








ORIGINAL ARTICLE

Cardiovascular disorders in patients with Zika virus: integrative review

Distúrbios cardiovasculares em pacientes com Zika vírus: revisão integrativa

Lucas Dalvi Armond Rezende^{1,*} , Paula de Souza Silva Freitas^{1,2} , Davi de Souza Catabriga³ ,
Helaine Jacinta Salvador Mocelin⁴ , Kelly Eduarda de Jesus Silva¹ , Lavinya Moreira Silva¹ ,
Bruno Henrique Fiorin^{1,2} 

¹Department of Nursing, Health Sciences Center, Federal University of Espírito Santo (UFES). Vitória, Espírito Santo, Brazil.

²Postgraduate Program in Nursing (PPGEnf), Center for Health Sciences. Federal University of Espírito Santo (UFES). Vitória, Espírito Santo, Brazil.

³School of Sciences of the Santa Casa de Misericórdia de Vitória (EMESCAM). Vitória, Espírito Santo, Brazil.

⁴Postgraduate Program in Public Health (PPGSC), Center for Health Sciences. Federal University of Espírito Santo (UFES). Vitória, Espírito Santo, Brazil.

Submitted on Sep 7, 2021, accepted on Feb 25, 2022, published on Mar 29, 2022

KEYWORDS

Cardiology
Cardiovascular
abnormalities
Zika virus infection

ABSTRACT

Objective: To describe the primary cardiovascular disorders manifested in patients infected with the Zika virus and understand the pathophysiological process.

Methods: This integrative literature review occurred in January 2021 through the PICO strategy, which answered the guiding question: "What are the main cardiovascular disorders manifested in patients infected with Zika virus?" For this, a time interval of 5 years was defined, using the descriptors "Zika Virus", "Heart" and "Cardiovascular Diseases" in English, Portuguese and Spanish. The contemplated databases were MEDLINE, LILACS, and BDNF.

Results: There were a total of 77,872 articles, of which, after the exclusion and inclusion processes, it was summarized in eight articles included in this review. The main cardiovascular findings present were apical muscular ventricular septal defect and *ostium secundum*, in addition to atrial fibrillation and heart failure with reduced ejection fraction.

Conclusions: Further studies with more robustness that clearly establish the mechanism of cellular tropism for cardiac muscle cells and involve the pathophysiological process of cardiac alterations more clearly and reliably are needed.

*Corresponding author:

Departamento de Enfermagem, Universidade Federal do Espírito Santo.
Addr.: Av Marechal Campos, nº 1468, Maruípe. Vitória, ES, Brasil | CEP: 29.043-900
E-mail: lucas.dalviar@gmail.com (Rezende LDA)

This study was conducted at the Nursing Department of the Federal University of Espírito Santo.

<https://doi.org/10.21876/rcshci.v12i1.1210>

How to cite this article: Rezende LDA, Freitas PSS, Catabriga DS, Mocelin HJS, de Jesus Silva KE, Moreira Silva L, et al. Cardiovascular disorders in patients with Zika Virus: integrative review. Rev Cienc Saude. 2022;12(1):47-53.

<https://doi.org/10.21876/rcshci.v12i1.1210>

2236-3785/© 2022 Revista Ciências em Saúde. This is an open-access article distributed under a CC BY-NC-SA licence. (<https://creativecommons.org/licenses/by-nc-sa/4.0/deed.en>)



PALAVRAS-CHAVE

Anormalidades
cardiovasculares
Cardiologia
Infecção por Zika virus

RESUMO

Objetivo: Descrever os principais acometimentos cardiovasculares manifestados em pacientes infectados por Zika vírus, bem como entender o processo fisiopatológico.

Métodos: Trata-se de uma revisão integrativa de literatura que ocorreu em janeiro de 2021, através da estratégia PICO, o qual visou responder a questão norteadora “Quais os principais acometimentos cardiovasculares manifestados em pacientes infectados por Zika vírus?” Para isso delimitou-se intervalo temporal de 5 anos, sendo usado os descritores “Zika Vírus” (“Zika Virus”), “Coração” (“Heart”) e “Doenças cardiovasculares” (“Cardiovascular Diseases”), nos idiomas inglês, português e espanhol. Para a pesquisa, as bases de dados contempladas foram MEDLINE, LILACS e BDNF.

Resultados: Totalizou-se 77.872 produções, das quais, após os processos de exclusão e inclusão, resumiu-se em oito produções incluídas nessa revisão. Entende-se que os principais achados cardiovasculares presentes foram a comunicação interventricular muscular apical e *ostium secundum*, além de fibrilação atrial e insuficiência cardíaca com fração de ejeção reduzida.

Conclusões: Salienta-se a necessidade de novos estudos com mais robustez que estabeleçam claramente o mecanismo de tropismo celular para as células musculares cardíacas e que envolvam com maior clareza e fidedignidade o processo fisiopatológico das alterações cardíacas.

INTRODUCTION

Zika virus, transmitted by *Aedes aegypti* mosquitoes, was identified in *Rhesus* monkeys in the Zika forest, located in Uganda. The first human infections were reported in 1950 in Uganda and the United Republic of Tanzania and had its transmission restricted to the African continent for about 30 years. Later, in 2007, there was the first report of a small outbreak in a territory in Oceania. Since then, Zika Virus (ZIKV) infections have been reported epidemically around the world^{1,2}.

In mid-2014 and 2015, Brazil was the epicenter of the epidemic that affected 27 Federated Units of the country. Approximately 80 countries have confirmed their exposure to the virus, estimating the occurrence of 1.5 million cases between 2015 and 2016³. In Brazilian territory, this epidemic was marked by symptoms never before described in the scientific literature, requiring numerous studies and research to decipher the history of the disease and the virus behavior. The symptoms found, mainly in newborns, called Congenital Zika Virus Syndrome (CZVS), corresponded to a set of congenital

defects found among fetuses and babies infected during pregnancy, such as severe microcephaly, reduced brain tissue, eye abnormalities, congenital contractures, early muscle hypertonia, and extrapyramidal symptoms⁴⁻⁷. The transmission mechanism is depicted in Figure 1.

In addition to these symptoms, the infected individual may experience muscle fatigue, dyspnea, and heart palpitations. Researchers have suggested a relationship between viral infection and changes in the human cardiovascular profile^{3,7,8}. Karina Carta was one of the most influential authors describing cardiac alterations in patients infected with ZIKV; her studies point to patients with heart failure and cardiac arrhythmias⁹.

Given the need to deepen and prove the association of ZIKV with cardiovascular alterations, as well as to understand the pathophysiological process, it is necessary to identify the available evidence in the scientific literature about the infection of this virus and the association of cardiovascular abnormalities to develop public policies to track and follow-up infected individuals.

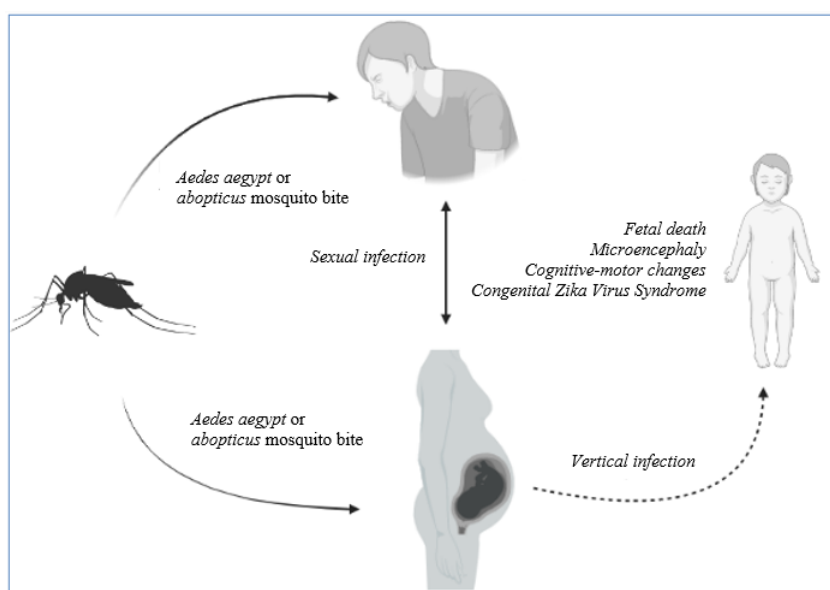


Figure 1 – Mechanism of transmission of the Zika Virus.

METHODS

This is an integrative literature review, based on the rules of Botelho et al., conducted in six different steps: 1st) identification of the topic under study and elaboration of the guiding question, 2nd) production of the inclusion and exclusion criteria, 3rd) identification of the studies, 4th) categorization of the selected studies, 5th) interpretation of the results and 6th) presentation of the review/knowledge synthesis¹⁰. Moreover, the article selection steps were represented using the PRISMA-ScR Guidelines for scoping reviews¹¹.

Studies in Spanish, English, and Portuguese were selected from the following databases: MEDLINE/PubMed (Medical Literature Analysis and Retrieval System Online), LILACS (Latin American and Caribbean Literature on Health Sciences Information), and BDEF (*Base de Dados de Enfermagem*). The search strategy was independently designed and conducted by two experienced authors. The following *Descritores em Ciências da Saúde* (DeCS)/Medical Subject Headings (MeSH) were used: "Zika Virus" ("Zika Virus"), "Coração" ("Heart") and "Doenças Cardiovasculares" ("Cardiovascular Diseases"), separated by Boolean operators, where the search method was summarized in the following: "Zika Virus" AND "Heart" OR "Cardiovascular Diseases".

To follow the described steps, this study sought to identify the articles that addressed the cardiovascular complications of patients with ZIKV, through the guiding question, based on the PICO protocol: P - Population, I - Intervention, C - Comparison, O - Outcome: "What are the main cardiovascular disorders manifested in patients infected with Zika virus?", described in Table 1. The primary outcomes included the identification of cases of ZIKV with cardiovascular alterations.

Studies with a maximum of five years of publication, in English, Spanish, or Portuguese, and all types of studies with full text available or not, were included. Additionally, case reports, classic original articles, clinical study, clinical trial, meta-analysis, randomized controlled trial, and systematic review were included in the search. After applying the described filters, the studies to be used were identified through selection by title, abstract, and thorough reading. Productions that did not contemplate the described guiding question and works classified as books, documents, preprints, and duplicate articles were excluded.

Due to the high number of articles found in the databases, the research was uploaded to the software Rayyan - Intelligent Systematic Review to facilitate the

mechanism of exclusion of articles to compose the manuscript. Besides, two authors were determined as double-blind reviewers to analyze the articles in the forms. When there was no consensus between the authors, the author, a professor at a Federal University with a Ph.D. in Collective Health, who has experience in integrative and systematic reviews, was contacted for the ultimate decision.

After reading and selecting the articles, they were summarized according to the year of publication, authors' names, the title of publication, journal of publication, cardiovascular alteration, language, and a brief conclusion about the article's content, determined as step number 4.

Additionally, the level of evidence shown in each article included in this review was analyzed, aiming to bring greater methodological rigor and benefits to the research. To analyze the level of evidence, GRADE System was used, which defines the levels as High, Moderate, Low, and Very Low¹².

RESULTS

In total, 77,872 publications regarding cardiac alterations and infectious profiles by ZIKV were found in the databases used in this research. Exclusions were performed by repeated articles (7,536), exclusion of works through the title due to the non-contemplation of the guiding question (70,270), and exclusion through the abstract and complete reading (58) totaling 8 for inclusion in this review (Figure 2).

Concerning the published language, all productions were in English. Among the years of publication, 50% were from 2017 (n = 4), 25% from 2018 (n = 2) and 25% from 2020 (n = 2). As for the content, all confirmed the correlation between ZIKV infection and cardiovascular manifestations; however, none clearly established its pathophysiological criteria.

The main cardiovascular findings were limited to hypoplastic left heart syndrome (n = 2), myocarditis (n = 2), interatrial communication (atrial septal defect - ASD) (n = 2), interventricular communication (ventricular septal defect - VSD) (n = 1), alterations in cardiac rhythmic and conduction (n = 2), heart failure (n = 2), increased risk of systemic arterial hypertension (n = 1), ostium secundum (n = 1) and patent ductus arteriosus (n = 1).

Based on the methodology of the analyzed articles, several studies with low or moderate level of evidence (LE) were found: case report (n = 3; 37.5% / LE: Very Low), literature review (n = 2; 25% / LE: Very Low), retrospective study (n = 1; 12.5% / LE: Moderate), cross-sectional study (n = 1; 12.5% / LE: Moderate) and laboratory study (n = 1; 12.5% / LE: Low).

By understanding the need to check the qualification of the journals used in this review so that we can consider the robustness of the study, their impact factors were also evaluated: *Virology Journal* (2,464), *Neonatology* (2,742), *PLoS One* (2,740), *PLoS Neglected Tropical Diseases* (3,885), *Journal of the São Paulo Institute of Tropical Medicine* (1,460) and *European Journal of Prevention Cardiology* (5,640), all in English. Table 2 demonstrates the findings and the main characteristics of this review.

Table 1 – Descriptors used for the acronym PICO.

Item	Descriptor
"Population"	Population with a positive diagnosis of Zika virus
"Intervention"	Clinical cardiac assessment
"Comparison"	Healthy patients
"Outcome"	Assessment of cardiovascular involvement

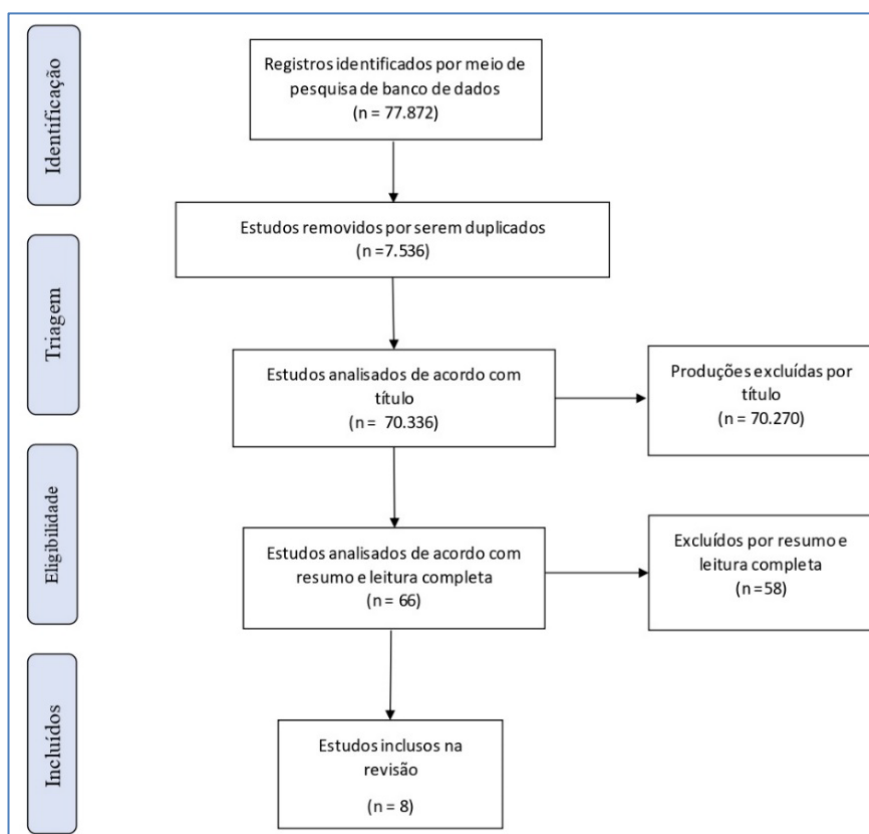


Figura 2 – Fluxograma de seleção dos artigos.

DISCUSSION

Among the main points of this review, we should consider the low evidence found in the selected articles, highlighting the importance of research associating cardiovascular abnormalities with ZIKV infection. Moreover, the cardiovascular alterations in patients with ZIKV are totally heterogeneous, being summarized in cardiac electrical conduction alterations, inflammatory alterations of the myocardial tissue, cardiac hypoplasia, ASD and VSD, besides significant pressure alterations.

The possibility of cardiac alterations during ZIKV infection could be hypothesized from observing manifestations of other arboviruses, such as Dengue. Nevertheless, when compared to this disease, ZIKV has a smaller range of clinical signs and symptoms¹³.

Studies demonstrated the viral tropism and pathophysiology, which is possibly related to the changes in the cardiovascular profile of these patients. The AXL receptor tyrosine kinase is among the most studied receptors concerning ZIKV entry into neural progenitor cells. The virus binds to the specific Gas6 to interrupt the growth of the phosphatidylserine pathway on the viral membrane and, consequently, binds to AXL^{14,15}. Rossi et al. demonstrated that ZIKV infects fetal cardiac mesenchymal stromal cells (fcMSCs) via the AXL receptor, promoting cell death. This AXL receptor-mediated entry could be linked to cardiovascular alterations^{13,16}.

ZIKV infection can be asymptomatic or symptomatic, with a self-limited course lasting four to seven days, and the main clinical manifestations are

briefly elucidated in Table 3.

In 2017, nine adult patients diagnosed with ZIKV were reported, where they had cardiovascular manifestations during the disease, these being arrhythmogenic alterations and heart failure with reduced and preserved ejection fraction¹⁷.

A study was conducted with 120 children aged between 1 and 376 days, with confirmed fetal exposure to ZIKV. The neonatal cardiovascular evaluation was performed, including a complete clinical examination, 2D transthoracic, and M-mode echocardiography with pulsed and continuous Doppler and color Doppler. Approximately 48 neonates were diagnosed with some cardiovascular alteration observed on echocardiogram. In approximately 70% of the 48 neonates, Patent Foramen Ovale (PFO) was the most common abnormality on ECHO. Another finding, with a lower incidence, was Patent Ductus Arteriosus (PDA) in six patients. The cardiac alterations found in this article corroborate the hypotheses of the possibility of cardiovascular damage in neonates infected vertically by ZIKV; however, with a smaller number, such as atrial septal defects (ostium secundum), physiological tricuspid regurgitation, and pulmonary arterial hypertension. In this research, approximately 11% of cardiac abnormalities were noted⁸.

Furthermore, another descriptive study analyzed a sample of 15 newborns by cardiac Holter and found no records of alterations such as supraventricular or ventricular extrasystoles, QT interval blocks or changes, conduction pauses, or junctional rhythm. Nonetheless, a significant difference in the standard deviation values of

Table 2 – List of selected articles.

Title	Author	Journal, Year	Study type	Cardiovascular involvement
Atrial fibrillation in a patient with Zika virus infection.	Abdalla et al. ¹³	Viol J, 2018	Case report	Atrial fibrillation
Is There More to Zika? Complex Cardiac Disease in a Case of Congenital Zika Syndrome.	Angelidou et al. ¹⁴	Neonatology, 2017	Case report	Hypoplastic left heart syndrome with mitral and aortic atresia, severely hypoplastic aorta, moderate tricuspid regurgitation, and moderate right ventricular dysfunction
Echocardiographic findings in infants with presumed congenital Zika syndrome: Retrospective case series study.	Calvacanti et al. ¹⁵	PLoS One, 2017	Retrospective study	IVC, ostium secundum, hemodynamically insignificant small apical muscular ASD and an infant with dyspnea had a large membranous ASD
Association of Zika Virus with Myocarditis, Heart Failure, and Arrhythmias: A Literature Review.	Minhas et al. ⁷	Cureus, 2017	Literature review	Myocarditis, heart failure and arrhythmias
24-hour Holter findings in infants with in-utero exposure to the Zika virus: a series of cases.	Orofino et al. ¹⁶	Rev Inst Med Trop S Paulo, 2020	Case report	Increased risk of hypertension
Cardiac findings in infants with in utero exposure to Zika virus- a cross sectional study.	Orofino et al. ⁸	PLoS Negl Trop Dis, 2018	Cross-sectional study	ASD, IVC, patent ductus arteriosus
Characterization of Zika virus infection of human fetal cardiac mesenchymal stromal cells.	Rossi et al. ¹⁷	PLoS One, 2020	Laboratory study	Hypoplastic left heart syndrome
Useful strategies for the emerging of Zika pandemic and its silent cardiovascular complication	Krittanawong et al. ¹⁸	Eur J Prev Cardiol, 2017	Literature review	Myocarditis

IVC: interventricular communication. ASD: Atrial septal defect.

Table 3 – Typical manifestations of Zika virus infection.

Viremic symptoms and signs	Pregnancy changes	Autoimmune conditions
Asymptomatic. Fever, skin rash, arthralgia, abdominal pain, diarrhea and meningoencephalitis	Microcephaly Fetal death Congenital Zika virus syndrome	Guillain-Barré syndrome Transverse myelitis

the intervals was reported between two consecutive R waves throughout the Holter "clean trace" time (SDNN) and in the RR values, which may indicate a possible development of cardiovascular comorbidities in the long and medium-term. Additionally, this factor may indicate a possible sudden infant death syndrome (SIDS)¹⁸.

The presence of cardiac alterations, such as those described above, related to an abnormality of the cardiac chamber architecture was corroborated through a retrospective observational study, where 103 children

with congenital Zika syndrome were examined, of whom 13.5% had ostium secundum-type interatrial communication (atrial septal defect), apical muscular VSD and membranous VSD¹³. Moreover, abnormalities were indicated in two other case reports. In a report, a 49-year-old man infected with ZIKV manifested cardiac electrical abnormalities of the atrial fibrillation type¹⁹; in another, cerebral cortical calcifications and hypoplastic left heart syndrome in a neonate were reported using Fetal Ultrasonography (FUS)²⁰.

Since ZIKV infection can often cause cardiovascular alterations, it becomes crucial to develop a specific screening in cases of suspected infection to identify possible cardiovascular complications to prevent new incidences of heart disease related to ZIKV infection. Examinations such as echocardiograms or electrocardiograms should be carried out to eliminate suspicions of heart dysfunction or diseases and guide better propaedeutic for treatment²¹.

Carta et al.⁹ introduced in the literature findings implying the gender dichotomy during cardiovascular manifestations of ZIKV. Their prospective study consecutively evaluated 18 patients with acute

myocarditis after ten days of illness onset, and physical and laboratory examinations were conducted, including Zika confirmation, electrocardiogram, echocardiogram, coronary arteriography, and cardiac magnetic resonance imaging. The authors reported a significant predominance of women (n = 13 / 68%), where only one had a positive pregnancy test. It was noted that 7 of the 13 observed patients developed heart failure (5 women and 2 men), 6 with reduced ejection fraction, 1 with preserved ejection fraction and moderate to severe pericardial effusion. Furthermore, the electrocardiographic alterations were substantial, noted in 94% of the patients with conduction disorders: atrial tachycardia, atrial fibrillation, and ventricular arrhythmias.

Much has been done to understand the various implications of the viral infection; however, all articles point to a need for more robust studies that involve the pathophysiological process of cardiac alterations in virus-infected patients in a clearer and more reliable way. Besides, there is unquestionable need for research that addresses the treatment and prevention, pharmacological or not, of how to avoid the structural changes described.

After discussing the article's results, it is understood that the manuscript has substantial limitations, such as the high presence of productions with low to moderate level of literary evidence, with

possible lack of coverage of other productions with the used descriptors.

CONCLUSION

In most of the studies in this review, some findings corroborate the hypotheses of cardiac alterations in cases of ZIKV infection, the most common being: apical muscular interventricular communication (ventricular septal defect) and ostium secundum-type interatrial communication (atrial septal defect), as well as heart failure with reduced ejection fraction. These contributions make us believe in a possible relationship between the development of cardiovascular diseases in the medium and long-term and other alterations manifested in adult patients, such as heart rhythm disturbances of the atrial fibrillation type, contribute to the data of this statement.

The cardiovascular alteration present mainly in women suggests a partial preference for the female gender; however, we did not find the primary viral mechanism for such a characteristic in our search. It is necessary to conduct further research regarding epidemiological data of the viral characteristics of ZIKV infection in synergy with cardiovascular alterations.

REFERENCES

- Wikan N, Smith DR. Zika virus: history of a newly emerging arbovirus. *Lancet Infect Dis*. 2016;16(7):e119-26. [https://doi.org/10.1016/S1473-3099\(16\)30010-X](https://doi.org/10.1016/S1473-3099(16)30010-X)
- Kuno G, Chang GJ. Full-length sequencing and genomic characterization of Bagaza, Kedougou, and Zika viruses. *Arch Virol*. 2007;152(4):687-96. <https://doi.org/10.1007/s00705-006-0903-z>
- Brasil P, Pereira JP Jr, Moreira ME, Ribeiro Nogueira RM, Damasceno L, Wakimoto M, et al. Zika Virus Infection in Pregnant Women in Rio de Janeiro. *N Engl J Med*. 2016;375(24):2321-34. <https://doi.org/10.1056/NEJMoa1602412>
- Gordon-Lipkin E, Peacock G. The spectrum of developmental disability with Zika exposure: what is known, what is unknown, and implications for clinicians. *J Dev Behav Pediatr*. 2019;40(5):387-95. <https://doi.org/10.1097/DBP.0000000000000665>
- Cao-Lormeau VM, Blake A, Mons S, Lastère S, Roche C, Vanhomwegen J, et al. Guillain-Barré Syndrome outbreak associated with Zika virus infection in French Polynesia: a case-control study. *Lancet*. 2016;387(10027):1531-9. [https://doi.org/10.1016/S0140-6736\(16\)00562-6](https://doi.org/10.1016/S0140-6736(16)00562-6)
- Moore CA, Staples JE, Dobyns WB, Pessoa A, Ventura CV, Fonseca EB, et al. Characterizing the pattern of anomalies in Congenital Zika Syndrome for Pediatric Clinicians. *JAMA Pediatr*. 2017;171(3):288-95. <https://doi.org/10.1001/jamapediatrics.2016.3982>
- Minhas AM, Nayab A, Iyer S, Narmeen M, Fatima K, Khan MS, et al. Association of Zika Virus with myocarditis, heart failure, and arrhythmias: a literature review. *Cureus*. 2017;9(6):e1399. <https://doi.org/10.7759/cureus.1399>
- Orofino DH, Passos SR, de Oliveira RV, Farias CV, Leite MF, Pone SM, et al. Cardiac findings in infants with in utero exposure to Zika virus- a cross sectional study. *PLoS Negl Trop Dis*. 2018;12(3):e0006362. <https://doi.org/10.1371/journal.pntd.0006362>
- Carta KG, Britto IJ, Meza Y, Morr I, Marques J, Flores VF, et al. Sex and gender differences in Zika myocarditis. *J Am Coll Cardiol*. 2019;73(9 Supp 1):719. [https://doi.org/10.1016/S0735-1097\(19\)31327-0](https://doi.org/10.1016/S0735-1097(19)31327-0)
- Botelho LL, Cunha CC, Macedo M. O Método da revisão integrativa nos estudos organizacionais. *Gestão e Sociedade*. 2011;5(11):121-36. <https://doi.org/10.21171/ges.v5i11.1220>
- Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467-73. <https://doi.org/10.7326/M18-0850>
- Brugnolli A, Cavada L, Saiani L. Il sistema GRADE. Vol. 33, Assistenza Infermieristica e Ricerca. 2014. 924-926 p.
- Krittana Wong C, Zhang H, Sun T. Cardiovascular complications after Zika virus infection. *Int J Cardiol*. 2016;221:859. <https://doi.org/10.1016/j.ijcard.2016.06.293>
- Strange DP, Jiyarom B, Pourhabibi Zarandi N, Xie X, Baker C, Sadri-Ardekani H, et al. Axl promotes Zika Virus entry and modulates the antiviral state of human Sertoli cells. *MBio*. 2019;10(4):e01372-19. <https://doi.org/10.1128/mBio.01372-19>
- Lemke G. Biology of the TAM receptors. *Cold Spring Harb Perspect Biol*. 2013;5(11):a009076. <https://doi.org/10.1101/cshperspect.a009076>
- Rossi F, Josey B, Sayitoglu EC, Potens R, Sultu T, Duru AD, et al. Characterization of zika virus infection of human fetal cardiac mesenchymal stromal cells. *PLoS One*. 2020;15(9):e0239238. Erratum in: *PLoS One*. 2021;16(1):e0246112. <https://doi.org/10.1371/journal.pone.0239238>
- Seferović PM, Polovina M, Bauersachs J, et al. Heart failure in cardiomyopathies: a position paper from the Heart Failure Association of the European Society of Cardiology. *Eur J Heart Fail*. 2019;21(5):553-76. <https://doi.org/10.1002/ejhf.1461>
- Orofino DH, Passos SR, Pone SM, Pone MV, Aguiar EB, Araújo IO, et al. 24-hour Holter findings in infants with in-utero exposure to the Zika virus: a series of cases. *Rev Inst Med Trop São Paulo*. 2020;62:e50. <https://doi.org/10.1590/s1678-9946202062050>
- Angelidou A, Michael Z, Hotz A, Friedman K, Emami S,

- LaRovere K, et al. Is there more to Zika? Complex cardiac disease in a case of Congenital Zika Syndrome. *Neonatal*. 2018;113(2):177-82. <https://doi.org/10.1159/000484656>
20. Abdalla LF, Santos JH, Barreto RT, Souza EM, D'Assunção FF, Borges MA, et al. Atrial fibrillation in a patient with Zika virus infection. *Virology*. 2018;15:23. <https://doi.org/10.1186/s12985-018-0938-2>
21. Cavalcanti DD, Alves LV, Furtado GJ, Santos CC, Feitosa FG, Ribeiro MC, et al. Echocardiographic findings in infants with presumed congenital Zika syndrome: Retrospective case series study. *PLoS One*. 2017;12(4):e0175065. <https://doi.org/10.1371/journal.pone.0175065>

Conflicts of interest: No conflicts of interest declared concerning the publication of this article.

Author contributions:

Conception and design: LDAR, DSC, KEJS, PSSF

Analysis and interpretation of data: LDAR, PSSF, HJSM, LMS

Data collection: LDAR, DSC, KEJS, LMS

Writing of the manuscript: LDAR, BHF, PSSF

Critical revision of the article: BHF, PSSF, HJSM

Final approval of the manuscript*: BHF, PSSF, HJSM, LDAR, DSC, KEJS

Statistical analysis: Not applicable

Overall responsibility: LDAR, DSC, KEJS

*All authors have read and approved of the final version of the article submitted to Rev Cienc Saude.

Funding information: not applicable.