

This file has been cleaned of potential threats.

If you confirm that the file is coming from a trusted source, you can send the following SHA-256 hash value to your admin for the original file.

f8ec2637dc73bf20c023c47c8e9d535cfa7a9f49acdcd73c262a85c13b8dc9d7

To view the reconstructed contents, please SCROLL DOWN to next page.

**The text that follows is a PREPRINT.
O texto que segue é um PREPRINT.**

Please cite as:

Favor citar como:

Ferrante, L., S. Livas, W.A. Steinmetz, A.C.L.
Almeida, J. Leão, R.C. Vassão, U.
Tupinambás, P.M. Fearnside, L.H. Duczmal.
2021. **The first case of immunity
loss and SARS-CoV-2 reinfection
by the same virus lineage in
Amazonia.** *Journal of Racial and Ethnic
Health Disparities* <https://doi.org/10.1007/s40615-021-01084-7>

ISSN: 2197-3792

Copyright: Springer Nature Switzerland AG.

DOI: 10.1007/s40615-021-01084-7

The original publication is available at
O trabalho original está disponível em:

<https://doi.org/10.1007/s40615-021-01084-7>

<https://link.springer.com/content/pdf/10.1007/s40615-021-01084-7.pdf>

1 **The first case of immunity loss and SARS-CoV-2 reinfection by the same virus**
 2 **lineage in Amazonia**

3 Lucas Ferrante^{1,*}, Sophia Livas², Wilhelm Alexander Steinmetz³, Alexandre Celestino
 4 Leite Almeida⁴, Jeremias Leão⁵, Ruth Camargo Vassão⁶, Unaí Tupinambás⁷, Philip
 5 Martin Fearnside⁸, Luiz Henrique Duczmal⁹

6

7 ¹Instituto Nacional de Pesquisas da Amazônia (INPA), Programa de Pós-Graduação em Biologia
 8 (Ecologia), Manaus, Amazonas, Brazil.

9 ²Universidade Federal do Amazonas (UFAM) - Programa de Pós-Graduação em Saúde, Sociedade e
 10 Endemias na Amazônia (PPG-SEA-M), Manaus, Amazonas, Brazil.

11 ³Universidade Federal do Amazonas (UFAM) - Department of Mathematics, Manaus, Amazonas, Brazil.

12 ⁴Universidade Federal de São João del-Rei (UFSJ) - DEFIM, Ouro Branco, Minas Gerais, Brazil

13 ⁵Universidade Federal do Amazonas (UFAM) - Department of Statistics, Manaus, Amazonas, Brazil.

14 ⁶Retired from the Cell Biology Laboratory of the Instituto Butantan - São Paulo, São Paulo, Brazil.

15 ⁷Universidade Federal de Minas Gerais (UFMG) - Department of Internal Medicine, Belo Horizonte,
 16 Minas Gerais, Brazil.

17 ⁸Instituto Nacional de Pesquisas da Amazônia (INPA), Departamento de Dinâmica Ambiental, Manaus,
 18 Amazonas, Brazil.

19 ⁹Universidade Federal de Minas Gerais (UFMG) - Department of Statistics, Belo Horizonte, Minas
 20 Gerais, Brazil.

21 *Correspondence to: lucasferrante@hotmail.com

22

23 **Abstract**

24 We report the first confirmed record of a SARS-CoV-2 immunity loss and
 25 reinfection for the Amazon region and for Brazil by the same virus lineage. The patient
 26 presented an asymptomatic condition the first time and an aggravated one after
 27 reinfection. We raise the possibility of a recessive genotype in the Amazonian
 28 population that does not generate an immune memory response to SARS-CoV-2.
 29

30 **Keywords:** Amazonas, COVID-19, immunity loss, Manaus.

31

32

33 Cases of reinfection by SARS-CoV-2 have been reported for various locations
 34 around the world [1, 2]. We report a case in Manaus, the capital of Brazil's state of
 35 Amazonas -- the first confirmed record of immunity loss with a SARS-CoV-2
 36 reinfection for the Amazon region and for Brazil. The patient is a 24-year-old woman
 37 without comorbidities, 1.78 m in height and weighing 75 kg. The patient (Sophia Livas,
 38 the second author of this study) tested positive the first time on July 9, 2020 with a rapid
 39 test, showing no symptoms, confirmed on the same day by two RT-PCR tests (sample
 40 type: oropharyngeal swab) for SARS-CoV-2 and tested positive for IgM and negative
 41 for IgG. An RT-PCR test (oropharyngeal-swab sample) performed sixty days after the
 42 date of the first infection showed the absence of SARS-CoV-2. The first symptoms of
 43 reinfection were noticed on October 25, or 109 days after the first infection, with no
 44 symptoms of COVID-19 during this period.

45 The symptoms of reinfection started with a sudden headache at different times
 46 during the day, body pain that, according to the patient, was more constant in the
 47 afternoon than at other times of day, an inflammation in the throat, odynophagia, nasal

48 congestion, tiredness and fatigue, chest pain, lack of appetite, increased blood pressure
49 and tachycardia. The patient tested positive for IgM and negative for IgG on October
50 29, the reinfection being confirmed by an RT-PCR test that indicated potential
51 transmissibility. The symptoms worsened from October 30 to November 2, when the
52 patient reported fatigue even while speaking. In the critical period, the patient had a
53 heart rate 125 beats per minute, blood pressure of 190/100 mm Hg and body
54 temperature of 39.5 ° C (103 ° F). On November 8 the patient had no more symptoms,
55 returning to practice regular physical activities during the month of December. On
56 January 4, 2021, the patient again experienced fatigue and tachycardia, in addition to
57 new symptoms such as diarrhea and a drop in blood pressure. A new antibody test
58 showed IgM but not IgG production.

59 Although patients who have recovered from COVID-19 show a reduction in
60 levels of antibodies of type IgG [3], this patient had no IgG antibodies since the first
61 contact with SARS-CoV-2, a factor implying with a greater risk of reinfection [4]. In
62 addition, the patient did not produce IgG antibodies even after reinfection with severe
63 symptoms. The absence of an immune response in the form of IgG antibodies, both at
64 first contact and on reinfection, indicates that individuals may not acquire natural
65 immunity to SARS-CoV-2, undermining expectations of herd immunity.

66 The period from the first infection by SARS-CoV-2 to the first symptoms of
67 reinfection was 109 days. The existence of a negative laboratory test for SARS-CoV-2
68 and an asymptomatic period longer than 90 days between the first infection and
69 reinfection meet the epidemiological criteria established by the Pan American Health
70 Organization, the World Health Organization and Centers for Disease Control and
71 Prevention (CDC) to classify as a reinfection by SARS-CoV- 2 [5, 6]. Although we
72 have not performed sequencing for comparison with other strains, the reinfection caused
73 by the new strain of Amazonian (P1) origin is ruled out due to its estimated appearance
74 between December 2020 and January 2021; other variants are also not plausible since
75 there is no record of these for the Amazon region [7, 8].

76 It is likely that the third and most serious manifestation of the disease, observed
77 in January 2021, was due to the P1 variant, since the antibody test showed IgM but not
78 IgG production and the P1 variant was the predominant variant in Manaus in January
79 2021 [7, 8, 9], which suggests that reinfection this month could have occurred either by
80 the same variant or by the P1 variant. Since the two previous infections did not protect
81 against an additional reinfection in January even if the January infection was by the
82 original variant, this reinforces the argument that immunity from natural contact with
83 the virus is not guaranteed.

84 This case study warns of the possibility of reinfection by the same strain of
85 SARS-CoV-2 for patients who do not generate an immune response to the coronavirus,
86 as noted by the absence of IgG production. The observed data lead us to raise the
87 hypothesis of the existence of a recessive genotype within the population of Manaus
88 that does not generate an immune response to the coronavirus. Various cases of
89 reinfection in Amazonas have been reported [10], even before the appearance of new
90 strains in the region [7, 8]. Manaus has a mixed population with many residents of
91 indigenous descent, and the vulnerability due to genetic factors of indigenous peoples
92 and their descendants to respiratory diseases caused by viruses reinforces this
93 hypothesis [11].

94 Confirmation of reinfection in the Amazon region is an essential alert for Brazil
95 because of the potential of infections to overwhelm the health system, as occurred
96 during the first wave in Manaus [11]. It is also important because of the vulnerability of
97 traditional communities, including indigenous peoples in the region [11, 12]. The risk to

98 the health system is because the demand for ICU beds for individuals exposed to SARS-
99 CoV-2 for the first time is added to the demand from re-infected patients who may have
100 more serious symptoms due to long-term effects from a previous infection.

101 Data from the Foundation for Health Surveillance of Amazonas (FVS) confirm
102 that the second wave was bigger than the first, starting 21 days after the return of face-
103 to-face classes in public schools on September 24, 2020 [13]. None of the population
104 had been vaccinated at that time. By April 21, 2021 Brazil had vaccinated 13% of its
105 entire population with the first dose of a vaccine and 5% of the population with the
106 second dose [14]. Less than 15% of the population of Manaus had received the first
107 dose of a vaccine and 5% had received the second dose as of the same date; the elderly
108 and health and public-safety professionals had been the priority groups [15]. Records of
109 infection by the P1 variant have been observed in younger individuals than previously,
110 and there was an increase in infections and hospitalizations in the 18 - 49 year age group
111 [16], which is the age group not yet covered by the vaccine. The data in this case study
112 confirm the possibility of reinfection not only by different variants [1, 2], but also by the
113 same variant. Epidemiological models predict a third wave for Manaus, considering the
114 current rates of immunization by vaccination [9, 17]. The possibility of unvaccinated
115 people being re-infected by either the same or a different variant of SARS-CoV-2,
116 together with the low immunization rates by vaccination and the loosening of restrictive
117 measures (such as the planned resumption of face-to-face classes in the second half of
118 May), point to the continuity of the pandemic in Amazonas and in Brazil.

119

120 **Conclusion**

121 Here we report the case of a patient who did not generate an immune response to
122 SRAS-CoV-2. This case suggests the possibility of a recessive genotype within the
123 population preventing generation of a natural immune response to the coronavirus,
124 making reinfection possible by the same strain to which the individual originally
125 became infected. These results are particularly important because the record is from
126 Manaus, one of the world's cities with the most critical situations in the COVID-19
127 pandemic. In addition, given the low rate of immunization via vaccination of the
128 Brazilian population and the possibility of reinfection by either the same or by a
129 different variant, continuation of the country's pandemic is expected.

130

131 **Acknowledgments.** This study was supported by the Conselho Nacional de
132 Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo à
133 Pesquisa do Estado do Amazonas (FAPEAM).

134

135 **Author contributions:** LF conceived of the idea; LF, SL, WAS, ACLA, JL, RCV, UT,
136 PMF and LHD wrote the manuscript; LF, SL, WAS, ACLA, JL, RCV, UT, PMF and
137 LHD revised the manuscript.

138

139 **Conflict of Interest:** The authors declare that they have no conflict of interest.

140

141 **References**

142

- 143 1. ECDC. Reinfection with SARS-CoV-2: considerations for public health
144 response. ECDC. 2020; <https://bitly.co/5T1h>

- 145 2. Prado-Vivar B, Becerra-Wong M, Guadalupe JJ, et al. A case of SARS-CoV-2
146 reinfection in Ecuador. *Lancet Infect Dis.* 2020; DOI: 10.1016/S1473-
147 3099(20)30910-5
- 148 3. Yang OO, Ibarondo FJ. Loss of anti-SARS-CoV-2 antibodies in mild COVID-
149 19. *N Engl J Med.* 2020; 383:1697-1698. DOI: [10.1056/nejmc2027051](https://doi.org/10.1056/nejmc2027051)
- 150 4. Lumley SF, O'Donnell D, Stoesser NE, et al. Antibody status and incidence of
151 SARS-CoV-2 Infection in Health Care Workers. *N Engl J Med.* 2020; DOI:
152 10.1056/NEJMoa2034545.
- 153 5. PAHO/WHO. Interim guidelines for detecting cases of reinfection by SARS-
154 CoV-2. PAHO/WHO. 2020; <https://bit.ly.co/5T1y>
- 155 6. CDC. Reinfection with COVID-19. Centers for Disease Control and Prevention.
156 2020; <https://www.cdc.gov/coronavirus/2019-ncov/your-health/reinfection.html>
- 157 7. Naveca F et al. Phylogenetic relationship of SARS-CoV-2 sequences from
158 Amazonas with emerging Brazilian variants harboring mutations E484K and
159 N501Y in the Spike protein. *virological.org.* 2021; <https://bit.ly.co/5Chi>
- 160 8. Naveca F, Costa CF. Caracterização genética do SARS-CoV-2 circulante no
161 Estado do Amazonas. *FioCruz/FVS.* 2021; <https://amz.run/4GZF>
- 162 9. Ferrante L. et al. Nota técnica: Necessidade de lockdown e vacinação abrangente
163 em Manaus para contenção da pandemia da COVID-19. Instituto Nacional de
164 Pesquisas da Amazônia. INPA, DOI: 10.13140/RG.2.2.17456.48641. 2021;
165 <https://bit.ly.co/5arD>
- 166 10. O Globo. Médico de Parintins relata reinfecção pelo coronavírus. *O Globo.*
167 2020; <https://bit.ly.co/5T22>
- 168 11. Ferrante L, Fearnside PM. Protect Indigenous peoples from COVID-19. *Science.*
169 2020; 368: 251. DOI: 10.1126/science.abc0073
- 170 12. Ferrante L. et al. Brazil's policies condemn Amazonia to a second wave of
171 COVID-19. *Nat Med.* 2020; 26: 1315 [https://doi.org/10.1038/s41591-020-1026-](https://doi.org/10.1038/s41591-020-1026-x)
172 [x](https://doi.org/10.1038/s41591-020-1026-x)
- 173 13. FVS. Boletim diário COVID-19 no Amazonas 31/12/2020. FVS. 2020;
174 <https://bit.ly.co/5nAD>
- 175 14. G1. Brasil aplicou ao menos uma dose de vacina contra Covid em mais de 27,5
176 milhões de pessoas, aponta consórcio de veículos de imprensa. G1. 2021;
177 <https://tinyurl.com/5b2z6fuz>
- 178 15. FVS. Vacinação no Amazonas. Available at 21 april 2021. FVS. 2021;
179 https://www.fvs.am.gov.br/indicadorSalaSituacao_view/75/2
- 180 16. G1. Fiocruz diz que dados apontam aumento expressivo dos casos de Covid
181 entre os mais jovens. G1. 2021; <https://g1.globo.com/bemestar/coronavirus/>
- 182 17. Ferrante L. et al. Nota técnica: Reavaliação da pandemia de COVID-19 em
183 Manaus e necessidade de medidas restritivas para conter a terceira onda.
184 Instituto Nacional de Pesquisas da Amazônia & Universidade Federal de Minas
185 Gerais (INPA/UFMG). DOI: 10.13140/RG.2.2.31876.45444. 2021;
186 <https://bit.ly.co/6PAv>
- 187