

Epistemological disputes in the causal link between Zika virus and congenital syndrome: a controversy analysis

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Abstract *An increase in child malformations in 2015 in Brazil is associated with a Zika virus spread months earlier, leaving disputes that still echo. Using elements from a sociology field dedicated to scientific controversy mapping, the present study conducted 15 semi-structured interviews with researchers and administrators involved in this causal association. Our work investigated how actors from different areas observe the role of social conditions in the outcome of the Congenital Zika Syndrome (SCZ) and the paths taken to mitigate them after the epidemic. Concern with social variables and their relevance in the SCZ outcome was observed, with a widespread disappointment about the referral of these issues after the case's peak; however, these factors have not entered the core narrative about causality. There are epistemic disputes about this outcome. Some attach responsibility to the public power or resign themselves to the result; others demand more active positions from researchers who had access to the decision-making process, with disagreements about the positioning of science. The article points out the need for reflective sciences that dialogue with their agency on the phenomena, as well as for interdisciplinary and multicausal articulations for public narratives on public health crises in Brazil.*

Key words *Epidemics, Zika Virus, Public Health, Dissent and disputes, Sociology*

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Introduction

The Zika virus was first identified in April 2015 and, several months later, an increase in birth defects in newborns was observed in the state of Pernambuco. On November 28th of that year, the Brazilian Ministry of Health recognized a causal relationship between the Zika virus and what was then being called microcephaly. A document released by the Ministry listed all the evidence for assuming this relationship, although it had not yet been fully proven. There was a coincidence between the first months of pregnancy and the widespread circulation of Zika in the Brazilian Northeast; the virus had been identified in the amniotic fluid of two pregnant women in Paraíba, and tests conducted by the Instituto Evandro Chagas, in the state of Pará (PA), detected the presence of the virus in stillbirths with visible birth defects¹. Cohort, case-control, and laboratory model studies confirmed the relationship over time²⁻⁵.

This study is the narrative as it related to the causal association between the Zika virus and what is now known as Congenital Zika Syndrome (CZS). However, the story leaves a trace of epistemological disputes, direction, and behind-the-scene scenarios of researchers that is not found in scientific articles. This study aims to recuperate part of these expectations and disputes over the specific causal relationship (the association of the Zika virus with visible birth defects), reconstructing it through a heterogeneous narrative that recovers different connections between participants. The focus here is on understanding how the interviewees understood the role of social factors in the outcome of Congenital Zika Syndrome.

The work uses tools associated with Science, Technology, and Society Studies, a field that, from the 1980s onward, has developed studies that strive to understand both science and society as formed by heterogeneous elements – human, non-human, and discursive. The main project is to investigate scientific work from a wide range of connections in an interdisciplinary approach that integrates reports and artifacts, in addition to scientific discourses considered to be “losers” in clashes and outcomes in science. The social aspect in these narratives is not a specific place formed by humans, but rather by connections between different elements, considering that science is not only constituted by artifacts and techniques, but also by dissent, individuals, and narratives. The primary aim is to show that we live in a common world and emphasize that dy-

namic and local processes are as equally real as those that are universal and stable. Society and science are phenomena that co-produce each other, with science being explained by its content and aspects of the process of evidence formation; analogously, in addition to the classical categories of its field, sociology is explained by technique⁶⁻¹⁰. The scope of this type of analysis has been diverse, ranging from investigating disputes involving the use of embryos in human research to disagreements surrounding the concept of death^{11,12}.

Controversy analysis is a didactic version of one of the main theories belonging to this field, the Actor-Network Theory (ANT). Here, society is not merely comprised of social material, and science is not merely comprised of scientific material^{6,7}. Controversy is a specific moment of the social phenomenon in which the authors consider that these heterogeneous relationships become more visible and easier for the field researcher to map. Venturini¹³ defines controversy as the event in which actors with divergent positions or from different areas perceive the need to establish connections for dialogue with a common objective in mind. To be considered controversial, the phenomenon not only multiplies the number of answers, but also the number of questions.

Methods

This article is an excerpt from a broad mapping of controversy conducted in Brazil in the course of doctoral research and provides a causal association between the Zika virus and visible birth defects in newborns¹⁴. For this reason, the method used here consists of two steps: 1) a mapping conducted within a doctoral thesis with a variety of resources (interviews, observations, analysis of documents, and scientific articles) and based on the ANT, and 2) a selection of twenty-two interviews from this mapping presented in this text, using oral history. Step 1 consists of observing the construction of the causal association from the multiplicity of observation points recommended by the network analysis, considering that, in this perspective, objects of science are the result of discursive constructions, artifacts, individuals, and institutions^{6,15,16}.

The mapping in Step 1 consists of observations and readings of official documents, news, and scientific articles, as well as semi-structured interviews with actors participating in this construction, including scientists from different specialties, managers, families, and public health

professionals, which corresponds to the multiplicity of techniques that can be used in this type of analysis^{6,13}. Fifty interviews were conducted in this step in eight Brazilian states: Bahia (Salvador), Brasília (Federal District), Pará (Ananindeua and Belém), Paraíba (Campina Grande), Pernambuco (Recife), Rio de Janeiro (Rio de Janeiro), Rio Grande do North (Natal), and São Paulo (Jundiaí, São Paulo, and Campinas). This study was approved by Conep (National Research Ethics Committee), logged under protocol number 01208718.9.0000.542. The field work was carried out in 2019 in the form of anonymous interviews; therefore, names and references of selected interviews will not be cited. As recommended by the ANT, these actors had not been previously stabilized. Here, this principle was applied in a practical manner by following the trail of the causal association discourses without favoring a specific research group or institution.

In Step 2, fifteen interviewees who reflected on the weight of social factors in the Zika epidemic were selected from this broad mapping. These factors were non-specific, and this characteristic was included as part of the reports, yet it was possible to group them into a broad category that included the full reflection on the epidemic that could not be recorded in the laboratory, and roughly concerned the world of humans and their collectives.

This work includes the interviewees' testimony about the elements considered social in the epidemic. Oral history was the applied method when selecting these testimonies, in dialogue with ANT. The objective in oral history is to obtain the subjects' reflections on a specific historical moment, in this case, the disagreements surrounding the causal relationship and the role of other factors in the outcome of the congenital syndrome and the epidemic. Oral history is most commonly used to cover facts with people who have had a common experience yet were not recorded in other documentation^{17,18}. However, the objective in the interface with network analysis is also to show the processes involved in the construction of a scientific fact and its stabilization.

Results

The actors' reflections on the weight of the social factors related to the Zika epidemic is presented in two items: 1) how the causality of the congenital syndrome was presented, and how scientists understood the dissent and the weight of social

factors in the epidemic and 2) the disputes of a group of public health officials concerning the presentation of the causal relationship. Such a progression aims to show how social issues were understood in the outcome of CSZ.

The presentation of causality, disputes, and social factors

The first step toward understanding the weight of social factors in the outcome of the congenital syndrome was to ask interviewees how they saw the causal relationship between the Zika virus and the observed anomalies. In general, those who were linked to the laboratory and management spoke about the research groups that described the Zika virus, sometimes emphasizing their pioneering spirit or some degree of competition among the researchers themselves. The leading role of Brazilian science was reported, with scientists and local health professionals working together, as well as joint efforts being made to conduct tests and observe the extent of the cases. Causality controversies that raised doubts about the virus were observed among several groups at the beginning of the epidemic, with some sustaining a number of questions during the field work conducted in 2019, such as the epidemiological distribution of cases, with a higher incidence in the Northeast, which triggered the need for further investigations¹⁹. Other controversies – such as expired vaccines and transgenic mosquitoes – were regarded by many as disinformation that did not deserve further consideration. However, the dissent was polarized, nearly always pointed out as an attempt to deny the action of the Zika virus.

These controversies were internal. Scientists involved in the first case studies and survey of the causal hypothesis said they were surprised by the controversy over the cause of the congenital syndrome within the scientific community, especially at the beginning, when some specialists hypothesized other causes. They reported having been questioned but not having understood, as there was still so much questioning about the role of the pathogen in the outcome, despite the fact that the virus had already been identified and described. One of them reported how there had not been a comprehensive internal debate for other infectious diseases, such as rubella and HIV. With Zika, he said, there was a “very marked” divide, where people were “clearly divided”:

We even scientifically discussed whether the dose of something was 10, 20, or 30, but we didn't

discuss “being and not and not being”, you know? And Zika generated this kind of phenomenon. So, it placed a heavy spotlight and generated the social phenomenon itself.

Another scientist linked to the association hypothesis also recalled disagreements in meetings with medical councils and managers where he met with staunch resistance when presenting the first round of evidence, in which the virus had been found in samples from fetuses with anomalies and stillbirths. Two other reports from Fiocruz virology centers (in the North and Northeast) discussed how epidemiologists asked for more data, when causality was obvious to the laboratory staff: “If you find a virus in the brain of a child with visible birth defects, it’s obvious there’s a causality”, one of them from the North of Brazil said.

The same interviewees referred to differences in the description of causality, which underscored epidemiological disputes between laboratory activities, usually conducted by virologists, and population studies performed by epidemiologists. Roughly speaking, while epidemiology dialogues with causal networks and multiple causal factors for the same condition, as well as with the epidemiological context, the laboratory is normally concerned with isolating a variable or a pathogen capable of causing the illness²⁰. A virologist in Recife reported the difference between specialties:

Because it was a business like that, I had seen, done in the laboratory, all the differentiated diagnoses of this, and so forth... [...], but then they said: you have to prove that it is an association. And I said: “ah, ok, then prove it”. And then [...] I think it’s really Zika, it’s over. We were just listening, you know?

For epidemiologists, the role of epidemiology is devalued in relation to laboratory sciences: “We’re in a scenario where virology speaks louder”. An epidemiologist from Rio Grande do Norte reported that, in the case of Zika, a lot of money was spent on the laboratory without first making basic correlations of epidemiological searches. From his perspective, it was important to know which index city, which municipality, registered the first case of congenital syndrome: “How did you get so far? Spending so much money on laboratory diagnoses and you didn’t want to know that? It’s unjustifiable”.

The reports denoted phenomena that dialogue with the literature of the Social Studies of Science and Technology. One of these was laboratory scientists placing science as a space of pu-

rification, dissociated from the environment^{6,16}. The virus was found in an organism with the condition; it was the cause. There was a reduction, an extraction, and later an expansion to the phenomenon as a whole, with a new narrative in the world that transforms it²¹, in which even dialogue with epidemiology becomes difficult. There is no room for hybrid objects, which transform together with the environment; the formation of Zika’s identity is thus unique, without multiple layers of action from its environment¹⁵. Science is separated from society, in a separate space, and takes the phenomenon for itself. A narrative for co-productions (with society and science acting on the phenomenon) is not imposed upon causality²².

In general, the influence of social factors is seen as being important, but they do not participate in the causality narrative. Virologists, pediatricians, public health workers, pathologists, entomologists; whatever the specialty, there was at least some understanding of this influence. In conversations about socioeconomic factors related to the epidemic, the associations were unanimous: those affected by it live in a place where the transmitting mosquito is found in abundance. They did not have access to family planning information, and other factors may have worsened the outcome, such as the lack of basic sanitation and intermittent supply of water.

The burden of the epidemic on those most vulnerable to it has been cited as a recurrent fact: “If you overlay the poverty map with the Zika map, it’s always in the same places”, said an epidemiologist at one of Fiocruz’s units in the Northeast. “This being a rhetorical democratic disease [...] it’s a socially marked disease”, stressed a researcher at the Federal University of Pernambuco. “Google ‘Recife and Água’ and you’ll see it”, reported a researcher from Fiocruz. “Urban cleaning efforts were undertaken, but they weren’t continuous, and garbage was literally ‘running down the hill’”. A researcher at the Instituto Evandro Chagas in Belém reported that the city was experiencing a chaotic situation: “Less than 10% of the area is clean”. He said it’s a broad, general problem for which he did not see a solution: “That doesn’t give a vote. It’s a job that no one sees”.

There was also a shared expectation in the interviews that more structural and political actions could have boosted the epidemic, but that did not happen. It was further mentioned how the tragedy of the families could have been the final appeal for the historical conditions linked

to arboviruses in Brazil, such as basic sanitation, to finally have a more resolute path. This expectation indicated the hybrid character of the epidemic, which was not merely an event of nature. While the factors considered social did not enter the narrative of Zika-syndrome causality, it was expected that they would have visibility precisely because of the phenomenon. The general feeling among the interviewees was that they had done their part, but that there were many social barriers to preventing the situation. Disappointment appeared even among managers, as explained in the statement below by an employee of the Ministry of Health:

I thought we would have solved the sanitation issues faster, which didn't happen [...] It was a bit frustrating, because almost nothing happened. Zika is still there, we still have cases. It's a matter of having the coincidences of a new epidemic.

The reports demonstrated the extent to which social factors were mentioned among the interviewees during the epidemic. Such aspects are often generically mobilized by actors and may or may not include the agency of other people (politicians), circumstances (sanitation and housing), and risk factor triggers (poverty). In most cases, these factors appear as not belonging to the cycle of causality per se, but rather as a background scenario that allows the emergence of the epidemic, the outcome, or an aggravating factor. The social element in science is narrated from internal controversies or polarized between the acceptance of the role of the virus in the outcome.

An almost transcendent social explanation was mobilized in the epidemic's narrative with little specificity, while nature [Zika] remained immanent and was an object of investigation. The debate thus reproduced what Latour called the modern constitution: the social element was separated from nature, so that criticism did not demobilize empiricism^{6,15}. It then followed that science operates in a scenario of purification, in which the pathogen and the outcome of the syndrome are not traceably associated with the environment.

It has also been observed that the social explanation is often mobilized to justify the recurrence of arboviruses. Bruno Latour⁶ discussed how the mobilization of social explanation in complex issues, as in the case of an epidemic, can leave part of the explanation of the phenomenon outside the purview of science, without being properly investigated. The "social" ends up as a category that impedes the movement of associa-

tions, "a hidden force capable of being mobilized when convenient"⁶(p.26). In the case of the Zika epidemic, some questions remained as hypotheses for a long time, without following their trail or trying to provide an answer with a more integrated causal explanation. The social determinants of health thus became a generic category that, although considered relevant, were neither delineated nor broken down to generate specific courses of action. While Zika has agency in the anomaly, it does not account for all of the syndrome's socio-determination, and its narrative has a specific place. Therefore, the narrative purified of causality seems to be displaced from its place of production: the laboratory.

Pressure from public health workers

"If you look at the local health department, they identified a social determinant, such as the issue of sanitation, but there were no subsequent actions to combat it", reported a public health worker at the Federal University of Bahia. The discussion of how social conditions are in the emergence of diseases and related problems has permeated numerous epidemics and finds its strength with the emergence of the so-called collective health. This was a movement that arose in the second half of the 20th century, in which health began to be studied by the social sciences. There was a fundamental criticism in this movement that involved the centrality of the biological narrative about the health-disease phenomenon, in which other constitutive processes were left out. Productive, political, and environmental elements also make up the illness or health scenario. Conditions that show greater vulnerability to arboviruses range from sanitation to unequal access to health services²³⁻²⁵.

Despite this being a tradition in the field, public health practitioners within institutions that studied causality found little room for this social proposition in the case of Zika and some professionals linked to the field preferred traditional approaches. A public health worker in Recife reported being in a Department of Public Health where potentially everyone shared a concern with social issues, yet the research turned out to be traditional:

All of the people who worked on studies that revealed an association between Zika and microcephaly, most of whom were from the department, but the research itself was traditional, focused on a direct association between a pathogen and an outcome. Later, there was some research related to

the situation of families, how it impacted women. But there was no research, no design, in the sense of identifying the processes that led to this particular epidemic.

Health experts continue to regret that researchers, even with all the accumulated knowledge in the field of social issues, only “stumble” upon them. It was the media – not science – that dictated the social discussion, said a researcher from Paraíba. She argued that many of these researchers had influence and access to centers of power, but they did not include social determinations in the epidemic’s core narrative. “There are researchers in this group who advise the Ministry of Health [...] They don’t criticize, so they can at least say it’s a problem linked to a socio-environmental issue”.

An important controversy within the field was the publication of a note on larvicide (pyriproxyfen), which is used to control *Aedes aegypti* larvae. Written by a collective health association working group, researchers were critical of the increased use of the product during the epidemic and called for an investigation of the teratogenic effects of these substances and potential association in the outcome of anomalies²⁶. The note led to the proposal of hypotheses on the teratogenic effect of these compounds and warned of the use of larvicide in the population’s drinking water within the context of anomalies. Meanwhile, the note was read as directly questioning the causality of Zika, with debates in the press, repercussions outside the country, and the cancellation of the use of larvicide in one Brazilian state²⁷⁻³⁰. The researchers who were interviewed saw it as part of a broader field of struggle, about the increased use in such a context, in which social determinants were not discussed and the way to control the disease was conducted by attacking the potability of water for the most vulnerable population.

“I no longer stray from the neutral study paradigm”, said a health worker at one of Fiocruz’s units in Southeast Brazil, who participated in writing the note. His studies showed his peers that there was a technical and scientific basis, but he knew there was also a means of confrontation and of entire populations living in conditions that depend on emancipatory knowledge: “There was a broader discussion of taking advantage of the gravity of this issue to bring about social determination”. It was enormously difficult to publish the note, but the researchers managed to disseminate it as a working group: “It’s similar to when you submit an article and your vision isn’t

hegemonic. New paradigms are complicated”.

The interviewee understood the group’s position as an attempt to introduce a “new paradigm”, by including the so-called social factors in a more central description of the syndrome. Such reflection refers to Thomas Kuhn and his classification of the functioning of normal science, in which references circulate without being disputed and to periods of paradigm shifts and revolutions in which these circulating references are contested³¹.

However, the position of the public health workers failed to upset the prevailing paradigm. As the scientific community continued to publish studies on the association between pathogen and outcome, a consensus on unicity was consolidated, and the public health workers were “defeated”. The controversy stabilized and, over time, the discussion ended up being seen as ignorance and misinformation about the role of Zika³². In the end, nature – or Zika as the sole explanation for the congenital syndrome – was not the starting point, but rather the outcome, whose social determinants were left in the shadows²¹.

Public health workers attempted a *translation* by proposing a new interpretation for the fact⁸ and, to a certain extent, they succeeded in including themselves in the network through the press, but without the same long-term effect. They disputed the construction of the black box, an expression used to designate a consolidated scientific fact, not through major findings, but rather through the stabilization of the controversy^{6,21}.

Most of the interviewees who were not involved in writing the note (among the managers and laboratory scientists) limited it to an analysis of the direct action of the larvicide on the outcome. They reiterated that there was no evidence for the association of the product, given that many cases of CSZ occurred in areas where the larvicide was not used. No questions were being asked about other social factors and determinants. “Whoever said it was pyriproxyfen had no supporting evidence. It hadn’t been used in Recife, which was the epicenter of the epidemic. So how can we talk about insecticide when it didn’t even exist at the heart of the epidemic?”, asked a virologist in Recife.

A comment was made about how difficult it is to mix militancy with science, considering it takes time to propose hypotheses and wait for a proper investigation to be conducted. “It’s not that it was impossible for it to be the pesticide, but it became almost an instant response [...] people had already been exposed to the idea and started defending their point of view even before

the questions were being asked”, an employee at the Ministry of Health observed.

Public health workers saw the possibility of an interdisciplinary study being done, in which there were indications of more data sharing and the possibility of greater integration between sectors and disciplines, given the complexity of the outcome, which, for them, would be an opportunity for social factors to occupy a bigger place in the narrative of arboviruses – and there would be a chance of a wider public view with greater priority in the area. However, after some initial exposure to these issues, this did not occur, as reported by a public health worker in Paraíba:

Zika came up with a “let’s integrate, let’s do everything together” speech, but that’s not what happened in practice. So that’s something you see as well. If you look at the analysis of resources, of the money, you have a profile of the research that was funded...

While citing pyriproxyfen as a possible cause of the congenital syndrome triggered a polarization in causality, there was also little room left to understand the questioning as a pathway to sociodetermination. Again, the dispute lies over differences between disciplinary fields, consolidating purified regions, and little network interaction with other epistemologies. Here, despite the triggering of the controversy, one sees a replacement of the modern constitution, with science on one side and society on the other. While laboratory scientists focused on the primacy of the etiological factor, public health workers took the position of denunciation, reinforcing the division and positioning the epidemic on the social side. However, differences in positioning regarding the proximity of hegemonic centers of science and power production must be considered, with the etiological factor being favored by these centers and, with the public health narrative being less visible, one can reflect on the attempt to produce dialogues.

Discussion: a reflective and inclusive science

The reports indicated that most of the interviewees reported social factors to the epidemic that led to CZS, but this association appeared in a diffuse way, not directly associated with causality or an attempt at a multicausal explanation. The relevance and importance of improving living conditions was understood to reduce the number of cases and change the course of arboviruses in Brazil. There were reports of internal controver-

sies, with other possibilities for investigation appearing as a threat to the performance of the Zika virus; however, these inquiries were not integrated into a multifactorial description of the outcome. The role of science for most researchers is centered on the production of specific evidence, with social determinants relegated to other subjects, such as the government, or discussions in which their importance is cited in directions for public opinion.

When social explanations are activated, some researchers start with a division that appears to put these questions outside the parameters of science, not only in the sense that it is up to the public authorities to resolve them, but also that their role, even among the most vocal, would be in publicly denouncing its importance and excluding relevant questions within their scientific investigations or even suggesting more interdisciplinary studies that describe causality.

Such reductionism in the explanation of diseases has already been mentioned through classic discussions in Public Health, such as those specified by public health specialist Sérgio Arouca. Arouca discussed how preventive medicine, even when dialoguing with elements other than the pathogen, often ends up being trapped in causal networks, in which social elements do not enter into the explanation and are only referenced³³. The fetal anomalies between 2015-2017 were primarily described through the paradigm of the natural history of the disease, which marks the horizon in two moments: the pre-pathogenic, before contact with the virus and the field of prevention, and the post-pathogenic, in which the symptoms and possibility of treatment appear³⁴. The problem with this description, according to Arouca, is that the being [the pathogen] ends up being very marked and included in a field of generalities. To add here Latour’s notion of hybridity^{6,15}, in addition to being marked, it is unique; it is neither transmuted nor transformed by the environment.

Although social factors have been cited, there are divergences and epistemological disputes as to the position of science in this process, as well as the centrality of these factors in a more direct discussion about causality. When analyzing the comments of some interviewees (primarily public health workers), the central narrative about Zika and the congenital syndrome was brought into question, in the sense that more room was needed for social determinants in causality. However, this dispute wound up taking a path of substitution of causes when the role of the larvicide

in the outcome of the syndrome became evident, which, in turn, ended up being understood as a direct questioning of Zika, generating polarization in causality.

While some scientists viewed this controversy with astonishment when considering the history of socio-determination of arborivorous trees in Brazil, the questions about the central role of Zika can only be understood as the virus's hybridity gains more visibility. The objects of science are dynamic when outside the laboratory; they interact with the social world and are transformed, taking different forms, consolidated from agencies while purified in the laboratory³⁵. The episteme of thinking about arboviruses in Brazil in a purified way has been questioned for decades, and the reflection on this questioning can be seen in the reports presented here; however, Zika showed a moment when there was an attempt to reach a more centralized dispute of this purification. Nevertheless, a greater centrality for socio-determination did not occur due to a complex network that involved reinforcing the nature-society division (either by the position of laboratory scientists or the position of health workers) and bringing some actors to the centers of power.

The disappointment expressed by the researchers about how social issues did not have the impetus they had hoped for indicated that the Zika epidemic, alone, was not capable of changing the course of events in the way it was conducted. If social factors are disconnected

from the causality of the syndrome, it can be inferred that there would be little reason to favor them as preventive actions. While it cannot be said that a more central multicausal description of the epidemic would be the place for social determinants to be resolved, they would have had more visibility.

It is worth noting that the mere disclosure of evidence produced in a laboratory or from specific scientific methods is only a part of the phenomenon. Other actors are needed to explain the phenomenon, both from other areas of expertise, as well as from other forms of knowledge and reports from those who confront the problem³⁶. Science must be part of democracy and coexist with other knowledge practices³⁷, so that, although expertise is part of the process, it is one intellectual tradition among many³⁶. With the public explanation of the outcome of the syndrome centered on the etiologic agent, the stabilization of the causal relationship between Zika and the anomalies excluded important socio-determinations from the process. Therefore, one of the lessons learned in advance of the next public health crises in Brazil is the composition of interdisciplinary discourses that integrate relevant aspects for the production of the outcome. There was an opportunity to have a more profound discussion on the role of social factors in Zika causality and scientists could have been taken advantage of it and included it as a relevant and interdisciplinary object of investigation.

Collaborations

MB Oliveira conducted the interviews, participated in fieldwork, and wrote and revised the article. M Akerman contributed to the method, composition, and review of the article.

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