described: "yes," "sometimes," and "not yet." The interviewer, who read the questionnaires to the primary caregivers, had the option to elicit the skill using the ASQ-3 materials kit. The Brazilian Portuguese ASQ-3 version was used in the current study. This ASQ-3 version has been validated among a population of primary caregivers in Brazil and has been found to be a brief and cost-effective tool for field research.[22]

In standard administrations, the ASQ-3 age interval is selected based on the child's chronological age or adjusted age based on prematurity. Due to the developmental characteristics of the ZODIAC sample, child development experts, including a developmental-behavioral pediatrician, collaborated with the questionnaire developer to create a new protocol for administering the ASQ-3 in this investigation. Children in the investigation were aged 15 to 26 months but started with the 6-month interval, regardless of their chronological age. In some cases, if the child had more typical development, based on clinical judgment, the interviewer started with the 12-month interval. If the primary caregiver responded "sometimes" or "not yet" to the first 2 items in a domain (which represent 2 SDs below the mean), the interviewer administered the previous age interval for that domain. If the primary caregiver responded "yes" to *all* the items in a domain, the interviewer administered the next age interval for that domain. The interviewer moved up an age interval until the child could not do all items in a domain. These procedures for moving up or back an age interval were repeated for each domain. This adapted protocol sometimes resulted in the use of questionnaires designed for different age intervals for assessment of a single child.

Developmental quotients (DQs) were calculated to reflect the relation of the age at which the child was functioning to their biological age, adjusted for prematurity. First, ASQ z-scores were calculated by comparing each child's ASQ-3 domain scores to the distribution of ASQ-3 scores identified in a large study of Brazilian children in public daycare centers.[22] These z-scores were converted to the distribution of DQs to which the ASQ was normed and

then adjusted using a conversion factor to account for the amended implementation protocol. This conversion factor, 10/9, was determined with algebraic equations using standard deviations (SDs) and percent delay values (e.g., −1.5 SD = 25% delay, 75 DQ) obtained from the developers of the ASQ-3. DQ z-scores were calculated separately for each child on each domain.

The DQ z-scores were used to assign children to 1 of 2 developmental groups for analysis based on ASQ SD cutpoints.[21] A DQ z-score greater than or equal to 2 SDs below the mean in at least 1 domain was considered a positive screen for developmental delay, in alignment with ASQ-3 cutoffs for referral.[21] Children who screened positive were assigned to a delay group, and children who did not screen positive were assigned to the no delay group.

Depressive Symptoms

Depressive symptoms were assessed with the Patient Health Questionnaire-9 (PHQ-9), a 9-item validated depression screening tool that is based on the Diagnostic and Statistical Manual criteria for a major depressive episode.[23] The Brazilian Portuguese version, which has been validated among a population of Brazilian adults,[24] was used. The screener asks the patient how often he/she experienced depressive symptoms in the 2 weeks prior to evaluation. Responses are coded on a Likert scale as follows: 0 (not at all), 1 (several days), 2 (more than half the days), and 3 (nearly every day). Total scores can range from 0 to 27 and represent depressive symptom severity. Cutoff scores of 5, 10, 15, and 20 represent mild, moderate, moderately severe, and severe depressive symptoms, respectively.[23] Primary caregivers with a PHQ-9 score ≥15 received a referral for mental health services so that additional information could be gathered to evaluate whether the individual met criteria for depression and supports could be administered as needed.

Care Demands and Supports (Care Demands)

Care demand items were derived from the 2017 National Survey of Children's Health (NSCH) English Topical Questionnaire (Children, 0–5 years).[25] Each primary caregiver answered a series of questions about their current level and quality of employment, family finances, social support, and time spent providing home health care for his/her child. A professional translator translated questions from English to Brazilian Portuguese.

Selected financial, child care, and health care items were included in the path analysis model. Primary caregivers were asked "since this child was born, how often has it been very hard to get by on your family's income— to cover the basics like food or housing?" ("never," "rarely," "somewhat often," or "very often"). Responses were dichotomized to represent never or rarely and somewhat often or very often. Primary caregivers were also asked "does this child receive care for at least 10 hours per week from someone other than his or her parent or guardian?" ("yes" or "no"). Finally, primary caregivers were asked "in an average week, how many hours do you or other family members spend providing health care at home for this child? Care might include changing bandages, or giving medication and therapies when needed" ("less than 1 hour," "1–4 hours," "5–10 hours," or "11 or more hours"). For the analyses, responses were dichotomized to represent <5 hours or ≥5 hours per week.

Data Analysis

Univariate and bivariate descriptive statistics and difference testing were conducted in SAS 9.4©. Mann-Whitney U tests, Kruskal-Wallis tests, log-linear regression, *t* tests, χ^2 tests, and Fisher exact tests were selected, as appropriate, according to normality statistics and variable type (continuous vs categorical). To evaluate hypothesized relationships and indirect effects, we conducted a path analysis model using the Lavaan package in R Studio.[26] Diagonal weighted least squares estimation was used to account for categorical variables with full information maximum likelihood estimation for missing data (n = 3). Data on gestational age were missing for 4 children. In each case, delay classification was the same under the assumption of full-term or the earliest preterm gestational age in the sample. Thus, those children were retained in the analyses. For all indirect effects, 10,000 bootstrap samples were specified to estimate 95% bias-corrected bootstrap confidence intervals. Model fit was evaluated using the global χ^2 test, the Tucker-Lewis index, and the standardized root mean square residual.

RESULTS

The Zika Outcomes and Development in Infants and Children (ZODIAC) investigation enrolled 151 primary caregiver-child pairs. The response rate was 44.7% in Paraíba and 55.8% in Ceará. One child was excluded from analysis because of the inability to match the participant's case-control and ZODIAC ID numbers. Thus, the final sample for analysis included 150 children and their primary caregivers. Children were a mean age of 21.9 months (SD = 2.2), and 74 children (49.3%) were female. Fifty (33.3%) children had microcephaly[27] at the time of the ZODIAC investigation. Based on the children's Ages and Stages Questionnaire-3 scores, 61 (40.7%) were assigned to the delay group and 89 (59.3%) were assigned to the no delay group. Of the 61 children with delay, 48 (78.7%) had microcephaly and 13 (21.3%) did not have microcephaly at the time of the ZODIAC investigation. Of the 89 children with no delay, 2 (2.2%) had microcephaly and 87 (97.8%) did not have microcephaly at the time of the ZODIAC investigation. More information on the health and development of a subset of these children is provided elsewhere.[2]

Demographic Characteristics

Primary caregivers' demographic information is presented in Table 1. The majority of primary caregivers were the child's mother (n = 143, 95.3%) with a mean age of 28 years (SD = 7.6). Almost three-fourths (74%) of primary caregivers reported a monthly household income of <R$1499 (approximately $400 USD). The majority of the primary caregivers (n = 125, 83.3%) had received government assistance in the 12 months prior to assessment. In Brazil, government assistance determinations are based on household income, disability status, or age over 65 years.[28] Primary caregivers of children with delay reported government assistance more often than primary caregivers of children with no delay (90.2% vs 78.7%). Follow-up analyses revealed differences in percentages of families reporting government assistance (Fisher exact test, $p = 0.041$): primary caregivers of children with microcephaly (93.8%) reported government assistance most frequently, whereas primary caregivers of children with no delay (78.7%) and primary caregivers of children with delay but not microcephaly (76.9%) reported similar percentages of assistance.

Depressive Symptoms and Care Demands Group Differences

Twenty-six (17.3%) of the primary caregivers had a Patient Health Questionnaire-9 score ≥15 (Table 2), indicating moderately severe or severe depressive symptoms, and were referred to mental health services. Overall, the most commonly reported depressive symptoms were feeling tired or having little energy (n = 58, 38.7%) and poor appetite or overeating (n = 52, 34.7%). The mean depression score was 9.4 (SD = 6.1) among primary caregivers of children with delay and 7.0 (SD = 6.1) among primary caregivers of children with no delay ($p = 0.018$). Primary caregivers of children with delay had a median depression score of 7.0 compared to 5.0 among primary caregivers of children with no delay (Mann-Whitney U, $p = 0.002$).

Thirty-four (55.7%) of the primary caregivers of children with delay reported that they or a family member had stopped working or cut down work hours because of their child's health status, compared to 11 (12.4%) of the primary caregivers of children with no delay, $\chi^2(1, N = 150) = 32.430$, $p < 0.001$. Forty-four (72.1%) of the primary caregivers of children with delay reported often having difficulty covering basic needs with the family's income since the child's birth, compared with 28 (31.5%) with children with no delay, $\chi^2(1, N = 150) = 23.446$, $p < 0.001$. Forty-nine (80.3%) of the primary caregivers of children with delay provided home health care for their child at least 5 hours per week on average, compared with 4 (4.5%) with children with no delay (Fisher exact test, $p < 0.001$). Among primary caregivers of children with delay, 20 (32.8%) had received help with child care, compared with 60 (67.4%) with children with no delay, $\chi^2(1, N = 150) = 17.438$, $p < 0.001$. Primary caregiver report of the availability of emotional support with parenting did not differ by child delay group, $\chi^2(1, N = 150) = 0.106$, $p = 0.745$ (Table 2).

Indirect Effects

Path analysis was used to investigate the hypothesis that the ability to cover basic expenses and time spent providing home health care had an indirect effect on the relationship between developmental delay and depressive symptoms. Primary caregiver age (log-linear regression, $\beta = -0.01$, standard error [SE] = 0.004 $p = 0.016$) and education (Kruskal-Wallis H = 10.195, degrees of freedom = 3, $p = 0.017$) were significantly associated with depression scores in the current sample and were included as covariates in indirect models to control for potential confounding. These variables were included in a multigroup multiple-mediation analysis to investigate the hypothesis that indirect effects would vary by whether families had child care support (Fig. 1A and B). Primary caregiver relationship with the child, monthly household income, household size, and government assistance were not statistically associated with depression scores and were thus excluded as covariates. Model parameter estimates are presented in Table 3. The model-fit indices indicated good fit to the data, with a nonsignificant χ^2 test of global fit, $\chi^2(2, N = 150) = 0.070$, $p = 0.966$, a Tucker-Lewis index of 1.417, and a standardized root mean square residual (SRMR) of 0.086. Although this SRMR is slightly high, other fit statistics indicate good model fit.[29] The R^2 for the depression score was 0.167 among those with child care support and 0.381 among those without support, indicating that the variables included in the models only explain part of the variation in this score.

Among primary caregivers with child care support, results indicated that those with less than 12 years of education had significantly higher depression scores compared to those with 12 or more years (β = 3.27, SE = 1.14, $p = 0.004$). Primary caregivers of children with delay were significantly more likely to report difficulty covering basic expenses (β = 0.63, SE = 0.22, $p = 0.005$) and that they provide 5 or more hours of home health care per week on average (β = 0.32, SE = 0.05, $p < 0.001$).

Among primary caregivers without child care support, results indicated that those with difficulty covering basic expenses had significantly higher depression scores on average (β = 3.72, SE = 0.86, $p < 0.001$). Primary caregivers of children with delay were significantly more likely to report difficulty covering basic expenses (β = 0.44, SE = 0.22, $p = 0.040$) and that they provide 5 or more hours of home health care per week on average (β = 0.45, SE = 0.04, $p < 0.001$).

Indirect effects of developmental delay on depressive symptoms through difficulty covering basic expenses, and through time spent providing home health care, were not statistically significant among primary caregivers with child care support.

However, among primary caregivers without child care support, the indirect effect of developmental delay on depressive symptoms through difficulty covering basic expenses was statistically significant (β = 1.64, SE = 0.88, 95% bias-corrected bootstrap confidence interval = 0.32–3.85). Stated differently, developmental delay was associated with a greater likelihood of reporting difficulty covering basic expenses (unstandardized β = 0.44), which was associated with higher depression scores (unstandardized β = 3.72) among those without child care support. The indirect effect of developmental delay on depressive symptoms through time spent providing home health care was statistically nonsignificant.

DISCUSSION

Among primary caregivers of children with evidence of congenital Zika virus infection (ZVI) who do not have child care support, there was an indirect relationship between child developmental delay and depressive symptoms through economic challenges. Our data are in line with the larger body of research on economic challenges as a risk factor for poor primary caregiver mental health. Further, these data add to the literature suggesting child care support as a protective factor for primary caregiver well-being.[16,17] This is the first study to examine these primary caregiver- and family-level factors among a large sample of children, aged 15 to 26 months, with evidence of congenital ZVI with and without developmental delays. These findings can help inform strategies that support families and address the social and economic impact of congenital ZVI.

We found partial support for both hypotheses tested in this study. First, group differences were found between primary caregivers of children with and without developmental delay. Primary caregivers of children with delay had more depressive symptoms, faced more economic and child care challenges, and spent more weekly hours providing home health care for their child. However, both delay groups reported similar levels of emotional support and the median and mean depression scores in both groups, though statistically different, fell

within the mild severity category. Second, the direct association between developmental delay and depressive symptoms was not significant. However, an indirect relationship emerged between developmental delay and depressive symptoms through difficulty covering basic expenses among those without child care support only. This suggests that instrumental support may help mitigate some of the impact of economic challenges on depressive symptoms. In contrast, there was not an indirect relationship between developmental delay and depressive symptoms through hours spent on home health care as hypothesized.

Overall, these findings are consistent with existing studies focused on mental health and care demands among primary caregivers of children with special health care needs (CSHCN). Data from the National Survey of Children's Health show that child mental, behavioral, and developmental disorders are associated with fair or poor parental mental health, economic challenges, and child care problems among young children.[30] Further, evidence shows that high levels of economic stress and low social support can serve as risk factors for depression among women living in low- and middle-income countries.[31] A review of interventions for reducing caregiver stress finds that respite care (i.e., child care support that gives families of CSHCN breaks from their caregiving duties) is 1 approach that can offer positive benefits, including emotional and physical relief.[32]

Previous studies have described an association between caring for CSHCN and caregiver demands, including increased time spent providing direct care, and poor parent/guardian mental health.[6,33] However, this investigation did not find a significant relationship between time spent providing home health care and depressive symptoms. Although the primary caregivers of children with developmental delay provided significantly more home health care, it is possible that these primary caregivers also had more outlets for support, such as engagement with the healthcare system and with families experiencing similar challenges. For example, following the ZIKV outbreak, numerous Brazilian organizations formed parenting groups to provide group-based psychosocial support to impacted families.[34, 35] It is possible some of the parents in this study were participating in these groups and parents across both delay groups reported high levels of emotional support; therefore, this support might have played a protective role in reducing the risk of depression.

Limitations

The findings of this study are subject to at least 6 limitations. First, some of the children who participated in the Zika Outcomes and Development in Infants and Children (ZODIAC) investigation did not meet criteria for a confirmed laboratory diagnosis of congenital ZVI.[2] However, all the children had laboratory (probable or confirmed) and/or clinical evidence of congenital ZVI.

Second, the Patient Health Questionnaire-9 (PHQ-9) and Ages and Stages Questionnaire (ASQ-3) are screening tools. Therefore, a primary caregiver's PHQ-9 score is not sufficient to diagnose depression, and a child's ASQ-3 score is not sufficient to diagnose developmental delay. It is possible that a primary caregiver with depressive symptoms may have more negative perceptions about their child, resulting in lower ASQ-3 scores. Future

studies could consider using more comprehensive assessments of caregiver mental health and child development.

Third, we used a 2-SD cutoff point for development delay in alignment with ASQ-3 cutoffs for referral. The ASQ-3 guidelines also suggest monitoring children between 1.5 and 2 SD delays for risk of delay.[21] These at-risk children were not included in the delay group for our analyses because we were interested in implementing a cutoff point for delay that would maximize true positives and minimize false positives.[21] Future analyses could examine the specific needs and supports of children with ZVI at risk for developmental delay, particularly because delays may not be evident at birth and children can benefit from ongoing monitoring of development.[3] Additionally, our definition of developmental delay captures a wide variety of presentations (i.e., all 5 domains screened by the ASQ-3). Therefore, a child with fine motor delays would fall in the same category as a child with cognitive delays; future work could examine differences across delay categories.

Fourth, ZODIAC implemented a nonstandard administration of the PHQ-9 and ASQ-3 because of sample characteristics. PHQ-9 questions were read aloud rather than self-administered. This method of administration allowed us to include primary caregivers with varied literacy levels; however, reading items to primary caregivers could also increase the chance of social desirability bias. The ASQ-3 followed a protocol based on the child's functioning rather than their chronological age to learn more about children with severe delays. Although this protocol has not yet been validated, it was developed with guidance from the questionnaire developer and child development subject matter experts. Further research is necessary to validate these nonstandard administration protocols.

Fifth, our hypotheses posited that developmental delay and difficulty covering basic expenses precede primary caregiver depressive symptoms. Recent information on the social and economic impact of the ZIKV outbreak support this assumption[5,28]; however, we cannot confirm temporal or causal relationships with the present data. Specifically, the PHQ-9 assesses depressive symptoms in the 2 weeks prior to assessment; it does not ascertain the onset of the primary caregiver's symptoms or determine their depression history. We acknowledge that primary caregiver mental health can be influenced by a number of factors apart from a child's developmental status, including genetic predisposition, prior episodes of depression, and trauma.

Finally, our path analysis model assumes a unidirectional relationship from child developmental delay to depressive symptoms. Although existing research supports a bidirectional relationship between these constructs among CSHCN,[11,12] the direction of effects have not yet been examined in a population of families affected by congenital ZVI. Further, our sample had unique clinical characteristics (i.e., 78.7% of children in the delay group had microcephaly) that are not known to be caused by primary caregiver depression; as such, we proposed a unidirectional path from developmental delay to depressive symptoms. Future studies could examine the direction of effects by exploring primary caregiver mental health and child behavioral issues among children with congenital ZVI as compared to children with other chronic neurodevelopmental disorders.

Implications and Conclusions

This study provides new information on the mental health and socioeconomic challenges faced by primary caregivers of children impacted by the recent ZIKV outbreak in Brazil. Though challenges are salient, the findings also identify potentially modifiable social and economic factors that may be associated with better family and child outcomes. Specifically, findings suggest that the provision of respite care and supports to cover basic financial needs may be effective strategies for promoting well-being among primary caregivers of children with evidence of congenital ZVI.

Brazil's existing government assistance programs have reached many of the families impacted by the ZIKV outbreak.[28] However, numerous reports highlight that the system may be unable to meet the increased demand for services, may only reach children with the most severe disabilities, and may need to integrate additional services that address the multiple needs of children and their families.[5,28] Among the ZODIAC sample, a majority of families were receiving at least 1 type of government assistance, and families of children with microcephaly were most likely to receive government assistance. Despite this, many families reported difficulty covering basic expenses and not having access to child care support. It is possible that the significant group differences in child care support are related, in part, to the availability of child care providers who are qualified to care for CSHCN. Information from our study could help inform future decisions about the levels and types of services available to families caring for CSHCN.

This study is the first to describe mental health and care demands among a large sample of primary caregivers of children, through 26 months of age, with evidence of congenital ZVI. Future longitudinal research would allow for measurement of child and family outcomes over time. The findings presented in this article can help inform ongoing public health prevention and response efforts that support families in countries that have had, or are at risk for, a ZIKV outbreak.

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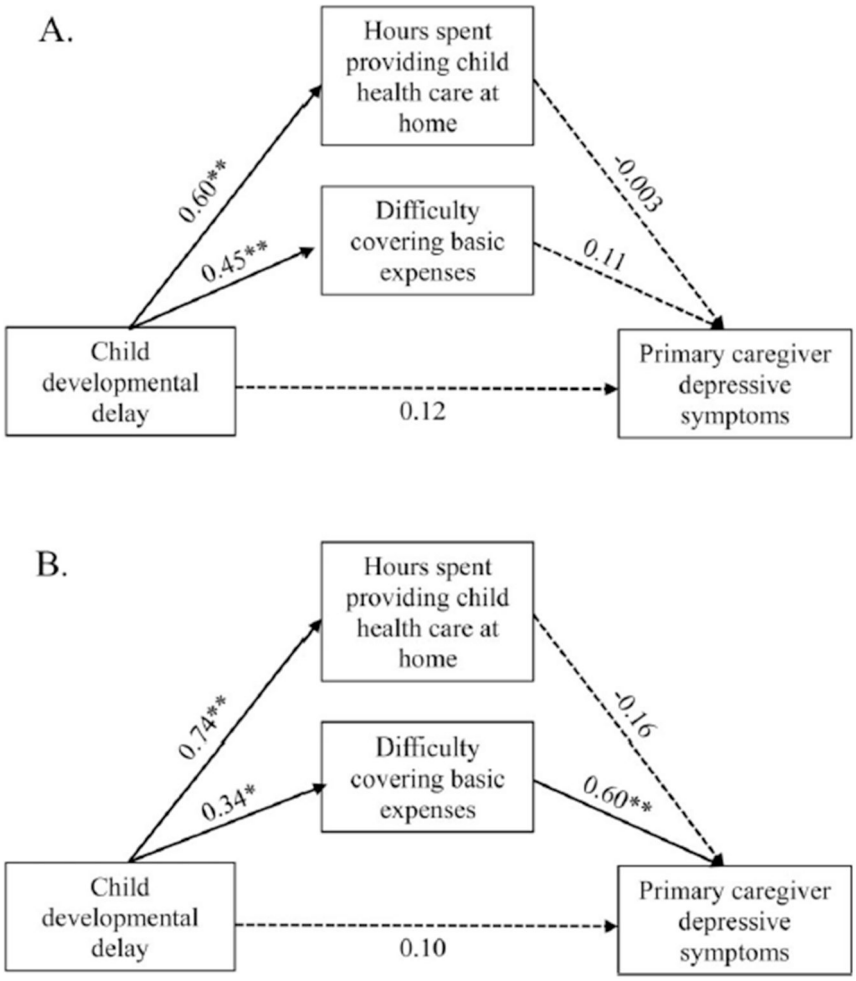

Figure 1.

A, Indirect effects of difficulty covering basic expenses and hours spent providing child health care at home on the relationship between child developmental delay and primary caregiver depressive symptoms, among primary caregivers with child care support. Standardized coefficient estimates are indicated along each path. *$p < 0.05$, **$p < 0.01$. Nonsignificant paths are noted by the dotted line. B, Indirect effects of difficulty covering basic expenses and hours spent providing child health care at home on the relationship between child developmental delay and primary caregiver depressive symptoms, among primary caregivers without child care support. Standardized coefficient estimates are indicated along each path. *$p < 0.05$, **$p < 0.01$. Nonsignificant paths are noted by the dotted line.

Table 1.

Demographic Characteristics of Primary Caregivers of Children with Evidence of Congenital Zika Virus Infection, n = 150

	Developmental Delay Group			
Characteristic	**No Delay (n = 89)**	**Delay (n = 61)**	**Total (n = 150)**	***p***
Relationship to child (n, %)				0.701
Mother	84 (94.4)	59 (96.7)	143 (95.3)	
Other caregiver[a]	5 (5.6)	2 (3.3)	7 (4.7)	
Caregiver age (range)	16–51	18–62	16–62	
Caregiver age (mean, SD)	28.7 (7.3)	27.3 (8.1)	28.2 (7.6)	0.136
Monthly household income (n, %)				0.010
<R$500	25 (28.1)	5 (8.2)	30 (20.0)	
R$500–R$1499	45 (50.6)	36 (59.0)	81 (54.0)	
>R$1500	15 (16.9)	16 (26.2)	31 (20.7)	
Unknown	4 (4.5)	4 (6.6)	8 (5.3)	
Household size (n, %)				0.738
2–4	60 (67.4)	41 (67.2)	101 (67.3)	
5–7	25 (28.1)	19 (31.2)	44 (29.3)	
≥8	4 (4.5)	1 (1.6)	5 (3.3)	
Family received government assistance in the past 12 mo (n, %)[b]	70 (78.7)	55 (90.2)	125 (83.3)	0.063
Education level (n, %)				
≤6 yr	16 (18.0)	8 (13.1)	24 (16.0)	0.821
7–11 yr	42 (47.2)	28 (45.9)	70 (46.7)	
High school	25 (28.1)	20 (32.8)	45 (30.0)	
Postsecondary	6 (6.7)	5 (8.2)	11 (7.3)	

[a]Other caregivers included 3 grandmothers, 2 aunts, 1 father, and 1 godmother.

[b]Cash assistance, food stamps, and/or child care assistance.

Table 2.

Primary Caregiver Depressive Symptom Severity and Care Demands by Child's Delay Group Among Children with Evidence of Congenital Zika Virus Infection, n = 150

	Developmental Delay Group			
	No Delay (n = 89)	**Delay (n = 61)**	**Total (n = 150)**	***p***
Depressive symptom severity (n, %)[a]				0.048
Minimal (score 0–4 on PHQ-9)	40 (44.9)	13 (21.3)	53 (35.3)	
Mild (score 5–9)	23 (25.8)	23 (37.7)	46 (30.7)	
Moderate (score 10–14)	12 (13.5)	13 (21.3)	25 (16.7)	
Moderately severe (score 15–19)	10 (11.2)	8 (13.1)	18 (12.0)	
Severe (score 20–27)	4 (4.5)	4 (6.6)	8 (5.3)	
Total depression score (mean, SD)[a]	7.0 (6.1)	9.4 (6.1)	8.0 (6.2)	0.018
Total depression score (median)[a]	5.0	7.0		0.002
Care demands				
Caregiver or family member stopped working or cut down on work hours because of child's health status (n, %)	11 (12.4)	34 (55.7)	45 (30.0)	<0.001
Hard to cover basic needs with family's income since the child was born (n, %)[b]				<0.001
Very often or somewhat often	28 (31.5)	44 (72.1)	72 (48.0)	
Rarely or never	60 (67.4)	17 (27.9)	77 (51.3)	
Missing	1 (1.1)	0 (0.0)	1 (0.7)	
Average number of hours spent per week providing health care at home for the child (n, %)[a]				<0.001
≥11 hr	2 (2.2)	33 (54.1)	35 (23.3)	
5–10 hr	2 (2.2)	16 (26.2)	18 (12.0)	
1–4 hr	29 (32.6)	8 (13.1)	37 (24.7)	
<1 hr	54 (60.7)	4 (6.6)	58 (38.7)	
Missing	2 (2.2)	0 (0.0)	2 (1.3)	
Has day-to-day emotional support with parenting (n, %)	65 (73.0)	46 (75.4)	111 (74.0)	0.745
Child receives care for at least 10 hr per week from someone other than caregiver (n, %)	60 (67.4)	20 (32.8)	80 (53.3)	<0.001

[a] PHQ-9.

[b] Bivariate statistical testing was based on nonmissing cases. PHQ-9, Patient Health Questionnaire-9.

Table 3.

Path Analysis and Indirect Effects of Developmental Delay on Depressive Symptom Severity Among Primary Caregivers of Children with Evidence of Congenital Zika Virus Infection with and Without Child Care Support, n = 150

Group 1—Primary Caregivers with Child Care Support (n = 80)	***b***	**β (SE)**	***p***	**95% Bias-Corrected Bootstrap Interval**
Total depression score				
Developmental delay	0.12	0.80 (1.11)	0.469	—
Difficulty covering basic expenses	0.11	0.53 (0.76)	0.488	—
≥5 hr of providing health care	−0.003	−0.04 (1.79)	0.982	—
Education				
12 or more years (ref)	—	—	—	
11 or fewer years	0.29	3.27 (1.14)	0.004	—
Caregiver age	−0.17	−0.13 (0.09)	0.163	—
Difficulty covering basic expenses				
Developmental delay[a]	0.45	0.63 (0.22)	0.005	—
≥5 hours of providing health care				
Developmental delay[a]	0.60	0.32 (0.05)	<0.001	—
Indirect effects				
Difficulty covering basic expenses	0.05	0.33 (0.57)[b]	—	−0.56 to 1.84
≥5 hr of providing health care	0.00	−0.01 (0.58)[b]	—	−1.14 to 1.21
Group 2—Primary Caregivers Without Child Care Support (n = 70)	***b***	**β (SE)**	***P***	**95% Bias-Corrected Bootstrap Interval**
Total depression score				
Developmental delay	0.10	0.78 (1.34)	0.563	—
Difficulty covering basic expenses	0.60	3.72 (0.86)	<0.001	—
≥5 hr of providing health care	−0.16	−2.07 (2.42)	0.392	—
Education				
12 or more years (ref)	—	—	—	—
11 or fewer years	0.08	1.06 (1.71)	0.534	—
Caregiver age	−0.11	0.02 (0.02)	0.540	—
Difficulty covering basic expenses				

Group 1—Primary Caregivers with Child Care Support (n = 80)	*b*	β (SE)	*p*	95% Bias-Corrected Bootstrap Interval
Developmental delay[a]	0.34	0.44 (0.22)	0.040	—
≥5 hours of providing health care				
Developmental delay[a]	0.74	0.45 (0.04)	<0.001	—
Indirect effects				
Difficulty covering basic expenses	0.21	1.64 (0.88)[b]	—	0.32 to 3.85
≥5 hr of providing health care	−0.12	−0.93 (1.10)[b]	—	−3.28 to 1.07
Index of moderated mediation				
Difficulty covering basic expenses	0.16	1.31 (1.05)[b]	—	−0.57 to 3.58
≥5 hr of providing health care	−0.12	−0.92 (1.24)[b]	—	−3.51 to 1.38

In total, 10,000 bias-corrected bootstraps were estimated; model fit: model $\chi^2 = \chi^2(2, N = 150) = 0.070$), TLI = 1.417, and SRMR = 0.086. Covariance between difficulty covering basic expenses and ≥5 br of providing health care was set to zero.

[a]Controlling for education and caregiver age — neither were significant.

[b]Significance of parameter determined by bias-corrected bootstrap confidence intervals not containing 0. SE, standard error; SRMR, standardized root mean square residual; TLI, Tucker-Lewis index.