COVID-19 pandemic evolution in the Brazilian Indigenous population

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Abstract

Introduction The COVID-19 pandemic has affected several neglected populations such as the Indigenous peoples, which have suffered a high impact from the pandemic.

Objectives To analyze the impact on the health and disease process according to the COVID-19 evolution in the Brazilian Indigenous population.

Methods Data was collected from press releases by the Health Ministry and a descriptive analysis of the numbers of Indigenous individuals infected with the SARS-CoV-2 in Brazil was carried out.

Results In February 2021, there were 41,855 confirmed cases of Indigenous individuals infected by the SARS-CoV-2, including 4,387 active cases, 36,809 recovered cases, and 549 deaths. The Brazilian Indigenous population is distributed in over 300 ethnic groups and, due to the high number of deaths by the COVID-19, many of these groups are endangered. The elderly are the most affected age group, and they play a fundamental role among the Indigenous population for transmitting their customs mainly orally. Indigenous populations do not have proper access to transport to specialized health centers, since many areas are inaccessible and other cases require air or river transportation, which many times results in late assistance. When managing the COVID-19, it is important to emphasize the need for social isolation to prevent the virus from spreading among the Indigenous groups, mainly due to their contact with other ethnic groups represented by missionaries, hunters, and wood explorers, among others.

Conclusion The adoption of practices that can reduce the virus transmission among the Indigenous population and provide them with better access to treatment, mainly for the elderly, must be prioritized in Brazil.

Keywords Indigenous population · Pandemic · Social isolation · SARS-CoV-2 · COVID-19 · Vulnerable group
**Introduction**

On March 11, 2020, the World Health Organization declared that the COVID-19 could be characterized as a pandemic due to the spread of the coronavirus disease 2019 (COVID-19) [1] caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [2]. Facing this scenery, the analysis of the health and disease processes in different social contexts became relevant for the COVID-19 control, mainly when considering the great territorial extension, the social and demographic aspects, and the populational heterogeneity in Brazil. Thus, a detailed analysis of each of the groups that form the Brazilian population is essential, mainly those groups that present higher degree of vulnerability to pandemic situations, such as the Indigenous peoples (Fig. 1).

Indigenous peoples, despite representing 0.4% of the Brazilian population, according to the census carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2000, constitute a cultural heritage that comprises 305 ethnic groups and 274 languages [3]. The struggle for the recognition of Indigenous rights is historical and continues until nowadays. The recognition of the Indigenous citizenship and guarantee of respect to their customs and traditions, health, rights to the lands traditionally occupied by indigenous tribes was only enacted in 1988 with the approval of the Brazilian Federal Constitution. Consequently, an increase in their political representativeness occurred along with achievements in the social area that resulted in a process of ethnic emergence with a 177% indigenous population growth in a period of 20 years [4].

The indigenous peoples’ achievements enabled better integration between this group and the rest of the Brazilian population, so that many Indigenous individuals live in the urban zone currently. However, their proximity with other ethnic groups was one of the factors that favored the spread of the SARS-CoV-2, and the first case of infection was associated to the contact with an infected medical doctor [5]. At the same time, wood exploration, deforestation of environmental preservation areas, and illegal mining increased the risk of these native people to be infected with the SARS-CoV-2 and to get other infectious diseases [5–7]. Also, despite the Indigenous peoples having constitutional rights, in practice they are not applicable, contrariwise, they are often violated by the Brazilian government through the adoption of anti-environmental measures that resulted in the highest rates of burning in the Amazon forest in the last 20 years. The federal government attitudes regarding environmental prompted the Brazil forests to devastation being observed a record of loss of vegetation cover, mainly on Amazon lands [8]. The neglect of the federal government in protecting Indigenous peoples against COVID-19 and its lands was described in the literature demonstrating a high impact of the COVID-19 pandemic on this population due the absence of better federal government attitudes [8, 9].

In contrast, state actions related to the Indigenous health started in 1999 through the division of their territory into Indigenous Health Special Districts (DSEIs, Brazilian acronym for Distritos de Saúde Especial Indígena), with the purpose of offering specific health measures to the local groups. Indigenous Health Units and the Indigenous Health Houses (CASAI, Brazilian acronym for Casas de Saúde Indígena) were implemented in the DSEIs, which were responsible for the medical assistance of higher complexity. Another measure adopted was the qualification of Indigenous individuals to work as health agents. The measures showed a beneficial effect on this population health resulting in a reduction in the mortality rate from 7.1% to 4.77%, in the period between 2000 and 2005 [10]. Despite the improvement in the Indigenous assistance, many individuals still refuse their own or the transportation of members of their families to more specialized health centers; for this reason, optimized medical assistance that respect the cultural divergences and traditions of those peoples is required [11]. Concomitantly, equipment, materials, and professionals are scarce, and the difficult access to the health units hampers such assistance [12].

The COVID-19 pandemic is a global challenge and a threat to the Indigenous culture, since many native customs started to be practiced only by the elderly and might get lost after these older individuals’ deaths—this is the age group most affected by the COVID-19 [13]. According to all the limitations related to the Brazilian indigenous health, it becomes relevant to analyze how this group has faced the pandemic in a prospective study. Therefore, this study aimed to verify the evolution of the COVID-19 impact on Indigenous peoples, regarding cultural aspects and their survival at a national level based on the epidemiological notes published by the Brazilian Health Ministry. In addition, a descriptive analysis of the number of cases of Indigenous individuals infected with the SARS-CoV-2 in Brazil is provided.

**Methods**

A prospective data survey was carried out based on the epidemiological notes released by the Brazilian Health Ministry [14]. The full text of all notes published were read and evaluated by the researchers responsible for this study. Notes whose content was about government actions such as the distribution of individual protection equipment (IPE) and clarifying notes by the Health Ministry regarding facts occurred were excluded, while those specifically related to the COVID-19 pandemic progression in the Indigenous population were included.

The data collected from the notes were (i) name of the DSEI of origin of the Indigenous patient; (ii) ethnic group that the Indigenous patient belonged according to the National Indian Foundation (FUNAI, Brazilian acronym for Fundação Nacional do Índio); (iii) age (years); (iv)
comorbidity; and (v) social status within the Indigenous community. In the case of death, the date was recorded. Other information used, whenever available, was the disease transmission history and how many people might have been infected with SARS-CoV-2 from one confirmed case in the community.

The instructions to the health units on the treatment and monitoring of Indigenous patients were given by the Health Ministry. The DSEI is a management unit decentralized from the Indigenous Health Attention Subsystem, so that the health service becomes guided to a certain ethnic-cultural group. The DSEIs are structured in Indigenous Basic Health Units (simple infrastructure destined to basic procedures and patients’ follow-up), base centers (structure with a multidisciplinary team and that might be located inside the indigenous community or in reference municipalities), and the CASAIs (places of support to the indigenous population, for example, to provide accommodation to the Indigenous patient and their families during the treatment, which includes assistance to patients after hospital discharge).

The Indigenous Health System provided information such as the total number of COVID-19-suspected cases (Indigenous individuals with acute respiratory symptoms that left the tribe or that had contact with another suspected or confirmed case in the last 14 days), COVID-19-confirmed cases (cases were described as confirmed after laboratory analysis and by clinical criteria), COVID-19-dismissed cases (suspected case with negative laboratory result for the SARS-CoV-2 identification), COVID-19-infected cases (confirmed cases with active infection), clinical cure (cases confirmed that spent 10 days in home isolation, as of the start of the symptoms, and that were asymptomatic for 24h), and number of deaths (cases presenting death as a result of the SARS-CoV-2 infection and its complications). Finally, the 1st phase of the COVID-19 vaccination program in Brazil considers the Indigenous population living on indigenous land as a priority group.

Results

Description of official notes by the Health Ministry in relation to the COVID-19 evolution in the Indigenous population

Out of the 79 notes evaluated, 70 were selected, which included specific reports of Indigenous cases aiming to evaluate parameters such as death, comorbidity presence, social function, and other problems faced by those individuals. The remaining 9 notes were excluded for only describing the contamination of professionals related to the DSEIs (medical doctors and other health professionals, DSEIs coordinators, 51 Indigenous individuals) without specifying details. There was also a note reporting the death of a FUNAI worker.

Table 1 presents the content of the notes published by the Health Ministry. According to the age range of those infected:

- (< 1 year old) two releases described death; malnutrition was reported in one of the cases;
- (Individuals between 10 and 19 years old) six releases; five of them reported death. One of these patients presented tuberculosis and congenital cardiopathy;
- (Individuals between 20 and 29 years old) three releases; none of them reported death;
- (Individuals between 30 and 39 years old) four releases; three of them reported the death of the Indigenous patient, including a tribe chief. Another of these patients who died was diagnosed with diabetes mellitus (DM) and suspected cancer, and the other was a nurse from the Indigenous Health Multidisciplinary Team who was diagnosed with asthma;
- (Individuals between 40 and 49 years old) four releases and all of them reported death. One of them was a tribe advisor and had influence in the local leadership. The comorbidities found were autoimmune hemolytic anemia (one patient); chronic kidney disease (one patient); obesity and systemic arterial hypertension (SAH) (one patient);
| Note         | Ethnic group | DSEI                  | Age         | Comorbidity          | Death   | Description found in the newsletter                                                                                                                                                                                                 |
|--------------|--------------|-----------------------|-------------|----------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 08/04/2020   | Kokama       | Alto Solimões         | 20 years    | ND                   | ND      | The Indigenous woman was an indigenous health agent (AIS, Brazilian acronym for Agente Indígena de Saúde) and was the first coronavirus disease 2019 (COVID-19) case in the Brazilian indigenous population. The professional was infected by being in contact with a physician that had been diagnosed with the COVID-19. Since 25/03/2020 up to the date of the publication, the medical doctor and the people that had been in contact to him, including 12 Indigenous individuals and 15 members of the health team, were isolated. Out of the 27 tests carried out, only the AIS tested positive for the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The Indigenous woman had not presented symptoms and the seven people that had been in contact with her were also tested for SARS-CoV-2. |
| 08/04/2020   | Kokama       | Alto Solimões         | 37 years    | ND                   | ND      | The Indigenous individual was one of the seven people who had been in contact with the first indigenous woman that tested positive. On the date of publication of the note, the man was in isolation. All the other indigenous that were being monitored were asymptomatic.                                                                                                           |
| 08/04/2020   | ND           | Alto Rio Solimões     | ND          | ND                   | ND      | Physician infected with the SARS-CoV-2 and asymptomatic returned from his vacation and started to attend patients of the ethnic group Tikuna in the Indigenous health special district (DSEI) in Alto Rio Solimões. As soon as the physician presented symptoms, he reported them to the district coordinator that isolated the medical doctor and the patients he had attended. Health authorities in the Amazonas state were communicated. The DSEI purchased 100 fast tests to identify the SARS-CoV-2 infection. |
| 10/04/2020   | ND           | Yanomami              | 15 years    | ND                   | ND      | First report of death of an Indigenous woman.                                                                                                                                                                                                                                                  |
| 11/04/2020   | Tikuna       | Alto Rio Solimões     | 78 years    | Heart problems       | ND      | Patient being treated for heart problems was admitted in the Tabatinga Hospital in the Amazonas state. Later on, the patient was transferred to the intensive care unit (ICU) of the Delphina Aziz Hospital (Manaus). On 25/03/2020, he was transferred to the Francisca Mendes Hospital. During the treatment period, SARS-CoV-2 was identified. |
| 11/04/2020   | Kokama       | Alto Rio Solimões     | 44 years    | Autoimmune hemolytic anemia | ND      | The Indigenous woman Kokama had been in hospital since 28/02/2020 in the municipality of Manaus to treat autoimmune hemolytic anemia. Her condition worsened after SARS-CoV-2 infection.                                                                 |
| 14/04/2020   | Galiby Kalinã| Amapá and Norte do Pará| 28 years    | ND                   | ND      | Indigenous man that worked as a nurse in the Indigenous health House in the municipality of Oiapoque—state of Amapá. The patient was in social isolation, but without any COVID-19 severe symptoms on the date of the note publication.                                                                           |
| 16/04/2020   | ND           | Eastern Roraima       | ND          | ND                   | ND      | The coordinator of the Eastern DSEI in Roraima tested positive for SARS-CoV-2. After the appearance of the first symptoms, the coordinator took a sick leave from the DSEI and remained in social isolation.                                                                                                                |
| 17/04/2020   | Sateré-Mawé  | ND                    | 67 years    | ND                   | ND      | The Indigenous patient had been in hospital since 13/04/2020 when he had presented the first COVID-19 symptoms. The patient belonged to the Tuxaua ethnic group ( Indigenous leader) and had been visited by his son that lived in Salvador and presented cough while visiting the tribe. |
| 18/04/2020   | Pitaguary    | Ceará                 | Pulmonary disease | ND   | 15/04/2020 |
| Date       | Ethnic Group | DSEI         | Age            | Comorbidity                                      | Description found in the newsletter                                                                 |
|------------|--------------|--------------|----------------|-------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 24/04/2020 | ND           | Alto Rio Solimões | 76 years old | ND                                             | A female Indigenous patient was admitted in hospital on 14/04/2020 with symptoms similar to those of the COVID-19. The SARS-CoV-2 test result had not been released until the publication of the note. |
| 24/04/2020 | ND           | Parintins | ND | ND                                             | ND                                                                                                   |
| 26/04/2020 | ND           | Palikur     | ND | 35 years old                                  | 30 tests to identify SARS-CoV-2 got positive results at the DSEI Alto Rio Solimões. The test results were a consequence of the contact with the physician that tested positive after return from his vacation. |
| 30/04/2020 | ND           | Tikuna      | ND | 63 years old                                  | ND                                                                                                   |
| 30/04/2020 | ND           | Tikuna      | ND | 68 years old                                  | ND                                                                                                   |
| 01/05/2020 | ND           | Guamá-Tocantins | 29 years old | ND                                             | ND                                                                                                   |
| 02/05/2020 | ND           | Yanomami | ND | ND                                             | ND                                                                                                   |
| 02/05/2020 | ND           | Yanomami | ND | 15 years old                                  | Digital human test positive for the SARS-CoV-2                                                                 |
| 03/05/2020 | ND           | Guamá-Tocantins | 79 years old | Anemia                                         | 30 positive results were identified at the DSEI Alto Rio Solimões. The test results were a consequence of the contact with the physician that tested positive after return from his vacation. |
| 09/05/2020 | Kariri Xocó  | Alagoas and Sergipe | 56 years old | Heart, kidney and pulmonary diseases          | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 09/05/2020 | Macuxi       | Eastern Roraima | 17 years old | ND                                             | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 10/05/2020 | Tabajara     | Ceará       | ND | ND                                             | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 12/05/2020 | Pitaguary    | Ceará       | ND | 53 years old                                  | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 12/05/2020 | Tikuna       | Alto Rio Solimões | ND | ND                                             | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 13/05/2020 | ND           | Xavante     | 40 years old | Chronic kidney disease                         | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 16/05/2020 | ND           | Alto Rio Solimões | 70 years old | Impaired sight                                 | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| 18/05/2020 | ND           | Porto Velho | ND | ND                                             | 09/05/2020 The Indigenous woman started to present symptoms on 04/05/2020.                            |
| Note          | Ethnic group | DSEI                  | Age       | Comorbidity                                    | Death       | Description found in the newsletter                                                                                                                                                                                                 |
|--------------|--------------|-----------------------|-----------|------------------------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20/05/2020   | Tikuna       | Alto Rio Solimões     | 76 years  | Systemic Arterial Hypertension (SAH)           | 19/05/2020  | On 29/04/2020, the Indigenous woman presented dyspnea and was admitted in hospital. On 30/04/2020, she tested positive for SARS-CoV-2. Her family did not allow her transfer to a more specialized medical center.          |
| 20/05/2020   | Apurinã      | Alto Rio Purus        | 16 years  | ND                                             | ND          | A 37-week pregnant Indigenous woman tested positive for SARS-CoV-2. She had presented respiratory symptoms and was submitted to an emergency cesarean section. On 19/05/2020, she presented improvement of the general clinical condition. |
| 20/05/2020   | Xavante      | 8 months              | 68 years  | ND                                             | 11/05/2020  | The COVID-19 fast test was carried out on 15/05/2020 and got a positive result. The patient’s family did not allow his transfer to a health service unit.                                |
| 22/05/2020   | Tikuna       | Alto Rio Solimões     | 76 years  | Diabetes mellitus and SAH                      | 19/05/2020  | On 17/05/2020, the Indigenous woman presented symptoms such as dyspnea and dry cough, with clinical condition worsening, presenting 48% transcutaneous oxygen saturation (SpO₂). The patient was referred to hospital treatment via river transportation (30 min), where the SARS-CoV-2 infection was confirmed. |
| 21/05/2020   | Kokama       | Alto Rio Solimões     | 60 years  | Diabetes mellitus                              | 14/05/2020  | On 11/05/2020, the Indigenous woman presented acute respiratory symptoms that worsened on 13/05/2020, when the patient was referred to the hospital unit and after being tested for SARS-CoV-2, she got a positive result. |
| 22/05/2020   | Tikuna       | Alto Rio Solimões     | 88 years  | Absence of previous comorbidities             | 21/05/2020  | ND                                                                                                                                                                                                                                 |
| 22/05/2020   | ND           | Alto Rio Solimões     | ND        | ND                                             | 20/05/2020  | ND                                                                                                                                                                                                                                 |
| 25/05/2020   | Munduruku    | Rio Tapajós           | 78 years  | ND                                             | 22/05/2020  | In the period between 20/04/2020 and 05/05/2002, the Indigenous man was in treatment in the intensive care unit. The patient was discharged and started to present flu symptoms; he tested positive for SARS-CoV-2 on 18/05/2020 and was admitted in hospital again. |
| 27/05/2020   | Apurinã      | Alto Rio Purus        | 56 years  | SAH                                            | 25/05/2020  | On 12/05/2020, the Indigenous woman presented flu symptoms after having had contact with a COVID-19-infected individual. The SARS-CoV-2 test was carried out on 22/05/2020. She tested positive and was referred to hospital treatment. |
| 28/05/2020   | Kokama       | Alto Rio Solimões     | 86 years  | ND                                             | 21/05/2020  | In the household visit on 13/05/2020, the Indigenous woman presented dry cough, loss of taste and smell, and fever. On that occasion, she was told to go to the hospital, but her family did not accept the advice. On 14/05/2020, the patient showed improvement of the symptoms; however, on 15/05/2020 she had difficulties breathing and 89% SpO₂ with rumbles in the pulmonary auscultation. She tested positive for SARS-CoV-2. On 21/05/2020, the patient presented worsened clinical condition and was transferred to the hospital, where she died. |
| 30/05/2020   | Munduruku    | Manaus                | 84 years  | ND                                             | 29/05/2020  | The Indigenous patient was admitted in hospital on 21/05/2020. The transportation to the hospital was by boat and land vehicle. The patient was diagnosed with SARS-CoV-2 on 27/05/2020.                                                                        |
| 30/05/2020   | Tikuna       | Alto Rio Solimões     | 75 years  | ND                                             | 28/05/2020  | ND                                                                                                                                                                                                                                 |
| Date       | Ethnic group | DSEI                 | Age   | Comorbidity                                                                 | Description found in the newsletter                                                                 |
|------------|--------------|----------------------|-------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 30/05/2020 | Tikuna       | Alto Rio Solimões    | 11 months | ND                                                                          | On 15/05/2020, the patient presented 80 and 90% SpO₂. At that point, the family refused sending him to the hospital. On 20/05/2020, he tested positive for SARS-CoV-2. On 26/05/2020, in the morning, his clinical condition worsened. |
| 31/05/2020 | Shawádawa    | Alto Juná (Arara)    | 61 years old | Since February, the patient had presented a series of diseases such as dengue, a neck tumor, and malaria | 21/05/2020 In a household visit on 20/05/2020, the patient presented respiratory difficulty and was referred to the region reference hospital, where the SARS-CoV-2 test result was positive. On 21/05/2020, the infant’s health condition worsened. |
| 02/06/2020 | Yanomami     | Yanomami             | 15 years old | Tuberculosis and congenital cardiopathy                                     | 31/05/2020 On 17/05/2020, the Indigenous man tested positive for SARS-CoV-2.                          |
| 02/06/2020 | Kayapó       | Kayapó do Pará       | 61 years old | ND                                                                          | 02/06/2020 On 14/05/2020, the patient presented symptoms similar to those of the COVID-19; the patient had a positive result in the SARS-CoV-2 test. |
| 02/06/2020 | Apuriná      | Alto Rio Purus       | 17 years old | ND                                                                          | 26/05/2020 On 24/05/2020, the Indigenous man presented cough, fatigue, and fever and was tested positive for SARS-CoV-2. At that moment, he was referred to treatment at the health unit, but his family refused that. |
| 03/06/2020 | Munduruku    | Rio Tapajós          | 59 years old | Chronic respiratory disease                                                | 01/06/2020 The indigenous woman was in the 37th week of pregnancy. On 13/05/2020, she presented symptoms like those in the COVID-19. On 14/05/2020, she underwent a cesarean section, and next, she was transferred to the ICU. On 18/05/2020, she got a positive result in the SARS-CoV-2 test. Her clinical condition worsened on 31/05/2020. |
| 03/06/2020 | Munduruku    | Rio Tapajós          | 71 years old | None                                                                       | 02/06/2020 On 25/05/2020, the Indigenous woman presented dyspnea and was referred to the emergency service unit. At that moment, she tested positive for SARS-CoV-2, and on 30/05/2020, the patient’s clinical condition worsened. |
| 03/06/2020 | Kayapó       | Kayapó do Pará       | 52 years old | ND                                                                          | 03/06/2020 On 23/05/2020, the patient arrived at the Health Basic Unit presenting acute respiratory syndrome, fever, cough, headache, and 78% SpO₂. He tested positive for SARS-CoV-2 on 25/05/2020. His family did not allow his transfer to a medical center with higher level of specialization. |
| 04/06/2020 | ND           | Javari               | ND    | ND                                                                          | 04/06/2020 Four health professionals from the DSEI Vale do Javari tested positive for SARS-CoV-2 on 03/06/2020. At that moment, the professionals were in isolation. |
| 06/06/2020 | Kaingang     | Interior Sul         | 64 years old | Obesity                                                                     | 06/06/2020 On 19/05/2020, the Indigenous man presented acute respiratory syndrome symptoms and was referred to the local hospital where he tested positive for SARS-CoV-2. On 28/05/2020, the patient was admitted in the ICU. |
| 08/06/2020 | Anacé        | Ceará                | 51 years old | Diabetes and heart diseases                                                 | 08/06/2020 On 10/05/2020, the Indigenous man presented sore throat, fever, and cough, and, later on, his clinical condition worsened. On 20/05/2020, he was admitted in the Emergency Service unit, where he tested positive for SARS-CoV-2 on 28/05/2020. |
| 08/06/2020 | Tapeba       | Ceará                | 85 years old | SAH                                                                         | 10/06/2020 On 11/05/2020, the Indigenous man arrived at the emergency service unit complaining of cough and dyspnea. He was tested for SARS-CoV-2; the positive result was only released after his death. |
| 10/06/2020 | Kayapó       | Kayapó do Pará       | ND    | ND                                                                          | 10/06/2020 On 10/05/2020, the Indigenous man presented acute respiratory syndrome symptoms and was referred to the local hospital where he tested positive for SARS-CoV-2. On 28/05/2020, the patient was admitted in the ICU. |
| Date     | Ethnic Group     | DSEI          | Age            | Comorbidity                          | Death                  | Note                                                                 |
|----------|------------------|---------------|----------------|--------------------------------------|------------------------|----------------------------------------------------------------------|
| 12/06/20 | Kaingang         | Interior Sul  | 44 years old   | Obesity and SAH                      | 12/06/20               | The Indigenous woman was admitted in the local hospital on 27/05/2020 complaining of dry cough and dyspnea. After 4 days in hospital treatment, she tested positive for SARS-CoV-2. On 28/05/2020, she was transferred to the ICU. |
| 16/06/20 | Xavante          | Xavante       | ND             | ND                                   | 14/06/20               | The Indigenous woman was an indigenous health agent and a leader among the women. She was admitted in hospital with suspected COVID-19. However, the SARS-CoV-2 test result had not been released yet at the moment the note was published. |
| 17/06/20 | Kayapó           | Kayapó do Pará| 72 years old   | ND                                   | 17/06/20               | The Indigenous man was a representative of his community and his actions were fundamental in several processes that led to indigenous achievements. |
| 18/06/20 | Kaingang         | Interior Sul  | 76 years old   | SAH                                  | 17/06/20               | The Indigenous woman was admitted in the local hospital on 02/06/2020 complaining of dyspnea, headaches, vertigo, inappetence, and dry cough. At that moment, she had tested positive for SARS-CoV-2. On 06/06/2020, she was transferred to the ICU. |
| 18/06/20 | Kaingang         | Interior Sul  | 96 years old   | Diabetes mellitus                    | 17/06/20               | On 16/06/2020, the female Indigenous patient was admitted in the respiratory unit with dyspnea and tested positive for SARS-CoV-2. |
| 20/06/20 | Kaingang         | Interior Sul  | 82 years old   | ND                                   | 18/06/20               | On 27/05/2020, the Indigenous man was attended reporting chest pain and dyspnea. On 30/05/2020, he was admitted in hospital and tested positive for SARS-CoV-2. On 02/06/2020, the patient was transferred to the hospital. |
| 02/07/20 | Huni Kuin        | Alto Rio Juruá| 69 years old   | No chronic disease background        | 30/06/20               | The Indigenous man presented respiratory symptoms on 25/06/2020 and was transferred to the local hospital; simultaneously, the clinical condition worsened with time. The patient was a local leader. |
| 06/07/20 | Shanenawa        | Alto Rio Juruá| 90 years old   | ND                                   | 03/07/20               | On 25/06/2020, the Indigenous woman presented respiratory symptoms and was transferred to the local hospital on 27/06/2020. The patient was a midwife in her tribe. |
| 07/07/20 | Xavante          | Xavante       | 60 years old   | Diabetes mellitus                    | 06/07/20               | The Indigenous man was a tribe chief and on 25/06/2020 was referred to the local hospital for the COVID-19 treatment. The patient had to wait for a bed in the ICU, which was made available on 06/07/2020. |
| 10/07/20 | Javaé            | Tocantins     | 79 years old   | Moderate aortic valvulopathy, SAH, chronic pulmonary disease. He used a pacemaker. | 09/07/20               | The Indigenous man was diagnosed with COVID-19 on 24/06/2020 and was transferred to the local hospital; later on, he was discharged and stayed at his daughter’s house. She is a nursing technician. On 06/07/2020, his clinical condition worsened, he was sent back to the hospital, where he died. |
| 13/07/20 | Huni Kuin        | Alto Rio Juruá| 99 years old   | Chronic obstructive pulmonary disease and cardiopathy | 11/07/20               | On 27/06/2020, the patient was admitted in hospital due to the presence of respiratory symptoms. |
| 13/07/20 | Xerente          | Tocantins     | 83 years old   | SAH and diabetes mellitus            | 12/07/20               | On 01/07/2020, the Indigenous man was diagnosed with acute respiratory syndrome and the SARS-CoV-2 infection was confirmed. The patient presented cerebrovascular accident (CVA), possibly as a result of the COVID-19. On 11/07/2020, the patient was transferred to the ICU. |
| 16/07/20 | Javaé            | Tocantins     | 102 years old  | SAH and hyperthyroidism              | ND                     | The Indigenous woman was diagnosed with the COVID-19 on 15/07/2020 and presented clinical stability during hospital treatment. |
Table 1 (continued)

| Note     | Ethnic group | DSEI                  | Age     | Comorbidity                                      | Death | Description found in the newsletter |
|----------|--------------|-----------------------|---------|--------------------------------------------------|-------|--------------------------------------|
| 16/07/2020 Javaê | Tocantins   | 83 years old          | ND      | The Indigenous patient tested positive for SARS-CoV-2 infection on 13/07/2020 and the use of oxygen therapy was prescribed; the patient had to wait for a bed in the ICU for a long time. |
| 23/07/2020 Rikbaktsa | Vilhena    | 46 years old          | ND      | Absence of chronic diseases                      | 22/07/2020 | The Indigenous man was a tribe advisor and had influence among the indigenous leaders. On 09/07/2020, he presented decreased saturation, dyspnea and tachycardia. On 10/07/2020, his clinical condition worsened and he was transferred to the ICU. On 16/07/2020, the COVID-19 diagnosis was confirmed. |
| 05/08/2020 ND | Xingu       | 71 years old          | SAH, hypercholesterolemia, coronary disease and he had an ischemic vacuum-assisted closure | 05/08/2020 | The Indigenous man was a tribe chief. |
| 12/08/2020 ND | Kayapó do Pará | 71 years old  | ND      | 11/08/2020 | The Indigenous man was the healer of his tribe and took part in several processes that resulted in achievements for his people. Also, this patient refused to be transported (twice by air transportation and once by land transportation) to a hospital. |
| 03/09/2020 Xavante | Xavante    | 75 years old          | SAH and diabetes mellitus | 01.09.2020 | The Indigenous man was the chief of his tribe and had high influence among the Indigenous leaders. |
| 04/09/2020 Xikrin  | Altamira    | 78 years old          | ND      | 31/08/2020 | The Indigenous man was a tribe chief and was transported by air to the general hospital in Altamira. |
| 08/09/2020 Xavante | Xavante    | 92 years old          | SAH      | 04/09/2020 | ND |
| 10/09/2020 ND | ND          | ND                   | ND      | 09/09/2020 | The note reported the death of the civil servant that worked for the Brazilian National Indian Foundation (FUNAI) and coordinated the Ethnic-Environmental Protection Agency Uru Eu Wau Wau, dedicated to the protection of isolated Indigenous groups in Brazil. |
| 05/10/2020 Krikati | Maranhão    | 87 years old          | Diabetes mellitus | 05/10/2020 | The indigenous man was a tribe chief and a leader. |
| 15/11/2020 Karii  | Ceará       | 39 years old          | ND      | 10/11/2020 | ND |
| 11/01/2021 Terena | Mato Grosso do Sul | 66 years old  | ND      | 10/01/2021 | The Indigenous man died of respiratory insufficiency; however, the COVID-19 infection was not confirmed. The patient worked for the Indigenous Health Special Secretariat Social Control, and was known and respected for his serenity, commitment, and diplomacy. |
| 01/02/2021 Nôke Kôi | Alto Rio Juruá | 56 years old          | Diabetes, SAH and congestive cardiac insufficiency | 01/02/2021 | The Indigenous man was a tribe chief; he was an important leader in the fight for health, education, and indigenous territorial management. |
| 02/02/2021 ND | Alto Rio Solimões | 36 years old          | Asthma   | 02/02/2021 | The female Indigenous patient was a nurse in the Indigenous Health Multidisciplinary Team. |

ND, nothing declared
(Individuals between 50 and 59 years old) seven releases; death was reported in all of them. One of the patients was a tribe chief that presented comorbidities such as DM and SAH and congestive cardiac insufficiency. A report was found that one of the patient’s family did not allow his transfer to a health service with more specialized assistance;

(Individuals between 60 and 69 years old) eleven releases; 10 of them reported death. The comorbidities listed were DM (three patients) and obesity (one patient) and one of the patients was recovering from arboviruses infection (dengue and yellow fever). One of the dead patients was a tribe chief. Three patients did not accept to be transferred to a health center with more specialized service. In one of the reports, the patient died of respiratory insufficiency, but the SARS-CoV-2 contamination was not confirmed;

(Individuals between 70 and 79 years old) fifteen releases; 14 of them reported death. Four of the dead patients were tribe chiefs and one was a tribe healer. Regarding comorbidities, one patient presented cardiac disease, one had pulmonary disease, four had SAH, and two presented DM and SAH. The families of three patients did not allow their transportation to health centers with more specialized service. One patient required river transport and another air transport to reach proper medical assistance;

(Individuals between 80 and 89 years old) nine releases; death was reported in eight of them. As for comorbidities, one individual presented SAH and another had DM. One patient presented both SAH and DM;

(Individuals between 90 and 99 years old) four releases; all of them reported death. One of the female patients had strong influence among the tribe women and was a midwife. Regarding comorbidities, one patient had SAH, one presented DM, and another had chronic obstructive pulmonary disease.

Four notes were also published whose reports did not inform the age of the patients. Two of them reported the death of Indigenous leaders, one of them was a female leader.

Pandemic characterization in the Indigenous population according to the DSEIs

In the early February 2021, the Health Ministry declared that there were 738 suspected cases, 41,949 confirmed cases, 51,235 dismissed cases, 4,300 infected and active cases, 36,986 recovered cases, and 554 deaths related to the COVID-19 (last update: 03/02/2021, 17:00) (Table 2). The notes only reported 62 deaths, that is, only 11.19% of the total deaths. In addition, the frequency of the publications throughout the pandemic was noticed to reduce. In April 2020, fifteen releases were selected for this study, in May/2020, there were 27 releases; in June/2020, seventeen releases were found; in July/2020, nine releases were selected; in August/2020, there were only two releases related to the relevant theme; in September/2020, four releases were found; in October/2020, one release was selected; in November/2020, there was one release; in January/2021, one release was found; and, finally, in February/2021, there were two releases.

Additionally, Table 2 draws attention to the high number of cases in three DSEIs, these are the DSEIs in Mato Grosso do Sul (3,902 cases), Interior Sul (2,284 cases), and Alto do Rio Solimões (2,007 cases). The DSEI in Mato Grosso do Sul also presented the highest number of deaths of Indigenous patients related to the COVID-19 (83 cases), followed by the DSEIs in Xavanté and in Leste de Roraima, with 47 death cases each. The DSEI structure according to the base municipality (Federal Unit): general Indigenous population assisted, number of ethnic groups; number of tribes; number of CASAI's; number of states and municipalities covered by the Indigenous assistance; and number of base centers are described in detail in Table 3.

Indigenous importance in the Brazilian vaccination program development

In the national vaccination program, the Indigenous peoples who live on indigenous lands were included in the first phase and the vaccination overview is presented in Table 4.

Discussion

Cultural and ethnic diversity among the Indigenous peoples

In 1500, the indigenous population in Brazil was estimated in three million people, while in 1957, it was around 70,000. This reduction is the result of several processes faced by these groups, from violent episodes to the outbreak of several epidemics [12]. Currently, there are many laws to protect these peoples, and this, somehow fostered some increase in the Indigenous population. According to the 2010 census, carried out by the IBGE, the indigenous population corresponded to 817,963 inhabitants [15]. This large number includes 305 different ethnic groups that speak 274 different languages (FUNAI), characterizing Brazil as the Latin American country with the greatest diversity of Indigenous ethnic groups.

The ethnic diversity is characterized by a wide range of social and cultural manifestations. In general, Indigenous peoples have certain specific customs such as sharing domestic utensils and community accommodations. These practices, commonly adopted by the Indigenous groups, become hazardous in the COVID-19 pandemic context, since they favor the virus spread among the members of the same community. Another remarkable characteristic of the Indigenous peoples is the use of medicinal therapies based on native herbs, and even if this kind of therapy might have a beneficial effect on the
treatment of many diseases [16], including appearing to have potential in the treatment of COVID-19 symptoms and simple cases [17, 18]; they would hardly be recommended to treat severe cases of the disease, which require admission in the intensive care unit and orotracheal intubation.

In such context, Indigenous peoples should be considered a population at risk for the COVID-19. Additionally, it seems relevant to emphasize that the term “Indigenous population” is generic and represents several ethnic groups that might become extinct because of this virus. In addition, the elderly are known to present higher chances of complication and death in the COVID-19, and in this age group plays a crucial role within the Indigenous communities; since they are the individuals that carry the knowledge and customs of that people, with the function of passing on their knowledge, mainly through orality [13].

**Factors associated to the COVID-19 pandemic spread in the Indigenous population**

According to Cupertino et al. (2020), with data obtained from the Health Ministry, on 15 May, there were 340 confirmed cases and 21 deaths in the Indigenous population [12]. On March 02, 2021, the number of confirmed cases was 41,855 and there were 549 deaths, showing a fast increase in the disease within this ethnic group. This fast advancement of the disease can be considered multifactorial. Being aware that the SARS-CoV-2 transmission is carried out mainly through interpersonal contact, one important factor of this increase in cases among the Indigenous population might be the Indigenous group proximity with other ethnic groups. The contact might occur through several activities such as tourism, wood exploitation, illegal hunting, drug dealing, missionary actions, and the return of Indigenous individuals from their workplace to the community, among others [5, 19].

Many other factors such as sharing domestic and cooking utensils and also the fact that a large number of Indigenous individuals share the same household might have contributed to the SARS-CoV-2 spread; however, these factors are the Indigenous population sociocultural characteristics, which makes it harder to prevent their occurrence. Even so, it is of great importance that the Brazilian Federal Government, along with the State governments and FUNAI, assist all indigenous populations that need it, by being the most transparent possible regarding the forms of infection by SARS-CoV-2. Simultaneously, information clarifying what the best prevention method is in each community is needed, in such a way that would never impose any sociocultural change, but rather by dialoguing with the Indigenous leaders in order to provide them with information about the best practices and respecting their sociocultural characteristics.

**Comorbidities in the Indigenous population and treatment refusal**

Belonging to the Indigenous population is a risk factor for respiratory diseases. In children under 1 year old, greater mortality was observed due to acute respiratory infections when compared to the general population [20]. Moreover, during the H1N1 pandemic in 2009, the incidence of severe respiratory condition was seen to be 4.5 times higher in the Indigenous population when comparing to the rest of the Brazilian population [21]. Finally, factors such as obesity, SAH, and DM are risk factors for severe cases and higher risk of mortality by the COVID-19 [22] and all these conditions are found in the Indigenous population. According to the study put forward by Freitas et al. (2020) in the Jaguapiru tribe, the prevalence of DM was 4.5%, obesity was 14.2% among male individuals and 30.8% in female individuals, and SAH
appeared in 29.7% in both sexes [23]. Curiously, the prevalence of such comorbidities differs from the national mean, since the self-reported DM in Brazil was around 6.9% in 2013, and the SAH mean varied from 21.4 to 32.3%, depending on the evaluation method used, while obesity was 20.7% in women and 18.7% in men [24, 25], which is probably directly related to the diet of the tribes.

Evaluating the different prevalence of comorbidities in Indigenous tribes is important, since each comorbidity shows a different degree of severity for the COVID-19 [26], which requires different measures in each tribe to decrease the chance of those individuals developing more severe conditions.

**How the SARS-CoV-2 spread among Indigenous peoples could have been prevented**

The Indigenous population is a risk group for the COVID-19 [9]. Therefore, the adoption of practices to prevent this virus from spreading within the tribes is essential. Thus, restricting transportation of foreigners inside Indigenous areas is necessary, for example, by interrupting

### Table 2 SARS-CoV-2 infection in Brazilian Indigenous people epidemiological data*

| DSEIs                        | Suspected | Confirmed | Dismissed | Infected (Active) | Clinical cure | Deaths |
|------------------------------|-----------|-----------|-----------|-------------------|---------------|--------|
| Alagoas and Sergipe          | 55        | 258       | 442       | 11                | 241           | 4      |
| Altamira                     | 0         | 1,275     | 1,527     | 50                | 1,222         | 2      |
| Alto Rio Jurua               | 0         | 851       | 245       | 24                | 816           | 10     |
| Alto Rio Negro               | 34        | 2,152     | 881       | 129               | 2,001         | 20     |
| Alto Rio Purus               | 0         | 600       | 357       | 0                 | 594           | 5      |
| Alto Rio Solimões            | 1         | 2,062     | 1,099     | 12                | 2,007         | 37     |
| Amapá e Norte do Pará        | 25        | 973       | 842       | 36                | 930           | 5      |
| Araguaia                     | 0         | 344       | 539       | 21                | 316           | 7      |
| Bahia                        | 15        | 718       | 1,046     | 66                | 645           | 7      |
| Ceará                        | 30        | 966       | 1,738     | 45                | 911           | 8      |
| Cuiabá                       | 31        | 1,301     | 771       | 56                | 1,221         | 24     |
| Guamá-Tocantins              | 4         | 1,489     | 2,033     | 20                | 1,450         | 17     |
| Interior Sul                 | 47        | 2,462     | 4,015     | 135               | 2,284         | 41     |
| Kaiapó do Mato Grosso        | 7         | 985       | 1,029     | 6                 | 973           | 5      |
| Kaiapó do Pará               | 31        | 1,213     | 1,162     | 3                 | 1,174         | 9      |
| Leste de Roraima             | 18        | 3,748     | 3,834     | 1,974             | 1,720         | 47     |
| Litoral Sul                  | 8         | 1,184     | 2,051     | 76                | 1,091         | 15     |
| Manaus                       | 17        | 925       | 1,358     | 79                | 823           | 14     |
| Maranhão                     | 0         | 1,676     | 1,042     | 1                 | 1,643         | 27     |
| Mato Grosso do Sul           | 8         | 4,100     | 9,893     | 108               | 3,902         | 83     |
| Médio Rio Purus              | 0         | 506       | 15        | 0                 | 501           | 5      |
| Médio Rio Solimões and affluents | 6     | 752       | 953       | 14                | 725           | 11     |
| Minas Gerais and Espírito Santo | 60   | 442       | 1,424     | 20                | 417           | 4      |
| Parintins                    | 45        | 569       | 831       | 11                | 544           | 12     |
| Pernambuco                   | 2         | 588       | 1,405     | 6                 | 570           | 9      |
| Porto Velho                  | 19        | 1,266     | 1,288     | 121               | 1,134         | 10     |
| Potiguaru                    | 7         | 675       | 860       | 2                 | 669           | 4      |
| Rio Tapajós                  | 0         | 1,959     | 2,437     | 47                | 1,895         | 12     |
| Tocantins                    | 26        | 1,165     | 875       | 28                | 1,122         | 10     |
| Vale do Javari               | 0         | 821       | 364       | 6                 | 811           | 2      |
| Vilhena                      | 80        | 819       | 1,124     | 48                | 755           | 15     |
| Xavante                      | 3         | 899       | 2,525     | 20                | 826           | 47     |
| Xingu                        | 129       | 892       | 810       | 303               | 573           | 16     |
| Yanomami                     | 30        | 1,314     | 420       | 822               | 480           | 10     |
| **Total**                    | **738**   | **41,949**| **51,235**| **4,300**         | **36,986**    | **554**|

*Data updated up to the first week of February 2021*
missionary actions [13]. Additionally, it is relevant to reinforce the need for social isolation, use of masks, and gel alcohol. This might be a problem, since the adoption of such practices might be interpreted by the Indigenous individuals as loss of their cultural identity, possibly, damaging their mental health [27]. Moreover, although social isolation, use of masks, and gel alcohol and other attitudes are considered a public health measure by the World Health Organization to reduce the contagion rate, several speeches by the Brazilian President Jair Messias Bolsonaro are against this recommendation because he prioritizes the economy. It is a contradictory attitude that
Table 4  Description of the Indigenous Health Special Districts in Brazil

| DSEI Base | Municipality | General indigenous | Ethnic group | Tribe | CASAI | States covered | Municipalities | Base Center |
|-----------|--------------|--------------------|--------------|-------|-------|----------------|---------------|------------|
| Alagoas Sergipe | Maceió (AL) | 12,250 | 12 | 31 | 0 | Alagoas and Sergipe | 10 | ND |
| Altamira | Altamira (PA) | 3,974 | 10 | 60 | 1 | Pará | 5 | 1 |
| Alto Rio Negro | São Gabriel da Cachoeira (AM) | 40,233 | 25 | 707 | 1 | Amazonas | 3 | 25 |
| Alto Rio Jurú | Cruzeiro do Sul (AC) | 17,672 | 17 | 148 | 1 | Acre | 8 | 7 |
| Alto Rio Purus | Rio Branco (AC) | 13,555 | 7 | 150 | 1 | Amazonas, Acre, and Rondônia | 7 | 6 |
| Alto Rio Solimões | Tabatinga (AM) | 70,519 | 7 | 234 | 1 | Amazonas | 7 | 12 |
| Alto Amapá and northern Pará | Macapá (AP) | 12,440 | 11 | 139 | 2 | Amapá and Pará | 4 | 6 |
| Araguaiá | São Félix do Araguaia (MT) | 5,562 | 8 | 41 | 1 | Mato grosso, Goiás, and Tocantins | 12 | 4 |
| Bahia | Salvador (BA) | 29,284 | 21 | 77 | 0 | Bahia | 23 | 9 |
| Ceará | Fortaleza (CE) | 26,129 | 15 | 100 | 1 | Ceará | 16 | 9 |
| Cuiabá | Cuiabá (MT) | 6,830 | 10 | 120 | 3 | Mato grosso | 16 | 3 |
| Guamá-Tocantins | Belém (PA) | 13,913 | 138 | 153 | 5 | Tocantins and Pará | 17 | 8 |
| Interior Sul | Florianópolis (SC) | 63,118 | 4 | 180 | 0 | São Paulo, Santa Catarina, and Rio Grande do Sul | 65 | 8 |
| Kaiapó MT | Colíder (MT) | 6,424 | 4 | 51 | 3 | Pará and Mato Grosso | 6 | 3 |
| Kaiapó do Pará | Redenção (PA) | 5,796 | 1 | 50 | 4 | Pará | 6 | 4 |
| Leste Roraima | Boa Vista (RR) | 53,213 | 7 | 323 | 0 | Roraima | 10 | 34 |
| Litoral Sul | Curitiba (PR) | 22,975 | 11 | 129 | 2 | São Paulo, Santa Catarina, Rio Grande do Sul, Rio de Janeiro, and Paraná | 68 | 15 |
| Manaus | Manaus (AM) | 30,768 | 35 | 218 | 1 | Amazonas | 15 | 16 |
| Maranhão | São Luís (MA) | 36,060 | 8 | 424 | 3 | Maranhão | 16 | 6 |
| Mato Grosso do Sul | Campo Grande (MS) | 83,434 | 8 | 99 | 3 | Mato Grosso do Sul | 129 | 15 |
| Médio Rio Purus | Lábrea (AM) | 6,822 | 17 | 105 | 2 | Amazonas | 3 | 10 |
| Médio Rio Solimões and affluents | Tefé (AM) | 24,538 | 16 | 184 | 2 | Amazonas | 14 | 15 |
| Minas Gerais and Espírito Santo | Governador Valadares (MG) | 16,648 | 10 | 93 | 2 | Minas Gerais and Espírito Santo | 14 | 18 |
| Parintins | Parintins (AM) | 16,911 | 10 | 124 | 2 | Amazonas and Pará | 5 | 13 |
| Pernambuco | Recife (PE) | 39,231 | 13 | 224 | 1 | Pernambuco | 15 | 12 |
| Porto Velho | Porto Velho (RO) | 10,311 | 68 | 172 | 6 | Rondônia, Mato Grosso, and Amazonas | 15 | 5 |
| Pontiguara | João Pessoa (PB) | 14,024 | 1 | 33 | 0 | Paraíba | 3 | 3 |
| Rio Tapajós. | Itaituba (PA) | 12,722 | 4 | 141 | 4 | Pará | 4 | 11 |
| Tocantins | Palmas (TO) | 11,908 | 11 | 160 | 2 | Tocantins and Goiás | 12 | 5 |
| Vale do Javari | Atalaia do Norte (AM) | 6,263 | 6 | 59 | 1 | Amazonas | 1 | 8 |
| Vilhena | Cacoal (RO) | 7,159 | 17 | 172 | 4 | Amazonas | 2 | 4 |
| Xavante | Barra do Garças (MT) | 20,653 | 1 | 305 | 1 | Mato Grosso | 12 | 6 |
| Xingu | Canarana (MT) | 7,213 | 16 | 81 | 4 | Mato Grosso | 8 | 4 |
| Yanomami | Boa Vista (RR) | 25,486 | 2 | 323 | 1 | Roraima and Amazonas | 1 | 37 |

ND, nothing declared; CASAI, Indigenous health houses; DSEI, Indigenous Health Special Districts; FU, federation unit
can cause a higher number of COVID-19 cases and deaths prompting the population to higher contagion rate with no or limited health supported. This fact can be worst among Indigenous peoples with a low access for health services. Moreover, the Federal Government neglects the Indigenous as a vulnerable group for the COVID-19 pandemic [9]. Because the Indigenous population is a risk group for the COVID-19, they were included in the Brazilian vaccination program as a priority group [28]. This measure is very important, since the control of the virus spread and the immunity of the elderly are fundamental for the preservation of the Indigenous culture diversity.

**Other ethnic minority groups and people living on more deprived regions**

Brazil is a country with a heterogeneous population, so there are other ethnic minorities besides Indigenous people and other people living on more deprived regions, such as Brown and Blacks. These people can be more susceptible for mortality due to COVID-19 as shown in a study that comprised 11,321 individuals with a positive test RT-PCR for SARS-COV-2 considering ethnic and racial issues on Brazil [29]. Curiously, a higher mortality in Brown and Black individuals comparing to White people was demonstrated [29]. Another interesting fact was the higher hazard ratios for mortality for the people from the northern and northeast regions from Brazil where the access for health services is low [29]. Baqui et al. (2020) demonstrated the outcomes for eight Indigenous according to COVID-19, being described five non-survivors [29]. The North region is the Brazilian region with the largest number of Indigenous people according FUNAI.

The divergence of prognosis to COVID-19 in different ethnicities has been noticed in other countries as well. Millett et al. (2020) conducted a study about American Black population, and it was noticed that cities with a higher concentration of Black people were associated with higher numbers of COVID-19 cases, as well as higher mortality [30]. In the cities with great counties of Black people, also were observed a higher number of comorbidities, elderly people ≥ 65 years of age, unemployment, lack of health insurance, and a higher air pollution index [30]. In brief, it was demonstrated that among the ~20% US counties are disproportionately Black, and they accounted for 52% of COVID-19 diagnoses and 58% of COVID-19 deaths in the USA [30]. Curiously, the same outcome occurred at Baqui et al. on Brazil [29].

Holtgrave et al. also noticed differences of prognosis between white non-Hispanic, Black non-Hispanic, and Hispanic adults in New York City [31]. The mortality risk from COVID-19 in non-Hispanic Black adults and Hispanics was 5.38 and 3.48 times greater, respectively, than non-Hispanic Whites. It is known that the Black population is considered vulnerable, considering that they correspond to an ethnic group with a higher poverty rate and, consequently, less access to health services [32]. The divergence was also noticed in the city of Chicago, and in the states of Louisiana and Michigan [33]. In Chicago and Louisiana, the Black people correspond to ~30% of the population, and ~70% of reported deaths due to COVID-19. In Michigan, Black people constitute 14% of the population and represent ~40% of deaths due COVID-19 [33]. As discussed by Holtgrave et al., Hispanic had differences in infection experience and non-Hispanic Black had differences in both infection experience and in the need for hospitalization due the SARS-COV-2, relative to White to be the cause for the disparities [31].

Also, Lusignan et al. analyzed a population sample from Oxford and noted that the chances of contamination rate by SARS-CoV-2 were higher in people of other ethnicity than White or in people living in poorer areas [34]. The problem behind this situation extends beyond the health issue, also affecting economic issues, considering that the measures of social restriction to combat the COVID-19 pandemic cause huge economic impact, mainly among the people who deserve more attention, due to higher social and economic vulnerability.

Once the social vulnerabilities are identified, it is important to discuss the epidemiological aspects that involve the different minority groups and people living on more deprived regions to implement a better planning to combat the pandemic and to preserve each group. However, it was not the reality. Unfortunately, in state of Connecticut, for example, there was negligence in the racial characterization of the victims of COVID-19: more than 50% of the laboratory reports related to the disease in question did not contain information about race [32].

Brazil should implement measures to deal with the pandemic considering the vulnerability groups related to COVID-19 being the Indigenous peoples the most vulnerable to infection with SARS-CoV-2 and the most impoverished monetarily [35]. Furthermore, Brown and Black people are more vulnerable to infection with SARS-CoV-2 than White and Asian groups, and the states with greatest vulnerability deserve more attention to control the pandemic [35].

Unfortunately, the negligence of minority groups and people living on more deprived regions is not a current problem. For example, it was also noticed the different impacts during the H1N1 pandemic among minority groups and people living on more deprived regions. A study done in England during 2009 and 2010 outbreak analyzed the deaths due H1N1. It was observed that 19.9% of deaths corresponded to non-white ethnicities, while this population corresponds to only 12.5% of the country population [36].
Limitations

There were limitations in the data collection from the Brazilian Health Ministry database. Several published releases (notes) did not present complete information, and in many of the information such as DSEI of origin, ethnic group, age, or the presence of comorbidities was not reported. Additionally, some negligence was observed regarding the publication of information during the pandemic. In May, for example, twenty-seven notes described the criteria determined for inclusion in this paper, while in other months, only one newsletter met the inclusion requirements.

Conclusion

Taking into consideration the concept of universality, the Indigenous population must be assisted in a holistic way, considering their customs and traditions. Therefore, more specialized health units should be made available closer to the tribes to provide proper assistance to this population during the current pandemic and in future emerging problems that might affect that population.

Code availability Not applicable.

Author contribution All authors have approved the manuscript and agreed with its submission to the journal. Also, all authors wrote and revised the manuscript.

Data availability Not applicable.

Declarations

Ethics approval and consent to participate Not applicable.

Consent for publication Not applicable.

Additional declarations for articles in life science journals that report the results of studies involving humans and/or animals Not applicable.

Competing interests The authors declare no competing interests.

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