

Kidney Transplant in Brazil During the Peripandemic Period: Finally, Have we Recovered?

Reginaldo Passoni^{1*} , Luiz Henrique Korilo¹ , Gabriele Medeiros Dias¹ 

1. Centro Universitário de Univel – Curso de Graduação em Enfermagem – Cascavel (PR) – Brazil.

*Corresponding author: regipassoni@gmail.com

Section editor: Ilka de Fátima Santana F. Boin 

Received: June 15, 2025 | Approved: July 13, 2026

ABSTRACT

Introduction: The COVID-19 pandemic has significantly impacted healthcare systems worldwide, especially kidney transplant programs. **Objective:** To analyze the variation in kidney transplant registries in Brazil before, during, and after the COVID-19 pandemic. **Methods:** This is an ecological study conducted using data from the Brazilian Transplant Registry, referring to the pre-pandemic (2018-2019), pandemic (2020-2021) and post-pandemic (2022-2023) periods. Variables such as the annual number of transplants, death rate on the waiting-list, and proportion of potential and effective donors were analyzed. One-way analysis of variance was performed to compare the periods, with significance set at $p < 0.05$. **Results:** The annual average number of kidney transplants fell from 6,128 procedures in the pre-pandemic period to 4,803 during the pandemic (-21.6%) and recovered to 5,682 in the post-pandemic period, still below initial levels. The North region was the only one that resumed pre-pandemic levels of transplants, while other regions still registered deficits. The death rate on the waiting-list increased significantly from 5.5% to 8.8% during the pandemic and fell to 5.7% post-pandemic ($p < 0.0001$). The proportion of potential donors fell from 54.2 pmp in the pre-pandemic period to 53.3 pmp during the pandemic and reached 65.6 pmp post-pandemic. **Conclusion:** The results of this study suggest that the COVID-19 pandemic was associated with a reduction in kidney transplant rates and an increase in the death rate on the waiting-list during the pandemic period, accompanied by signs of partial recovery in kidney donation and transplantation indicators in Brazil in the immediate post-pandemic period.

Descriptors: COVID-19; Kidney Transplantation; Tissue and Organ Procurement; Epidemiology.

Transplante Renal no Brasil no Período Peripandêmico: Enfim, nos Recuperamos?

RESUMO

Introdução: A pandemia de COVID-19 impactou significativamente os sistemas de saúde em todo o mundo, especialmente os programas de transplantes renais. **Objetivo:** Analisar a variação ocorrida nos registros de transplante renal no Brasil antes, durante e após a pandemia por COVID-19. **Métodos:** Trata-se de um estudo ecológico conduzido com base em dados do Registro Brasileiro de Transplantes, referentes ao período pré-pandêmico (2018-2019), pandêmico (2020-2021) e pós-pandêmico (2022-2023). Foram analisadas variáveis como número anual de transplantes, taxa de óbitos em lista de espera, e proporção de potenciais doadores e doadores efetivos. Aplicou-se análise de variância para comparar os períodos, com significância definida em $p < 0,05$. **Resultados:** A média anual de transplantes renais caiu de 6.128 procedimentos no período pré-pandêmico para 4.803 durante a pandemia (-21,6%) e se recuperou para 5.682 no período pós-pandêmico, ainda abaixo dos níveis iniciais. A região Norte foi a única que retomou os níveis pré-pandêmicos de transplantes, enquanto outras regiões ainda registraram déficits. A taxa de óbito em lista de espera aumentou significativamente de 5,5% para 8,8% durante a pandemia e caiu para 5,7% no pós-pandemia ($p < 0,0001$). A proporção de potenciais doadores caiu de 54,2 pessoas por milhão de população (pmp) no período pré-pandêmico para 53,3 pmp durante a pandemia, alcançando 65,6 pmp no pós-pandemia. **Conclusão:** Os resultados do presente estudo sugerem que a pandemia de COVID-19 esteve associada a uma redução nas taxas de transplante renal e a um aumento na taxa de óbito em lista de espera durante o período pandêmico, acompanhados de sinais de recuperação parcial nos indicadores de doação e transplante renal no Brasil no período pós-pandêmico imediato.

Descritores: COVID-19; Transplante de Rim; Obtenção de Tecidos e Órgãos; Epidemiologia.

INTRODUCTION

COVID-19 had a significant impact on healthcare systems in Brazil and around the world, revealing and intensifying pre-existing vulnerabilities. In Brazil, the pandemic overwhelmed the healthcare system, resulting in a critical shortage of beds, supplies, and healthcare professionals. The need to treat COVID-19 patients led to the interruption or postponement of elective procedures and treatments for other medical conditions¹. The lack of political coordination and the competition for vital resources, such as vaccines and safety equipment, intensified the complexity of the pandemic response². Several countries have begun to re-evaluate their public health strategies, focusing on alternatives to meet clinical demands.

In this regard, it is worth noting that COVID-19 had a considerable impact on kidney transplantation activities in Brazil and other nations. During the early stages of the pandemic, numerous transplant centers suspended or postponed procedures to prioritize the care of COVID-19 patients, leading to a significant reduction in the number of transplants performed^{3,4}.

In Brazil, the National Transplant System (*Sistema Nacional de Transplante -SNT*) is the primary public policy established to promote organ donation and transplantation, as well as to ensure equitable access and quality in procedures. Created in 1997, the Ministry of Health manages it and operates in collaboration with public and private healthcare institutions; it encompasses everything from donor procurement to post-transplant follow-up, while also promoting and encouraging educational activities aimed at increasing public awareness regarding organ donation⁵.

During the pandemic, it was observed that COVID-19 had a negative impact on patient survival and on all aspects of transplant-related activities in Brazil—including referrals and listing for transplantation, organ acquisition and donation, and increased mortality among those on the waiting-list^{6,7}. Several studies were conducted during the pandemic to identify the immediate impacts of COVID-19 on organ transplant data in Brazil^{1-4,6-7}. However, the literature is limited regarding the analysis of national data on kidney transplantation before, during, and after the pandemic in Brazil.

This analysis provides a comprehensive assessment of the pandemic's actual impact. It makes it possible to determine whether the country—which has the world's largest public transplant system—was able to recover following the aforementioned period. Accordingly, this study was developed based on the following guiding question: What was the variation in kidney transplant rates in Brazil during the peri-pandemic period? To address this question, the study aimed to analyze the variation in kidney transplant records in Brazil before, during, and after the COVID-19 pandemic.

METHODS

This study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines⁸. This study was conducted in accordance with all guidelines outlined in Resolution No. 466/2012 of the Brazilian National Health Council, and all principles of the Declaration of Helsinki regarding research ethics were observed. Given that the study involved the analysis of publicly available data, submission to a Research Ethics Committee for review was not required.

To investigate the effect of the pandemic on kidney transplant rates, we conducted an ecological study comparing data from the Brazilian Transplant Registry (*Registro Brasileiro de Transplantes - RBT*) before, during, and after the pandemic. RBT data are publicly available by the Brazilian Association of Organ Transplantation (*Associação Brasileira de Transplante de Órgãos - ABTO*), which obtains the data from a survey conducted among hospitals across all regions of the country that perform organ transplants⁹.

After transplant centers submit their information, ABTO aggregates the data in the RBT. Accordingly, in this study, we extracted and analyzed the following variables: the annual number of kidney transplants, stratified by donor type (living or deceased) and geographic region (North, Northeast, Central-West, Southeast, and South); the number of active patients and the death rate on the waiting-list; and the proportion of potential and actual donors.

To evaluate kidney transplant records during the peri-pandemic period, we extracted data from 2018 to 2023, defining each period by two-year intervals. Thus, we defined the years 2018 and 2019 as the pre-pandemic period, 2020 and 2021 as the pandemic period, and 2022 and 2023 as the post-pandemic period.

The decision to analyze data in two-year periods (2018–2019, 2020–2021, 2022–2023) is justified by the need to smooth out monthly seasonal fluctuations and capture distinct epidemiological phases: pre-pandemic stability, the cumulative impact of infection peaks and troughs, and sustained post-vaccination recovery.

The annual waiting-list mortality rate was calculated as the ratio of patients who died while awaiting transplantation to the number of active patients. Similarly, the annual waiting-list entry rate was calculated as the ratio of newly registered patients to the total number of active patients on the list during the year.

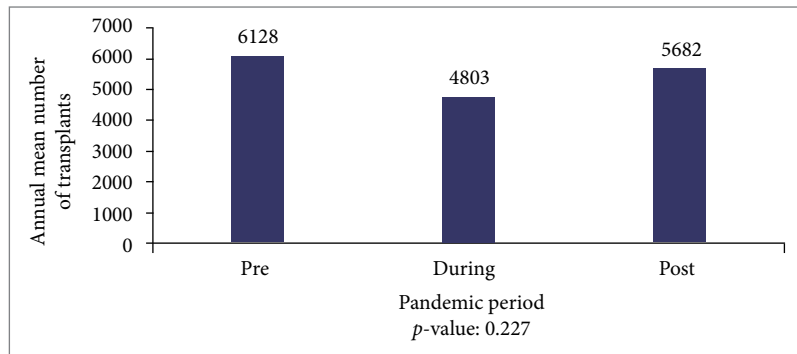
To identify the annual number of kidney transplants performed during each period, we collected absolute data as well as relative figures expressed as rates per million population (pmp). The distribution of all variables was tested for normality using the

Shapiro-Wilk test. Following confirmation of a normal distribution, comparisons across different periods were performed using one-way analysis of variance (One-Way ANOVA).

All variables were compared according to the pandemic period (before, during, and after the pandemic). Data were tabulated in Microsoft Excel (version 2013), and statistical analyses were performed using XLSTAT software (version 2024.3.0). For all inferential analyses, a p -value < 0.05 was considered statistically significant.

RESULTS

The annual mean number of kidney transplants performed during the pandemic was 4,803 procedures. In the post-pandemic period, the annual average was higher, yet it remained below the annual mean observed in the pre-pandemic period (Fig. 1).



Source: Elaborated by the authors.

Figure 1. Annual mean number of kidney transplants in Brazil according to pandemic period.

Stratifying the data according to donor type, the mean annual proportion of transplants showed a statistically significant decrease (p -value < 0.0001) during the pandemic, being 2.5 ± 0.5 transplants pmp for living-donor procedures and 20.4 ± 0.8 for deceased-donor transplants (Table 1).

Table 1. Mean proportion of kidney transplants in Brazil by donor type and pandemic period.

Donor type	Pandemic period			p -value
	Pre (2018-2019)	During (2020-2021)	Post (2022-2023)	
Living	5.5 ± 0.2	2.5 ± 0.5	3.9 ± 0.5	< 0.0001
Deceased	24.4 ± 0.9	20.4 ± 0.8	23.5 ± 3.0	< 0.0001

Source: Elaborated by the authors.

When data were evaluated by geographic region, all regions showed a statistically significant decrease in the mean annual proportion of kidney transplants. As shown in Table 2, the North region was the only one in which the mean annual proportion of transplants in the post-pandemic period returned to pre-pandemic levels.

Table 2. Mean proportion of kidney transplants in Brazil by geographic region and pandemic period.

Region of Brazil	Pandemic Period			p -value
	Pre (2018-2019)	During (2020-2021)	Post (2022-2023)	
North	4.5 ± 0.2	1.3 ± 0.6	4.5 ± 3.1	< 0.0001
Northeast	19.1 ± 1.6	13.3 ± 1.1	17.3 ± 2.5	< 0.0001
Midwest	18.1 ± 3.1	16.6 ± 3.0	16.6 ± 4.7	< 0.0001
Southeast	37.0 ± 1.6	31.1 ± 0.2	36.2 ± 3.7	< 0.0001
South	47.9 ± 1.8	32.2 ± 3.5	40.2 ± 3.3	< 0.0001

Source: Elaborated by the authors.

Table 3 shows that, even during the pandemic, the number of active patients on the kidney waiting-list exhibited a steady upward trend throughout the analyzed period, a pattern also observed regarding the number of potential donor notifications. Conversely, the patient mortality rate while awaiting a kidney transplant was significantly higher during the pandemic. In contrast, the proportion of actual donors was even higher in the post-pandemic period.

Table 3. Activities of transplant centers in Brazil, according to analysis period.

Region of Brazil	Period			p-value
	Pre (2018-2019)	During (2020-2021)	Post (2022-2023)	
Active waitlist candidates (n)	23,872 ± 1,826	27,238 ± 531	31,276 ± 2,243	0,57
Waitlist mortality rate (%)	5.5 ± 0.4	8.8 ± 3.0	5.7 ± 0.2	< 0.0001
Potential donors per (pmp)	54.2 ± 5.0	53.3 ± 2.0	65.6 ± 5.2	< 0.0001
Actual donors (pmp)	17.6 ± 0.8	15.5 ± 0.5	18.2 ± 2.4	< 0.0001

Source: Elaborated by the authors.

DISCUSSION

The results of this study demonstrate the significant impact of the COVID-19 pandemic on kidney transplant rates in Brazil. During the pandemic period, a substantial reduction in the average annual number of kidney transplants was observed (Figure 1), accompanied by a proportional drop in transplants performed using both living and deceased donors (Table 1). These findings corroborate previous studies^{1-4,6-7} that identified the diversion of hospital resources toward COVID-19 management as a critical factor in the disruption of elective procedures, including kidney transplants.

A study conducted in Brazil during the pandemic highlighted that, in 2020, kidney transplants fell by 43.2% in the second quarter and by 37.8% in the third quarter compared to the same period of the previous year⁴. A reduction in kidney transplants during the pandemic was also evident internationally. In developed countries such as the United States, Italy, and Spain¹⁰, there was a significant decrease in the number of kidney transplants performed. Although the pandemic affected kidney transplant activities worldwide, a multinational study indicates that the impact was even greater in low-income countries¹¹.

The recovery of kidney transplant services in the post-pandemic period has shown considerable variability. This heterogeneous recovery is the result of diverse factors, such as national health policies, the structure of transplantation systems, and regional economic and logistical conditions. As evidenced in this study, the world's largest public transplant system has shown resilience by progressively increasing the rate of kidney transplants. Despite this, regional disparities remain evident: while the North region returned to levels observed in the pre-pandemic period, regions such as the South and Northeast still showed a considerable deficit in transplants, even in the post-pandemic period (Table 2). This discrepancy can be attributed to regional structural and socioeconomic factors¹².

Part of the uneven recovery observed across Brazilian regions may be linked to structural differences in diagnostic capacity during the pandemic. National studies¹³⁻¹⁴ have demonstrated significant disparities in COVID-19 underreporting rates among the country's states, with states in the North and Northeast regions accounting for the seven highest rates of underreporting. This suggests that the true magnitude of the pandemic's impact on healthcare services in these regions was underestimated in official records, thereby compromising planning for the resumption of elective procedures such as kidney transplantation.

This scenario is corroborated by the fact that, even at the height of the pandemic, Brazil had tested only about 6.3% of its population—ranking among the countries with the lowest testing rates globally—with significant regional disparities in diagnostic and epidemiological surveillance capacity¹⁴. A study conducted in Alagoas reinforces that the presentation of severe acute respiratory syndrome cases due to COVID-19 has a regional component, reflecting differences in healthcare access and social inequality across the country's regions, with a higher prevalence of comorbidities among hospitalized patients in the North region¹⁵. Regions with lower testing rates tend to underestimate the true healthcare burden of COVID-19, hindering the rational allocation of hospital resources and, indirectly, delaying the safe resumption of transplant activities.

Family refusal is a key determinant of organ availability in Brazil. It shows a marked geographic variation, which may explain some of the heterogeneity in regional recovery rates observed in this study. A Brazilian study conducted at a large hospital in Curitiba (State of Paraná), based on the analysis of medical records and documented accounts from family members, identified that the primary reasons for refusal were related to the family's difficulty in understanding the diagnosis of brain death, a lack of preparedness in communication between the healthcare team and the family during this critical moment, and a lack of prior knowledge regarding the potential donor's wishes¹⁶.

The findings are consistent with national surveys showing that the family refusal rate remains historically high in the country, with a marked concentration in the North and Northeast regions. This disparity stems, in part, from the legal framework in place since 2001, under which organ donation depends exclusively on family authorization, even when the potential donor had expressed a wish to donate during their lifetime. Regions with more structured family interview teams and higher-quality processes for communicating brain death—as discussed in the Curitiba study¹⁶—tend to show lower refusal rates and, consequently, higher rates of actual donation; this factor likely contributed to the more consistent recovery observed in certain regions of the country during the post-pandemic period.

Based on the data presented in Table 3, the multifactorial impact of the COVID-19 pandemic on transplant activities in Brazil is further evidenced. In this regard, the unequal distribution of intensive care unit (ICU) beds across the country is another structural factor relevant to understanding the heterogeneous recovery of transplant activities. Data from the pandemic period show that the Southeast region accounted for 51.9% of the country's ICU beds, whereas the North (5.2%) and Midwest (8.5%) regions did not reach 10% of the national total¹³. Although the absolute number of ICU beds increased significantly during the pandemic, that same analysis concluded that regional inequalities in the public-private distribution of hospital capacity remained significant—even in resource-rich regions—imposing serious limitations on the response to COVID-19 and exacerbating health inequalities in the country¹³.

The concentration of critical care beds in a few regions implies greater competition for resources between intensive care for COVID-19 patients and the maintenance of infrastructure required for transplant, such as operating rooms, post-transplant ICUs, and specialized teams. This may have disproportionately delayed the resumption of kidney transplants in regions with lower installed capacity, such as the North and Central-West.

Nevertheless, regional socioeconomic disparities exacerbated by the pandemic may have also influenced the recovery capacity of local health systems. Analyses based on data from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística-IBGE*) indicated that smaller businesses in the construction and services sectors—located primarily in the Northeast and Southeast regions—were the most economically affected by the pandemic, experiencing an increase in the labor force underutilization rate¹⁷.

Long-term economic projections conducted by researchers at the Federal University of Minas Gerais (UFMG) using computable general equilibrium models reinforce this asymmetry: the largest negative impacts projected on regional Gross Domestic Product (*Produto Interno Bruto - PIB*) through 2050 are concentrated in states of the Northern region, such as Amazonas and Acre, associated with differences in the age profile of mortality and the local productive structure¹⁸. Regional economic contraction tends to reduce public health investment and the medium-term sustainability capacity of organ procurement and transplantation programs, helping to explain why certain regions, even after the end of the acute phase of the pandemic, have not yet fully recovered the pre-pandemic levels of kidney transplantation observed in this study.

The results of this study reflect both the resilience and the limitations faced by the SNT in the peripandemic period. The progressive growth in the number of active waitlisted patients, even during the pandemic, reinforces the ongoing demand for kidney transplantation in Brazil. This increase can be explained by the accumulation of patients whose clinical condition qualifies them for transplantation, but who did not undergo the procedure due to the temporary disruption of services during the pandemic¹⁹. Similar studies conducted in countries such as the United States have also pointed to a significant growth in the number of active waitlisted patients following the partial resumption of transplant activities¹¹.

The statistically significant increase in the waitlist mortality rate during the pandemic (from 5.5% in the pre-pandemic period to 8.8% during the pandemic) highlights the challenges faced by patients with chronic kidney disease, whose health frequently deteriorates while awaiting transplantation. This trend was also observed in India, where the healthcare system's overburden limited chronic kidney disease patients' access to appropriate renal replacement therapies during the pandemic²⁰. Furthermore, patient reluctance to seek medical care, driven by fear of SARS-CoV-2 exposure, contributed to the worsening of comorbidities²¹.

The decline in the number of potential donors during the pandemic period (from 54.2 pmp in the pre-pandemic period to 53.3 pmp during the pandemic) reflects the direct impact of social distancing measures and the prioritization of hospital beds for critical COVID-19 patients. Studies conducted in European countries, such as France and Germany, report similar declines in donor identification and notification during lockdown periods and hospital restrictions²².

However, the proportional increase in actual donors in the post-pandemic period (from 15.5 pmp during the pandemic to 18.2 pmp) indicates a significant recovery of transplant services in Brazil. This growth can be attributed to SNT initiatives to reorganize organ procurement logistics, using technologies to enable evaluations and transport even under challenging conditions. Countries such as Spain and Portugal have implemented similar strategies, featuring rigorous screening systems and resource optimization, resulting in a steady increase in the number of donors²³⁻²⁴.

Compared to other countries, Brazil shares a unique characteristic: the robustness of the SNT. Although there was a reduction in the number of transplants during the pandemic, national efforts for effective donor retrieval in the post-pandemic period demonstrate a more accelerated recovery compared to countries with less centralized systems.

However, this study has several limitations that must be considered. First, this is an ecological study; consequently, it was not possible to directly evaluate the clinical and social factors contributing to variations in transplant numbers—the four explanatory factors discussed above (testing, family refusal, ICU beds, and economic impact) constitute plausible etiological hypotheses, grounded in the national literature. Still, they could not be directly tested using the aggregated data employed in this study. Furthermore, the analyses are limited to secondary data available from the Brazilian Transplant Registry (RBT), which depend on the quality and consistency of reports provided by transplant centers. Future studies could explore these issues in greater detail using prospective designs and qualitative approaches to better elucidate the challenges faced by patients and healthcare professionals regarding kidney transplantation activities in Brazil, incorporating regional variables of testing, family refusal, hospital infrastructure, and socioeconomic context as explanatory covariates.

Furthermore, the data from the present study highlight the importance of strengthening public health policies that ensure the continuity of transplant activities, even during periods of health crises. Brazil's ability to partially recover its kidney transplant rates reinforces the central role of the Brazilian National Transplant System (SNT) as a global reference model for resilience and equity in access to healthcare.

CONCLUSION

The results of the present study suggest that the COVID-19 pandemic was associated with a reduction in kidney transplant rates and an increase in waiting-list mortality during the pandemic period, followed by partial recovery in organ donation and kidney transplantation indicators in Brazil during the immediate post-pandemic period. Nevertheless, pre-pandemic levels were not fully restored across all regions of the country, pointing to heterogeneous recovery across Brazilian regional contexts. Such regional disparity is influenced by several concurrent factors, ranging from family refusal to regional economic inequalities.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Passoni R, Korilo LH, Dias GM; **Conception and design:** Passoni R, Korilo LH, Dias GM; **Data analysis and interpretation:** Passoni R; **Article writing:** Passoni R, Korilo LH, Dias GM; **Critical revision:** Passoni R, Korilo LH, Dias GM; **Final approval:** Passoni R.

DATA AVAILABILITY STATEMENT

All data are presented in the article.

FUNDING

This research was developed with financial support from the Research and Extension Center (Call for Proposals 12/2024), linked to the Univel University Center.

DECLARATION OF USE OF ARTIFICIAL INTELLIGENCE TOOLS

The authors declare that no artificial intelligence tools were used in the preparation, writing, data analysis, or revision of this manuscript.

ACKNOWLEDGEMENT

Not applicable.

REFERENCES

- Costa LRO, Furtado LCC, Braga RC, Brito BDB, Sales TJB, Motta DL, et al. Impact on the solid organ transplant waiting-list during the COVID-19 pandemic: an integrative review. *Braz J Transpl.* 2023; 26: e2323. https://doi.org/10.53855/bjt.v26i1.477_ENG
- Makenze M, Nascimento MI, Saad MAN. Transplante renal e pandemia de COVID-19: síntese da literatura de procedimentos realizados no Brasil. *Id on Line Rev. Psic.* 2024; 18 (73): 145-158. <https://doi.org/10.14295/idonline.v18i73.4017>
- Teichmann PV, Moschetta MO, Franco RF, Vicari AR, Nunes GLS, Lazzaretti MAK, et al. Impacto de um ano da pandemia COVID 19 na terapia renal substitutiva e no transplante renal em centro terciário no Sul do Brasil. *Braz J Nephrol.* 2023; 45 (2): 211-218. <https://doi.org/10.1590/2175-8239-jbn-2022-0034en>
- Ribeiro MAF Junior, Costa CTK, Néder PR, Aveiro IA, Elias YGB, Augusto SS. Impacto do COVID-19 no número de transplantes no Brasil durante a pandemia. Situação atual. *Rev Col Bras Cir.* 2021; 48: e20213042. <https://doi.org/10.1590/0100-6991e-20213042>
- Ministério da Saúde. Sistema Nacional de Transplantes. Brasília; [s.d.]. [access on 2024 Nov 10]. Available at: <https://www.gov.br/saude/pt-br/composicao/saes/snt>
- Passoni R, Gadonski B, Carvalho ARS, Freitas TVS, Peres LAB. The impact of COVID-19 on kidney transplant activities in Brazil: a descriptive study. *São Paulo Med J.* 2023; 141 (1): 60-66. <https://doi.org/10.1590/1516-3180.2021.0956.r1.29042022>
- Sandes-Freitas TV, Cristelli MP, Requião-Moura LR, Andrade LGM, Viana LA, Garcia VD, et al. Temporal reduction in COVID-19-associated fatality among kidney transplant recipients: the Brazilian COVID-19 registry cohort study. *Transpl Int.* 2022 jan; 35: 10205. <https://doi.org/10.3389/ti.2022.10205>
- Malta M, Cardoso LO, Bastos FI, Magnanini MMF, Silva CMFP. Iniciativa STROBE: subsídios para a comunicação de estudos observacionais. *Rev Saúde Pública.* 2010; 44 (3): 559-565. <https://doi.org/10.1590/S0034-89102010000300021>
- Associação Brasileira de Transplante de Órgãos. Registro Brasileiro de Transplantes. São Paulo; 2023. [access on 2024 Oct 10]. Available at: <https://site.abto.org.br/conteudo/rbt/>
- Cravedi P, Mothi SS, Azzi Y, Haverly M, Farouk SS, Pérez-Sáez MJ, et al. COVID-19 and kidney transplantation: results from the TANGO International Transplant Consortium. *Am J Transplant.* 2020; 20: 3140-3148. <https://doi.org/10.1111/ajt.16185>
- Sandal S, Massie A, Boyarsky B, Chiang TP-Y, Thavorn K, Segev DL, et al. Impact of the COVID-19 pandemic on transplantation by income level and cumulative COVID-19 incidence: a multinational survey study. *BMJ Open.* 2022; 12: e055367. <https://doi.org/10.1136/bmjopen-2021-055367>
- Medina-Pestana JO, Galante NZ, Tedesco-Silva H Junior, Harada KM, Garcia VD, Abbud-Filho M, et al. O contexto do transplante renal no Brasil e sua disparidade geográfica. *Braz J Nefrol.* 2011; 33 (4): 472-484. <https://doi.org/10.1590/S0101-28002011000400014>
- Cotrim DF Junior, Cabral LMS. Crescimento dos leitos de UTI no país durante a pandemia de COVID-19: desigualdades entre o público x privado e iniquidades regionais. *Physis.* 2020; 30 (3): e300317. <https://doi.org/10.1590/s0103-73312020300317>
- Magno L, Rossi TA, Mendonça-Lima FW, Santos CC, Campos GB, Marques LM, et al. Desafios e propostas para ampliação da testagem e diagnóstico para COVID-19 no Brasil. *Cien Saúde Colet.* 2020 set; 25 (9): 3355-3364. <https://doi.org/10.1590/1413-81232020259.17812020>
- Baggio JAO, Exel AL, Calles ACN, Minatel V. Síndrome Respiratória Aguda Grave (SRAG) causada por COVID-19: um fator regional. *Arq Bras Cardiol.* 2021; 117 (5): 976-977. <https://doi.org/10.36660/abc.20210803>
- Rosário EN, Pinho LG, Oselame GB, Neves EB. Recusa familiar diante de um potencial doador de órgãos. *Cad Saúde Colet.* 2013 set; 21 (3): 260-266. <https://doi.org/10.1590/S1414-462X2013000300005>
- Freire DG, Carvalho KCM, Oliveira CC. Impactos econômicos da pandemia de COVID-19 no Brasil: análise a partir das pesquisas experimentais do IBGE. *Rev Bras Estat.* 2020; 78 (244): 101-124. [access on 2026 Jul 11]. Available at: <https://www.researchgate.net/publication/357002696>
- Brasil. Ministério da Ciência, Tecnologia e Inovação. Impactos econômicos da pandemia no Brasil poderão ser observados até 2025. Brasília; 2022. [access on 2026 Jul 23]. Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/noticias/2021/10/impactos-economicos-da-pandemia-no-brasil-poderao-ser-observados-ate-2045>
- Associação Brasileira de Transplante de Órgãos. Registro Brasileiro de Transplantes. São Paulo; 2022. [access on 2024 Dec 10]. Available at: <https://site.abto.org.br/conteudo/rbt/>
- Kute VB, Gupta A, Patel HV, Engineer DP, Banerjee S, Rivzi SJ, et al. The impact of COVID-19 pandemic on nephrology and transplant services and clinical training in India. *Exp. Clin. Transplant.* 2021; 19(7): 651-658. <https://doi.org/10.6002/ect.2021.0018>

21. Loupy A, Aubert O, Reese PP, Bastien O, Bayer F, Jacquelinet C. Organ procurement and transplantation during the COVID-19 pandemic. *Lancet*. 2020 May; 395 (10237): e95-e96. [https://doi.org/10.1016/S0140-6736\(20\)31040-0](https://doi.org/10.1016/S0140-6736(20)31040-0)
22. Requião-Moura L, Foresto RD, Sandes-Freitas TV, Medina-Pestana J. A COVID-19 overview from the perspective of the Brazilian kidney transplantation program. *COVID*. 2023; 3 (8): 1173-1186. <https://doi.org/10.3390/COVID3080083>
23. Instituto Português do Sangue e da Transplantação. Apresentação dos Dados da Atividade Nacional de Doação e Transplante de Órgãos | 2022. Lisboa; [2023]. [access on 2024 Dec 10]. Available at: <https://www.ipst.pt/index.php/pt/comunicacao/destaques-ipst-ip/49-ipst-newsletter/744-apresentacao-dos-dados-da-atividade-nacional-da-doacao-e-transplantacao-de-orgaos-2022>
24. Eurotransplant. Eurotransplant Annual Report 2021. Leiden; [2021]. [access on 2024 Dec 10]. Available at: <https://cdn.sanity.io/files/ngz8tmzz/production/ac4a5089e6c4dad93d487535644fab1493103691.pdf>