

Original Research Article

Analysis of kidney transplants in brazil: a comparative study pre and post-COVID-19 pandemic

Thaina B. Santos^{1*}, Brenda E. S. de Oliveira¹, Emilie V. Bispo¹, Paulo J. R. de A. Coutinho Filho¹, Thiago S. C. Pereira¹, Victor H. B. G. e Silva¹, Camila G. C. Passarinho²

¹Department of Medicine, ZARNS Medical School, Salvador, Bahia, Brazil

²Department of Pediatric Nephrology, Roberto Santos General Hospital, Salvador, Bahia, Brazil

Received: 15 April 2025

Accepted: 14 May 2025

*Correspondence:

Dr. Thaina B. Santos,

E-mail: thainabrasileiro16@hotmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Kidney transplantation is essential for patients with advanced Chronic Kidney Disease (CKD), a condition that affects 13% of the global population. Although Brazil stands out internationally, ranking fourth worldwide in kidney transplants, the COVID-19 pandemic posed significant challenges. The restructuring of the healthcare system and restrictions led to a reduction in transplants by up to 50% globally and 32% in Brazil, exacerbating disparities in access to the procedure.

Methods: It is an ecological study based on data from the Brazilian Transplant Registry (RBT), which examined the evolution of kidney transplants in Brazil across the pre-pandemic (2018-2019), pandemic (2020-2022), and post-pandemic (2023) periods.

Results: Between 2018 and 2023, a total of 33,224 kidney transplants were performed in Brazil, with a significant decline during the pandemic (-18.8% annual average) but a partial recovery in 2023 (18.2% of the total). The waiting list increased by 175.8%, with a 104.9% rise in the number of untreated patients. The productivity of medical teams dropped from 43 to 34 transplants per team during the pandemic, and deceased donors predominated (85.7%). Regionally, the Southeast accounted for the highest number of procedures, with São Paulo responsible for 32.6% of the transplants, highlighting inequalities in access to treatment.

Conclusions: Finally, it is observed that the COVID-19 pandemic negatively impacted kidney transplants in the country due to the reorganization of hospital care, with a gradual post-pandemic recovery, although still below pre-crisis levels.

Keywords: Brazil, COVID-19, Epidemiology, Kidney transplantation

INTRODUCTION

Chronic kidney disease (CKD) represents a serious global public health challenge, affecting approximately 850 million people, which corresponds to about 13% of the world population. This alarming scenario highlights the crucial role of kidney transplantation as one of the main therapeutic options for patients with end-stage renal disease.¹ It is estimated that around 100,000 kidney transplants are performed worldwide each year, a

significant number, yet still insufficient to meet the growing global demand.²

In Brazil, this reality mirrors a similar scenario, with approximately 1.5 million individuals affected by CKD and a high demand for transplants that significantly exceeds the number of procedures performed.² Even so, the country stood out in 2022 by ranking fourth worldwide in the number of kidney transplants performed.³ This performance underscores Brazil's relevance in the international landscape of kidney surgical

procedures, highlighting not only its technical and organizational capacity but also the urgent need to intensify efforts to meet the growing demand for such interventions.⁴

However, the changes brought about by the COVID-19 pandemic including disruptions to regular healthcare workflows and shifting priorities within health systems significantly impacted the performance of these transplants, exacerbating access disparities and challenging the full resumption of services.⁴

Globally, a decrease in transplant procedures was observed, ranging from 30% to 50%.⁴ In Brazil, the eighth-largest global reduction was recorded in 2020, with a 32% decline in kidney transplant procedures.⁵ This significant drop is directly associated with mobility restrictions implemented to contain the spread of the virus, along with the reorganization of healthcare services aimed at prioritizing care for patients infected with SARS-CoV-2, which led to a decrease in elective procedures.⁵

Furthermore, the number of kidney donors also experienced a substantial decline, as 75% of kidney transplant centers in Latin America suspended the search for living donor candidates.⁶ This situation not only intensified disparities in access to kidney transplants and compromised organ availability but also amplified the ethical challenges related to prioritization and clinical management of patients.⁷ This impact is particularly significant, considering that the pandemic led to a marked increase in mortality, with rates 2.2 times higher among patients on the waiting list for kidney transplants.⁸

In addition, the pandemic resulted in a 1.4-fold increase in mortality among organ recipients, highlighting the risks faced by these patients during the global health crisis.⁸ Among kidney transplant recipients, the immunosuppression required to prevent organ rejection significantly increased susceptibility to viral infection and contributed to the development of severe forms of the disease. This vulnerability increased the complexity of clinical management and demanded greater prioritization of procedures.⁹

With the stabilization of healthcare systems and the advancement of vaccination, kidney transplants in Brazil gradually resumed. However, the demand for these procedures increased significantly, reflecting the accumulated effects of disruptions in regular outpatient follow-up during the health crisis.¹⁰ In this context, the present study aims to analyze the epidemiology of kidney transplants in Brazil, with a focus on the impacts of the COVID-19 pandemic on the performance of these procedures, highlighting the changes in the pre-pandemic, pandemic, and post-pandemic periods.

METHODS

This is an ecological study with a descriptive and quantitative approach, based on information collected from the Brazilian Transplant Registry (RBT), a tool linked to the Brazilian Association of Organ Transplants (ABTO), aimed at analyzing and disseminating data on organ transplants in Brazil. Records of kidney transplants performed in the country were analyzed, covering the pre-COVID-19 pandemic period (2018 and 2019), the pandemic years (2020 to 2022), and the post-pandemic period, represented by the year 2023. Over this interval, the following variables were considered: the number of kidney transplants performed annually; demand and deaths on the waiting list; the performance of medical teams responsible for carrying out the transplants; participation of kidney donors, including degree of kinship and classification as living or deceased donors; and the distribution of transplants by regions and states in Brazil.

To ensure accuracy and consistency in the epidemiological analysis, inclusion and exclusion criteria were established. The analysis included patients who underwent kidney transplants during the period defined for the study, covering all federative units of Brazil. Conversely, data from patients who underwent transplants of other organs, as well as those who had kidney transplants outside the study period, were excluded. Data were accessed and extracted from the RBT database and tabulated in Microsoft Excel spreadsheets, containing the variables and the period established in the study. The information was interpreted and organized into tables and charts, covering all the variables described.

The study complies with established ethical principles, using exclusively the public and freely accessible RBT database. Therefore, submission to the Research Ethics Committee (CEP) was not necessary, in accordance with current regulations.

RESULTS

Between 2018 and 2023, a total of 33,224 kidney transplants were performed in Brazil. In the pre-COVID-19 pandemic years, 2018 and 2019, transplants accounted for 17.9% and 19% of the total, respectively. With the onset of the pandemic in 2020, there was a significant drop in the number of procedures to 14.5% of the total, followed by a further decrease to 14.4% in 2021. Starting in 2022, a recovery trend was observed, with 16% of transplants performed that year. In 2023, this recovery advanced further, reaching 18.2%, representing a 0.3% increase compared to 2018, although still 0.8% below 2019 levels (Figure 1).

Overall, during the pandemic period, the annual average of kidney transplants performed in Brazil was 4,974 procedures, a figure significantly lower than the pre-pandemic average of 6,127 transplants. This difference

reflects an average reduction of 18.8% in the annual number of kidney interventions during the pandemic compared to previous years. However, in the post-pandemic period, a recovery was observed, with the number of transplants increasing by 21.6% compared to the average recorded during the pandemic, signaling a gradual resumption of the country's capacity to perform these procedures.

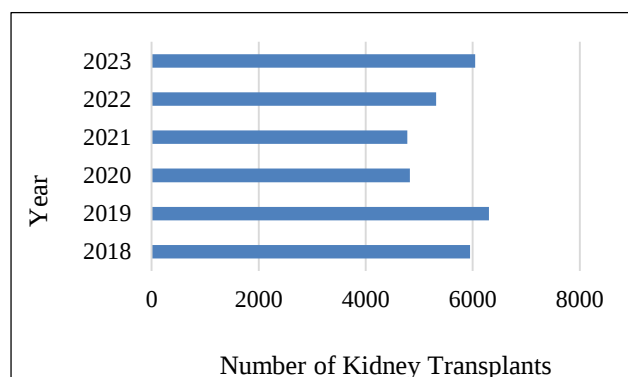


Figure 1: Kidney transplants performed in Brazil between 2018 and 2023.

The data related to the demand on the waiting list for surgical procedures highlight the impacts of the global health crisis and its consequences for the healthcare system. A 175.8% increase was observed in the kidney transplant waiting list when comparing the pre-pandemic and post-pandemic periods. Additionally, the percentage

of individuals who did not undergo the transplant and remained on the waiting list rose by 104.9% over the same periods.

In the pre-pandemic period, the average number of people waiting for a kidney transplant was 23,872, with 25.7% of patients on the waiting list managing to undergo the procedure. However, the average mortality rate among patients on the waiting list was 5.5%, while 68.8% remained without receiving a transplant. During the pandemic period, there was a significant increase in the waiting list, reaching an average of 28,055 people, 17.5% more than the pre-pandemic period. The average percentage of procedures performed relative to the waiting list dropped to 17.7%. At the same time, the average mortality rate among patients on the waiting list rose to 7.7%, while the average percentage of patients who did not receive a transplant and remained on the list increased to 74.6%, highlighting the worsening backlog of unmet patient needs during the period.

In the post-pandemic period, the waiting list continued to grow, reaching 32,862—the highest value recorded. Despite a slight recovery, the percentage of transplants performed was only 18.4%, still below pre-pandemic levels. On the other hand, the average mortality rate among patients on the waiting list dropped to 5.8%, but the percentage of patients who did not receive a transplant and remained on the list rose to 75.8%, indicating that the transplant system still faces significant challenges in meeting the growing demand (Table 1).

Table 1: Waiting list demand, kidney transplant procedures, and deaths.

Year	Waiting list	Kidney transplants performed	Percentage of kidney transplants performed in relation to waiting list demand (%)	Percentage of deaths while waiting on the list (%)	Percentage who did not receive the transplant and remained on the waiting list (%)
2018	22581	5952	26.4	5.8	67.8
2019	25163	6303	25	5.2	69.8
2020	26862	4826	18	6.6	75.4
2021	27613	4779	17.3	10.9	71.8
2022	29690	5317	17.9	5.6	76.5
2023	32862	6047	18.4	5.8	75.8

When evaluating the performance of medical teams in kidney transplants, an average of 144 teams were involved during the assessed period, with an average of 38 procedures performed per team. Although the number of teams remained relatively stable over the years, the pandemic primarily impacted the average productivity of professionals. In the pre-pandemic period, there was an average of 142 medical teams performing 43 transplants per team. During the pandemic, the average number of medical teams increased slightly to 146, while productivity dropped to 34 transplants per team, reflecting the negative impact of the health crisis. In 2023, a partial recovery was observed, with the average

number of transplants per team rising to 41, indicating a gradual return to previous productivity levels (Table 2).

To enable the flow of procedures and ensure the performance of kidney transplants, organ donors play a crucial role in the transplant system. A significant predominance of donations from deceased donors was observed, accounting for 85.7% of the total, in contrast to 14.3% from living donors. Prior to the pandemic, deceased donors represented an average of 82.8%, while living donors accounted for 17.1%. During the global health crisis, the share of deceased donors increased to 88.2%, whereas that of living donors dropped to 11.8%. In 2023, there was a partial recovery in the number of

living donors, reaching 14.2%, still below pre-pandemic levels, while deceased donors decreased slightly to

85.8%, remaining the primary source of kidney donations (Table 3).

Table 2: Performance of medical teams in kidney transplants.

Year	Total number of kidney transplants	Medical teams	Average number of transplants per medical team
2018	5952	136	44
2019	6303	149	42
2020	4826	137	35
2021	4779	141	34
2022	5317	160	33
2023	6047	146	41

Table 3: Percentage of deceased and living donors.

Year	Deceased donors (%)	Living donors (%)	Living donors with some degree of kinship (%)	Living donors as spouse (%)	Unrelated living donors (%)
2018	82.8	17.2	79.5	14.4	6.0
2019	82.9	17.1	77.3	15.3	7.4
2020	90.8	9.2	71.7	18.4	9.9
2021	87.6	12.4	73.2	16.4	10.5
2022	86.1	13.9	72.5	16.4	11.1
2023	85.8	14.2	71.2	18.6	10.1

Table 4: Kidney transplants performed by regions of Brazil.

Year	Kidney transplants performed	North (%)	Northeast (%)	South (%)	Southeast (%)	Center-west (%)
2018	5952	1.3	17.3	24.6	52.5	4.2
2019	6303	1.3	18.2	22.0	53.3	5.2
2020	4826	0.4	14.8	21.6	56.9	6.3
2021	4779	0.6	17.0	18.7	58.6	5.1
2022	5317	0.8	16.8	21.6	56.5	4.3
2023	6047	1.9	17.2	21.0	54.5	5.4

When evaluating the classification of living kidney donors, it is observed that the majority belong to the category of related donors, accounting for an average of 74.2% of the total during the analyzed period. Living donors who were spouses represented an average of 16.6%, while unrelated living donors made up the smallest portion, with 9.2%, indicating a lower frequency within this group.

Regarding the regional distribution of procedures, the data reveal significant heterogeneity among the different regions of Brazil. There is an approximate 98% difference between the number of kidney transplants performed in the North where the fewest procedures occurred and in the Southeast which had the highest volume highlighting a marked disparity in access to specialized healthcare services across regions.

The Southeast stood out with the highest concentration of kidney transplants throughout the entire period, increasing its share from 52.9% to 57.3% during the

pandemic. In 2023, although it declined to 54.5%, it remained above pre-pandemic levels. The South, the second-largest in terms of procedures, saw its share decrease from 23.3% to 20.6% due to the impact of COVID-19 but partially recovered to 21% in 2023. The Northeast, which accounted for 17.8% before the pandemic, dropped to 16.2% and reached 17.2% in the post-pandemic period, approaching previous levels. The Center-West region showed continuous growth, increasing its share from 4.7% to 5.2% during the health crisis and reaching 5.4% in 2023. The North, in turn, remained the region with the smallest share, dropping from 1.3% to 0.6%, and later recovering to 1.9% in the post-pandemic period surpassing pre-pandemic levels, but still representing the lowest contribution nationwide (Table 4).

Corroborating the regional analysis, there is a significant concentration of kidney transplants in certain Brazilian states. São Paulo leads with an average of 32.6% of the records, followed by Minas Gerais (11.6%), Paraná (9.5%), Rio de Janeiro (8.3%), and Rio Grande do Sul

(8%). These five states accounted for an average of 70% of all procedures performed during the pre-pandemic, pandemic, and post-pandemic periods, highlighting the predominance of the Southeast and South regions in the performance of kidney transplants.

DISCUSSION

Kidney transplantation is the second most common type of transplant performed in Brazil, second only to corneal transplants. The country stands out on the global stage, ranking among the world leaders in the number of procedures, behind only the United States, China, and India. Additionally, Brazil performs the highest number of kidney transplants in Latin America, reinforcing the efficiency and importance of its national transplant system.³

The present study demonstrated the significant impact of COVID-19 on the performance of kidney transplants in Brazil. Despite being one of the world leaders in this type of procedure, the country experienced a considerable decline in the number of transplants and a sharp increase in the transplant waiting list during the pandemic, highlighting the persistent challenges in meeting growing demand and restoring pre-pandemic levels.

In the years leading up to the pandemic, the country recorded a significant increase in kidney transplants, with a 5.9% growth in the number of procedures performed between 2018 and 2019. Globally, 195,576 kidney transplants were performed during the same period. The four leading countries accounted for 51.8% of the total, with Brazil contributing significantly by performing 6.3% of these procedures.^{11,12}

In 2020, the most critical year of the pandemic, the number of kidney transplants dropped significantly worldwide, with a 21% decline compared to the previous year.¹³ In Brazil, this decrease was even more pronounced, reaching 23.4%. In other countries, the reductions varied: the United States saw a 2.6% drop, China 9%, and India experienced a more substantial impact with a 43.7% decline.¹⁴⁻¹⁶ This was due to the redistribution of hospital resources to care for COVID-19 patients, leading to reduced availability of beds, medical teams, and equipment for transplant surgeries. Elective procedures were also suspended or postponed to avoid overwhelming hospitals and minimize the risk of infection.¹⁰ In Italy, more than 80% of kidney transplant programs suspended new patient registrations on the waiting list, and pre-transplant follow-up appointments were reduced by 95%.¹⁷

When analyzing the kidney transplant waiting list in Brazil, the study recorded a 37.7% increase in the average between the pre- and post-pandemic periods. This was largely due to the reduction of elective procedures at specialized centers a measure implemented to reduce infection risk and free up hospital resources for COVID-

19 patients.¹⁰ Similarly, in the United States, there was a 25% drop in additions to the kidney transplant waiting list in April 2020 compared to January and February of that same year.¹⁴ In the United Kingdom, the drop in transplants led to a 30% increase in the waiting list during the first six months of the pandemic.¹⁸

In addition, the postponement of consultations and elective treatments worsened the condition of patients with pre-existing kidney failure, while the progression of kidney disease in individuals infected with SARS-CoV-2 increased the demand for transplants. Patients on the waiting list who contracted COVID-19 also had a significantly higher risk of hospitalization.¹⁹ A study using data from the U.S. kidney transplant registry indicated that in 2020, 11% of deaths on the waiting list were associated with SARS-CoV-2 infection, and overall mortality on the list was 26% higher than in 2019. In the UK, 10% of patients on the waiting list who contracted COVID-19 died, and globally, mortality in this population increased by 43%.²⁰ In Brazil, the study observed a 2.2% increase in average mortality compared to previous years, highlighting the impact of the pandemic on those awaiting kidney transplants.

Another major concern was the high risk of infection among transplant recipients, as immunosuppressive therapy essential to prevent graft rejection left them more vulnerable to infections, including severe cases of COVID-19.²¹ A study in France analyzed 1,216 kidney transplant recipients, 66 (5%) of whom were diagnosed with COVID-19. Of these, 91% required hospitalization, 42% developed acute kidney injury (AKI), and 24% died from complications related to the disease.²² Another study in the U.S. evaluated 15 transplant recipients diagnosed with COVID-19, finding that 40% developed AKI and 13% died.²³ Similarly, an analysis of 53 transplant patients with COVID-19 in Italy showed that 85% required hospitalization and 28% had fatal outcomes.²⁴

These findings underscore the vulnerability of this population to SARS-CoV-2 infection and the high complication rates involved. As a result, the most severe cases were carefully prioritized, while patients with lower clinical risk remained on the waiting list for extended periods.⁸ In Brazil, comparing the pre-pandemic and pandemic periods in this study, a 5.8% increase was observed in the percentage of patients who remained on the waiting list without undergoing transplantation.

The reorganization of available healthcare resources to respond to the health crisis, as well as restrictive measures to prevent system overload, also directly compromised the logistics of organ procurement. Concerns about virus transmission led to stricter acceptance criteria for organs, complicating the management of potential deceased donors and further reducing organ availability. Regarding living donors, concerns over infection risk and hospital resource

reallocation led to a decrease in elective surgeries for organ donation.²⁵

Still, living donor transplants experienced a more significant drop compared to deceased donor transplants, with a global reduction of 40% in living kidney transplants in 2020. In Brazil, this study found a significant decline, with a 23.2% reduction in average donations during the pandemic compared to the previous period. Additionally, there was a 16.2% decrease in the number of deceased donors and a 58.6% drop in living donors when comparing 2019 to 2020. In the U.S., 72% of transplant programs temporarily suspended living donor procedures, while deceased donor transplant rates declined by 76%. Moreover, from January to November 2020, the number of living donor transplants was 24% lower compared to the same period in 2019.²⁵

Despite the containment measures, it was only with the advent of vaccination that the pandemic scenario began to change significantly. A major milestone occurred in December 2020, when the World Health Organization (WHO) granted emergency use authorization for the first COVID-19 vaccine, allowing global immunization efforts to expand.²⁶ Vaccination in Brazil began in January 2021, with the initial distribution of 10.7 million doses across federal units. By June, the country had administered 190 million doses, with over 80% of the target population receiving the first dose. This progress led to an average 60% reduction in case numbers, and Brazil ranked fourth globally in vaccine administration. In October, the moving average of COVID-19 deaths dropped by over 90% compared to the peak of the pandemic in April 2021.²⁷

With increasing immunization rates and a decline in severe cases, kidney transplants in Brazil began to gradually resume, and vaccination became mandatory in transplant protocols, offering greater protection to recipients. However, the present study identified that Brazil followed a different trend in 2021, registering a 1% reduction in kidney transplants compared to the previous year. In contrast, the United States recorded its highest number of kidney transplants since 2019, with a 5% increase. At the same time, China registered a 9% increase, while India saw a larger rise of 65% over the same period.²⁸

The recovery of kidney transplants in Brazil became evident only in 2022, with an 11.3% increase compared to the previous year, followed by a further 13.7% rise in 2023, indicating a trend of expansion.³ When comparing Brazil with the three leading countries in global kidney transplant rankings, all experienced significant drops in 2020 due to the pandemic.¹⁶ However, from 2021 onward, those countries began rapid recoveries, with the U.S. not only regaining but surpassing pre-pandemic levels.²⁸ Brazil, on the other hand, experienced a slower recovery and did not follow this global pace. While other countries quickly exceeded their pre-pandemic

performance, Brazil only surpassed its 2018 figures in 2023, revealing a more gradual post-crisis recovery.³

Additionally, a lingering effect of the pandemic was the backlog of procedures that should have been performed but were postponed³. As observed in the study, the kidney transplant waiting list not only continued to grow but faced an average annual increase of 5.2%. In 2023, the number of patients on the waiting list rose sharply 22.3% higher than in 2020. Between 2020 and 2023, an average of 74.9% of patients on the list were unable to receive a transplant.

This scenario highlights not only the limited transplant supply to meet growing demand but also the inequality in the distribution of procedures across the country³. As analyzed in this study, procedures remain centralized, with a strong concentration in the Southeast and South regions, which together account for an average of 76.9% of all transplants performed in Brazil. Nevertheless, all regions have returned to pre-pandemic levels, signaling a recovery of the system. However, the North and Center-West regions still have low transplant volumes, despite showing slight growth of 0.6% and 0.7%, respectively, compared to the pre-pandemic period. This indicates potential for expansion in these areas, reinforcing the need for investment in hospital infrastructure, medical team training, and optimization of organ procurement and distribution logistics.⁷ It is expected that, in the coming years, Brazil will move toward a decentralization of transplants, reducing regional inequalities and expanding access to the procedure throughout the national territory.

Finally, the study presents some relevant limitations that should be considered when interpreting the results. One of the main constraints is the lack of publicly available data in the Brazilian Transplant Registry (RBT) that would allow for the construction of a detailed profile of kidney donors, including information such as the cause of death for deceased donors, gender, age, and compatibility characteristics with recipients. Additionally, there is no public access to specific data on the waiting list, such as the underlying diseases that led patients to require kidney transplantation. Although these limitations do not compromise the validity of the findings, they do hinder a more comprehensive analysis of variables that could enrich the study.

CONCLUSION

The data obtained in this study provide important insights for assessing the impact of the COVID-19 pandemic on the kidney transplant system in Brazil. These elements are essential for supporting health policies, identifying gaps, and guiding the development of strategies aimed at improving the efficiency of the transplant system. The sector underwent drastic changes during the pandemic, marked by an increase in the waiting list and a significant reduction in the number of procedures performed, highlighting the need for interventions to restore progress.

The study also highlighted disparities in the distribution of transplants across Brazilian regions and states, offering a foundation for targeted actions to reduce these inequalities and promote a more decentralized system.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Bikbov B, Purcell C, Levey AS, Smith M, Abdoli A, Abebe M, et al. Global, regional, and national burden of chronic kidney disease, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2020;395(10225):709-33.
2. de Andrade CM, de Souza Andrade AM. Profile of morbidity and mortality due to chronic kidney disease in Brazil. *Bahi J Publ Heal*. 2020;44(2):38-52.
3. Camacho Filho RG, Ayres FERREIRA G, de Souza Nascimento AC, dos Santos Martins FM, Madlum R. Analysis of the epidemiological profile of corneal transplants in the State of São Paulo. *Corpus Hippocrat J*. 2023;1(1).
4. Passoni R, Gadonski B, Carvalho ARS, Freitas TVS, Peres LAB. The impact of COVID-19 on kidney transplant activities in Brazil: a descriptive study. *Sao Paulo Med J*. 2022;141(1):60-6.
5. Kramer A, Jager KJ, Chesnaye NC, Kerschbaum J, Hommel K, Comas Farnés J, et al. Changes in the epidemiology of kidney replacement therapy across Europe in 2020 the first year of the COVID-19 pandemic: an ERA Registry study. *Nephrol Dial Transplant*. 2024;39(11):1835-45.
6. Pefaur J, Toro L, Lorca E, Torres R. Impact of a national multicentric strategy to support kidney transplant patients during the COVID-19 pandemic in Latin America: FUTAC team creation and activities. *Transplantation*. 2022;106(4):680-4.
7. Vianna AM, Rosaneli CF, de Siqueira JE. Kidney transplantation in Brazil: a bioethical analysis. *HOLOS*. 2022;3.
8. Ribeiro Junior MAF, Costa CTK, Néder PR, Aveiro IA, Elias YGB, Augusto SS. Impact of COVID-19 on the number of transplants performed in Brazil during the pandemic. Current situation. *Rev Col Bras Cir*. 2021;48:20213042.
9. Raja MA, Mendoza MA, Villavicencio A, Anjan S, Reynolds JM, Kittipibul V, et al. COVID-19 in solid organ transplant recipients: a systematic review and meta-analysis of current literature. *Transplant Rev*. 2021;35(1):100588.
10. Costa LR, Furtado LC, Braga RC, Brito BD, Sales TJ, Motta DD, Nunes FH, Schmidt YF, Silva HR, Fonseca OC. Impact on the Solid Organ Transplant Queue During the Covid-19 Pandemic: An Integrative Review. *Brazil J Transplant*. 2023;26:e2323.
11. Global Observatory on Donation and Transplantation (GODT). Organ Donation and Transplantation Activities: International Report 2018, 2020. Available at: <https://www.transplant-observatory.org/wp-content/uploads/2020/10/glorep2018-2.pdf>. Accessed 01 January 2025.
12. Global Observatory on Donation and Transplantation (GODT). Organ Donation and Transplantation Activities: International Report 2019, 2021. Available at: https://www.transplant-observatory.org/wp-content/uploads/2021/06/GODT2019-data_web_updated-June-2021.pdf. Accessed 01 January 2025.
13. Global Observatory on Donation and Transplantation (GODT). Organ Donation and Transplantation Activities: International Report 2020, 2022. Available at: <https://www.transplant-observatory.org/wp-content/uploads/2022/09/2020-Report-para-web.pdf>. Accessed 01 January 2025.
14. Procurement O, Network T. and Scientific Registry of Transplant Recipients (SRTR). OPTN/SRTR 2010 Annual Data Report. Rockville, MD: Department of Health and Human Services, Health Resources and Services Administration, Healthcare Systems Bureau, Division of Transplantation. 2011;12(Suppl 1):1-56.
15. Brazilian Association of Organ Transplantation. Brazilian Association of Organ Transplantation-ABTO. 2019.
16. Brazilian Association of Organ Transplantation. Brazilian Association of Organ Transplantation-ABTO. 2020.
17. Vistoli F, Furian L, Maggiore U, Caldara R, Cantaluppi V, Ferraresso M, et al. COVID-19 and kidney transplantation: an Italian survey and consensus. *J Nephrol*. 2020;33(4):667-80.
18. Sharma V, Shaw A, Lowe M, Summers Â, van Dellen D, Agostinho T. The impact of the COVID-19 pandemic on renal transplantation in the UK. *Clin Med (Lond)*. 2020;20(4):82-6.
19. Mahalingasivam V, Su G, Iwagami M, Davids MR, Wetmore JB, Nitsch D. COVID-19 e doença renal: insights da epidemiologia para informar a prática clínica. *Nat Rev Nephrol*. 2022;18(8):485-98.
20. Mohan S, King KL, Husain SA, Schold JD. COVID-19-associated mortality among kidney transplant recipients and candidates in the United States. *Clin J Am Soc Nephrol*. 2021;16(11):1695-703.
21. Hilbrands LB, Duivenvoorden R, Vart P, Franssen CFM, Hemmelder MH, Jager KJ, et al. COVID-19-related mortality in kidney transplant and dialysis patients: results of the ERACODA collaboration. *Nephrol Dial Transplant*. 2020;35(11):1973-83.
22. Elias M, Pievani D, Randoux C, Louis K, Denis B, Delion A, et al. COVID-19 infection in kidney

- transplant recipients: disease incidence and clinical outcomes. *J Am Soc Nephrol*. 2020;31(10):2413-23.
23. Husain SA, Chang JH, Cohen DJ, Crew RJ, Dube GK, Fernandez HE, et al. Early description of coronavirus 2019 disease in kidney transplant recipients in New York. *J Am Soc Nephrol*. 2020;31(6):1150-6.
 24. Bossini N, Alberici F, Delbarba E, Valerio F, Manenti C, Possenti S, et al. Kidney transplant patients with SARS-CoV-2 infection: the Brescia Renal COVID Task Force experience. *Am J Transplant*. 2020;20(11):3019-29.
 25. Khairallah P, Aggarwal N, Awan AA, Vangala C, Airy M, Pan JS, et al. The impact of COVID-19 on kidney transplantation and the kidney transplant recipient-one year into the pandemic. *Transpl Int*. 2021;34(4):612-21.
 26. Silva S, Araújo DD, Ribeiro F, Araújo CS. Vaccinate or take the risk? The World Health Organization's message to promote vaccination against Covid-19. *Health Society*. 2024;33(1):e220584pt.
 27. Brasil. Ministério da Saúde. Painel de vacinação contra a COVID-19. Available at: https://infoms.saude.gov.br/extensions/SEIDIGI_DEMAS_Vacina_C19/SEIDIGI_DEMAS_Vacina_C19.html. Accessed 15 January 2025.
 28. Brazilian Association of Organ Transplantation (ABTO). Brazilian Transplant Registry: dimensioning of transplants in Brazil and in each State in 2021. São Paulo: ABTO; 2021.

Cite this article as: Santos TB, de Oliveira BES, Bispo EV, Coutinho Filho PJRD, Pereira TSC, e Silva VHBG, et al. Analysis of kidney transplants in brazil: a comparative study pre and post-COVID-19 pandemic. *Int J Community Med Public Health* 2025;12:2484-91.