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Analysis of the impact of the COVID-19 pandemic on the realization of kidney transplants carried out at a university hospital in Minas Gerais

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ABSTRACT

Introduction: Solid organ transplantation, including kidney transplantation, was impacted by the COVID-19 pandemic, affecting potential donors, candidates, and recipients. **Objective:** To comparatively evaluate the number of kidney transplants performed at a university hospital from 2018 to 2022, analyzing the impact of the COVID-19 pandemic in this scenario. **Method:** A cross-sectional epidemiological survey was conducted using data from the electronic medical records of patients undergoing kidney transplantation at a university hospital in Minas Gerais, between January 2018 and June 2022. **Results:** In 2018, 50 transplants were performed and, in 2019, 63. In 2020, the year the pandemic began, there were a total of 22 transplants, a reduction of 65.1% compared to 2019. In 2021, the number continued low, 26 were performed, and, in 2022, until the first semester, which was the period analyzed, 24 transplants were carried out, a value proportionally like the years which preceded the pandemic. Analyzing the clinical and epidemiological profile, the proportion of transplants from deceased donors increased, and male recipients, aged 40-49 years, who underwent hemodialysis maintained their predominance during the pandemic. Regarding laboratory data, the average creatinine value found among patients undergoing transplantation before 2020 (pre pandemic) was higher than during the pandemic, however, the average urea value was higher in the second group. **Conclusion:** The number of kidney transplants performed showed significant decline in the years 2020 and 2021, milestones of the pandemic, with the beginning of the resumption in 2022.

Keywords: COVID-19; Kidney Transplantation; Epidemiological Profile.

INTRODUCTION

COVID-19, caused by the coronavirus (SARS-CoV-2), is a potentially serious acute respiratory syndrome that spread to the world stage at the beginning of 2020.[1] In March of the same year, the disease was elevated to the status of pandemic by the World Health Organization (WHO).[1] In this context, Brazil suffered from several collapses in the public and private health system, due to the growth in the number of cases and deaths. The high occupancy rates of wards and beds in intensive care units affected the entire health system in the country, causing a significant decrease in the number of consultations, hospitalizations and elective surgeries, includ-

ing kidney transplantation, affecting potential donors, candidates and recipients.[1,2,3]

Chronic kidney disease (CKD), which affects around 5% to 10% of the world population, is experiencing a constant increase in occurrence in Brazil, according to data from the 2021 Brazilian Dialysis Census,[4] being associated mainly with the high number of people with hypertension and diabetes mellitus, as well as the aging of the population.[5] It is a public health problem, characterized by an insidious, irreversible, and progressive pathological process of loss of kidney function.[5] Patients who progress to terminal CKD need to use renal replacement therapies (RRT), such as hemodialysis, peritoneal dialysis, or kidney transplantation, considered the fifth stage of the CKD process. Among the treatment modalities for CKD, kidney transplantation is the most effective therapeutic strategy, providing an improvement in the individual's quality of life, which is affected by hemodialysis sessions. In some cases, RRT represents the only way to increase patient survival.[5]

Globally, there was a decline in organ donations during the pandemic. Initial reports from Italian epicenter revealed a 25% decline in deceased solid organ donation nationally, with a more pronounced decline in northern Italy, where COVID-19 rates were highest.[6] During the height of the first wave of the pandemic in Spain, there was an approximately eight-fold reduction in the number of transplants.[7] France, Netherlands, and the United Kingdom have also experienced substantial declines with lower transplant rates, driven by a 50-90% reduction in deceased donation during the peak of COVID-19.[8,9,10] Analysis of data from the United States Organ Sharing Network (UNOS), comparing monthly transplants in January and February 2020, with those performed in April 2020, demonstrated a 35.9% reduction in transplanted organs.[11]

In Brazil, Brazilian Association of Organ Transplantation (ABTO), responsible for creating standards that refer to organ transplants in the national territory, proposed the maintenance of transplants in 2020, the year in which the pandemic began, apart from corneal transplants and pancreas, which could be postponed under certain circumstances.[2] Although, the first negative impacts of the COVID-19 pandemic on the donation and transplant processes were observed in the first quarter of 2020 and, according to data from Brazilian Transplant Registry, there was a 24.5% drop in the rate of kidney transplants throughout 2020. This rate of 22.9 kidney transplants per million inhabitants caused a setback of 11 years, returning to the rate obtained in 2009. The waiting list for kidney transplants grew 6.2%, while admission to the list of the waiting period fell by 32% (9,064 patients joined) and mortality on the waiting list has increased by 27% (with 1,780 deaths), perhaps due to the greater risk of exposure to COVID-19 given the need to perform hemodialysis sessions.[12]

According to the national relevance of the facts presented, the aim of this study was to comparatively evaluate the number of kidney transplants performed in the period from 2018 to 2022 in a university hospital in Minas Gerais, a state with significant transplant activity in Brazilian scenario. The goal is to assess whether, due to the reduction in transplant activities and the delay in these procedures, there were variations in the epidemiological, clinical and laboratory aspects of the patients.

METHODS

Study design

This is a study conducted as a cross-sectional, retrospective epidemiological research, with the studied population being patients undergoing kidney transplantation at a university hospital, whose care is entirely directed to patients using the Unified Health System (SUS), located in the southern region of an important city in Minas Gerais.

Epidemiological (gender, age and background), clinical and laboratory data were collected from patients undergoing kidney transplantation for the development of the study. Among the clinical data, the number of transplants from living and deceased donors, the type of renal replacement therapy and its duration and the evolution in the renal transplant unit were evaluated. Among the laboratory data, there is the measurement of urea, creatinine, proteinuria, and creatinine clearance, collected prior to the transplants.

Sample

The study included data from electronic medical records of patients undergoing kidney transplantation admitted between January 2018 and June 2022 in a university hospital, 100% connected to the SUS, located in the southern region of an important urban center in Minas Gerais.

As inclusion criteria for the study, data from the electronic medical records of the MV® system of patients who were on the waiting list for kidney transplantation and who underwent the procedure were accepted. On the other hand, patients were excluded from the study who, based on data from the electronic medical record contained in the MV® system at the time of the procedure, were under 18 years of age, patients who underwent the transplant before January 1, 2018 or after June 30, 2022,the study also included patients who underwent other types of organ transplants besides kidney transplants, totaling a sample of 185 participants.

Tools and procedures

The present study was submitted and approved by the Medical Sciences Research Ethics Committee of Minas Gerais (CEPCM-MG), with a Certificate of Presentation for Ethical Appreciation (CAAE: 53479421.8.0000.5134), in accordance with Resolution 466/12, of the National Health Council.

The information was obtained from the electronic database of the MV® system. The data was then collected and organized in an electronic spreadsheet in Microsoft Excel and, subsequently, statistical analysis was carried out.

Statistical analysis

After data collection, they were compiled, tabulated in the Microsoft Excel® spreadsheet editor (2016) and analyzed in the R program (R Core Team, 2018). The study was performed using descriptive analysis of continuous categorical and numerical variables. Categorical variables were presented as absolute and relative frequencies, while numerical variables were presented as mean ± standard deviation and/or median and interquartile range. The possible association between the variables was calculated using Pearson's Chi-square test, with a significance level of 5%.

RESULTS

Characterization of the patient profile

To verify the epidemiological and clinical profile of patients who underwent kidney transplantation, patients were divided according to the semester in which the transplant was performed. According to Table 1, it is possible to observe that in all semesters that preceded the pandemic (1/2018, 2/2018, 1/2019, 2/2019, 1/2020), there was a predominance of male patients. In the semesters after the start of the pandemic (2/2020, 1/2021, 2/2021, 1/2022), although there was a drop in the number of procedures performed, the prevalence of males remained. Therefore, there was a higher frequency of male patients 62.2% (115) undergoing kidney transplantation throughout the analyzed period. The most common age group among patients who underwent the procedure during the analyzed period was 40 and 49 years old, corresponding to 29.2% (54) of total patients. Regarding the origin of patients who underwent kidney transplantation, 94.6% (175) came

from the state of Minas Gerais and 5.4% (10) from other Brazilian states.

Yet in Table 1, an analysis was made of the type and duration of renal replacement therapies performed by patients who underwent kidney transplantation, applying the division among semesters. Hemodialysis was the most used type of therapy in all semesters, both before and after the start of the pandemic. Regarding the duration of these therapies, the most frequent, considering all the patients in the study, was between 1 and 3 years (30.3%). The same occurred for transplant patients in the semesters that preceded the pandemic. Among patients who underwent transplantation during the pandemic, the duration of 3 to 5 years predominated.

History of kidney transplant procedures between 2018 and 2022

During the period from January 2018 to June 2022, 185 patients underwent kidney transplantation. In 2018, at the university hospital in Minas Gerais, 50 kidney transplants were registered, 52.0% (26) in the first semester and 48% (24) in the second semester. In 2019, 63 transplants were registered, 44.4% (28) of which were in the first semester and 55.5% (35) in the second semester. In 2020, the year in which the highest number of COVID-19 cases were reported, there were a total of 22 transplants, a 65.1% reduction in procedures performed compared to 2019, 18 of which in the first half of the year and only 4 in the second. In 2021, the number of transplants continued to decline, with only 26 being performed, and in 2022, until the first half of the year, 24 transplants were performed, a scenario similar to the years that preceded the COVID-19 pandemic (Figure 1.)

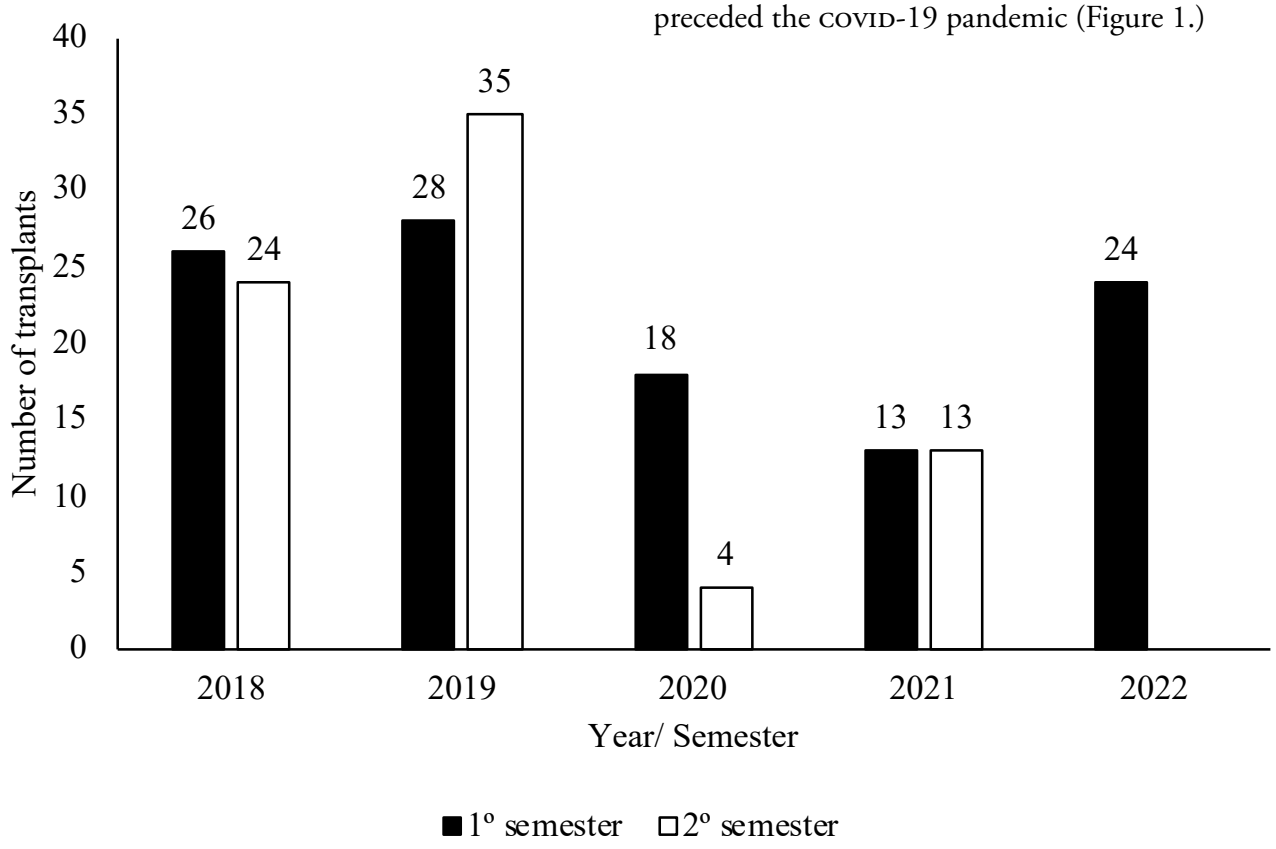

Figure 1 - Number of transplants performed between the first half of 2018 and the first half of 2022 in a university hospital in Minas Gerais. The data refers to the medical records of patients who underwent transplantation between January 2018 and June 2022.

Table 1 - Epidemiological and clinical data of patients undergoing kidney transplantation at a university hospital in Minas Gerais.

	Evaluated periods										
Characteristics	**Total** N = 185[1]	**1º/2018** N=26[1]	**2º/2018** N =24[1]	**1º/2019** N=28[1]	**2º/2019** N=35[1]	**1º/2020** N=18[1]	**2º/2020** N=4[1]	**1º/2021** N=13[1]	**2º/2021** N=13[1]	**1º/2022** N=24[1]	**p**[2]
Gender											0,3517
Women	70 (37,8%)	12 (46,1%)	11 (45,8%)	9 (32,1%)	14 (40%)	7 (38,9%)	1 (25%)	3 (23,1%)	5 (38,5%)	8 (33,3%)	
Men	115 (62,2%)	14 (53,8%)	13 (54,2%)	19 (67,9%)	21 (60%)	11 (61,1%)	3 (75%)	10 (76,9%)	8 (61,5%)	16 (66,7%)	
Age											**0,0132**
Mean ± Standard Deviation	53,5 (± 13,2)	43 (± 13,6)	46,6 (±12,3)	50,2 (±13)	46,6 (±12,8)	48,8 (±11,6)	44,2 (±13,4)	39,8 (±15)	44,3 (±15,2)	44,6 (±13,6)	
10-19	1 (0,5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (7,7%)	0 (0%)	
20-29	23 (12,4%)	5 (19,2%)	2 (8,3%)	2 (7,1%)	4 (11,4%)	2 (11,1%)	0(0%)	4 (30,8%)	1 (7,7%)	3 (12,5%)	
30-39	32 (17,3%)	4 (15,4%)	7 (29,2%)	3 (10,7%)	5 (14,3%)	1(5,5%)	2(50%)	3 (23,1%)	3 (23,1%)	4 (16,7%)	
40-49	54 (29,2%)	10 (38,5%)	4 (16,7%)	10 (35,7%)	8 (22,9%)	4 (22,2%)	0 (0%)	3 (23,1%)	3 (23,1%)	12 (50%)	
50-59	43 (23,2%)	4 (15,4%)	6 (25%)	5 (17,9%)	12 (34,3%)	8 (44,4%)	2 (50%)	2 (15,4%)	3 (23,1%)	1 (4,2%)	
60-69	29 (15,7%)	3 (11,5%)	5 (20,8%)	8 (28,6%)	6 (17,1%)	3 (16,7%)	0 (0%)	0 (0%)	1 (7,7%)	3 (12,5%)	
70-79	3 (1,6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (7,7%)	1 (7,7%)	1 (4,2%)	
Origin											**0,0041**
Minas Gerais	175 (94,6%)	26 (100%)	22 (91,7%)	28 (100%)	34 (97,1%)	17 (94,4%)	4 (100%)	11 (84,6%)	10 (76,9%)	22 (91,7%)	
Others	10 (5,4%)	0 (0%)	2 (8,3%)	0 (0%)	1 (2,9%)	1 (5,6%)	0 (0%)	2 (15,4%)	3 (23,1%)	2 (8,3%)	

Type of renal replacement therapy											0,3394
Peritoneal dialysis	10 (5,4%)	0 (0%)	2 (8,3%)	2 (7,1%)	1 (2,9%)	0 (0%)	0 (0%)	2 (15,4%)	1 (7,7%)	2 (8,3%)	
Hemodialysis	163 (88,1%)	23 (88,5%)	22 (91,7%)	22 (78,6%)	32 (91,4%)	18 (100%)	3 (75%)	11 (84,6%)	11 (84,6%)	21 (87,5%)	
Preemptive	12 (6,5%)	3 (11,5%)	0 (0%)	4 (14,3%)	2 (5,7%)	0 (0%)	1 (25%)	0 (0%)	1 (7,7%)	1 (4,2%)	
Time of renal replacement therapy											0,5059
Until one year	28 (15,1%)	2 (12,5%)	5 (20,8%)	7 (25%)	6 (17,1%)	2 (11,1%)	1 (25%)	0 (0%)	4 (30,8%)	2 (8,3%)	
Between 1 and 3 years	56 (30,3%)	13 (50%)	8 (33,3%)	9 (32,1%)	10 (28,6%)	4 (22,2%)	1 (25%)	6 (46,1%)	4 (30,8%)	1 (4,2%)	
Between 3 and 5 years	38 (20,5%)	2 (7,7%)	3 (12,5%)	8 (28,6%)	7 (20%)	3 (16,7%)	1 (25%)	2 (15,4%)	2 (15,4%)	10 (41,7%)	
Between 5 and 7 years	18 (9,7%)	1 (3,8%)	2 (8,3%)	0 (0%)	7 (20%)	3 (16,7%)	0 (0%)	1 (7,7%)	0 (0%)	4 (16,7%)	
Between 7 and 10 years	22 (11,9%)	3 (11,5%)	4 (16,7%)	1 (3,6%)	3 (8,6%)	3 (16,7%)	0 (0%)	3 (23,1%)	2 (15,4%)	3 (12,5%)	
More than 10 years	9 (4,9%)	1 (3,8%)	2 (8,3%)	0 (0%)	0 (0%)	2 (11,1%)	0 (0%)	1 (7,7%)	0 (0%)	3 (12,5%)	
Unknown time	14 (7,6%)	4 (15,4%)	0 (0%)	3 (10,7%)	2 (5,7%)	1 (5,5%)	1 (25%)	0 (0%)	1 (7,7%)	1 (4,2%)	

[1]n (%); [2]Chi-square test of independence; Fisher's exact test.

Profile of living and deceased donors

An important aspect evaluated was the comparison between types of kidney donors. It can be seen in Figure 2 that there was a predominance of the use of deceased donors throughout the analyzed period. However, from 2020 onwards, the proportion of transplants from deceased donors increased, compared to the total number of transplants performed. Regarding the comorbidities presented by patients, which may be related to the need for kidney transplantation, the most common is hypertension, which is present in 55.7% (160) of study participants. The second most common comorbidity is diabetes mellitus, of which 11.8% (34) were carriers. Less frequently, there is an allergy to drugs and polycystic kidneys as well as other comorbidities present.

Laboratory profile of patients

The laboratory data of patients undergoing kidney transplantation before and during the pandemic were evaluated. According to Table 2, it was observed that the average creatinine value in patients in the semesters preceding the pandemic varied between 9.5 and 21.9, while in the semesters after the pandemic, this variation was lower, between 9.0 and 10.6. However, the median value was slightly higher among patients undergoing the procedure during the pandemic period compared to the pre-pandemic period. Regarding serum urea values, their average was higher in patients undergoing the procedure during the pandemic, compared to patients before the pandemic period. The median urea values and interquartile range of patients before the pandemic were like the values observed in

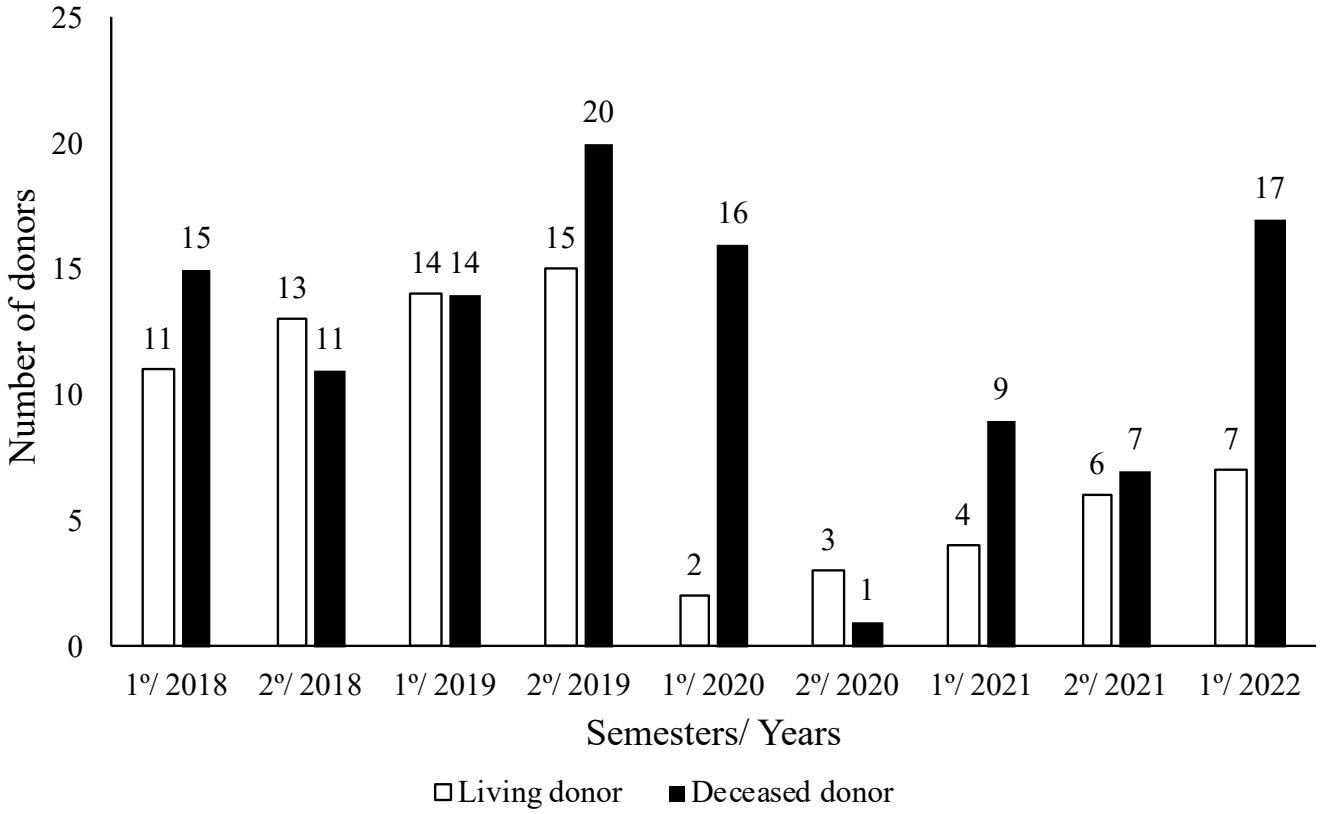

Figure 2 - Number of kidney transplants performed between 2018 and 2022 using organs from living or deceased donors in a university hospital in Minas Gerais.

patients who underwent the procedure during the pandemic. Of the total of 120 medical records analyzed, it was found that the average value of proteinuria in 24 hours of collected urine was 1365.8 mg. Of the 111 medical records that contained creatinine clearance, an average value of 6.8-ml/minute/1.73 m^2 was obtained.

Patient mortality

It was observed that among 185 patients who underwent kidney transplantation, 2.7% (5) died during hospitalization and 97.3% (180) patients were discharged.

DISCUSSION

The COVID-19 pandemic was announced by the World Health Organization and caused health bodies to recommend restrictive measures for hospitals, with the intention of reducing the chance of transmission by the SARS-CoV-2 virus and better directing efforts and materials to patients affected by the disease. Among the restrictions, elective surgeries, which include kidney transplants, have seen a significant reduction in their numbers.[13] In the proposed study, a significant drop in the number of kidney transplants performed during the pandemic in a university hospital in Minas Gerais was shown, despite the increase in the number of people on the waiting list for this type of transplant and the increase in mortality among those waiting.

One possible cause of increased mortality rates among patients waiting for kidney transplants is that the rates have increased due to delays in transplants. Another hypothesis would be that the mortality rate increased due to deaths from COVID-19 directly or due to delays in medical care asfear of infection.[14,15] The state of Minas Gerais, the focus of this study, had 539,745 confirmed cases of COVID-19 and 13,258 deaths from this cause in 2020, significant figures that possibly include those waiting for a transplant.[16]

It is worth mentioning that high blood pressure, diabetes mellitus and advanced age, some of the conditions that lead to CKD, may also be associated with a greater chance of serious cases and increased mortality from COVID-19 and, based on data At two of the largest kidney transplant centers in the country, approximately 10% of transplant patients were infected, with mortality rates between 2 and 2.5% and fatality rates between 20 and 25%.[13,17]

According to data provided by ABTO, when comparing the number of transplants performed in 2020 with the same period in 2019, there was an increase of 6.5% in the 1st quarter, a decrease of 43.2% in the 2nd quarter and 37.8% in the 3rd quarter.[14] There was a greater drop in the number of kidney transplants in the 3rd quarter in some Brazilian regions due to the late peak of the pandemic in the South region (54%), followed by the Northeast (42%), Southeast (30%) and Central-West regions. (23%).[14] In the proposed study, an intense drop in the number of kidney transplants performed mainly during the second half of 2020 was observed, corroborating the data presented for the entire country.

Evaluating some studies on the epidemiological profile of individuals undergoing kidney transplantation before the pandemic, that is, in the semesters of 1/2018, 2/2018, 1/2019, 2/2019 and 1/2020, it was observed that the majority were from male.[18,19] A study developed by Ribeiro et al. (2018), involving 51 patients, pointed out that the predominant age group was 46 to 60 years old (41.2%).[18] Another study, developed by Nga et al. (2017), in the years long before the pandemic, pointed out that between 2015 and 2016, the average age of recipients was 48 years old.[19] Hermosa et al. (2021) pointed out, when analyzing the results of a kidney transplant program, that in the three years preceding the pandemic (2017 to 2019), the frequency of male kidney transplant patients was,

Table 2 - Laboratory data of patients undergoing kidney transplantation at a university hospital in Minas Gerais.

		Evaluated Periods								
Characteritics	Total	1º/2018	2º/2018	1º/ 2019	2º/2019	1º/2020	2º/2020	1º/2021	2º/2021	1º/2022
Creatinine (mg/dl)										
N	185	26	24	28	35	18	4	13	13	24
Mean ± Standard Deviation	13,4 ±21,1	9,0 ±4,5	9,7 ±3,5	21,9 ±32,6	20,7 ±36,6	9,5 ±3,8	10,6 ±5,0	9,8 ±3,2	9,4 ±4,7	9,0 ±4,0
Median (AIQ)	8,9 (6,6-11,1)	8,9 (5,7-10,8)	9,0 (7,3-11,1)	8,6 (5,6-12,8)	8,9 (6,2-10,5)	8,8 (8,2-11,0)	10,8 (8,4-13,1)	9,5 (7,8-10,5)	8,7 (6,5-12,6)	8,6 (6,1-10,1)
Urea (mg/dl)										
N	184	26	24	28	35	18	4	13	12	24
Mean ± Standard Deviation	99,9 ± 46,3	111,4 ±44,9	107,6 ±34,6	90,2 ±62,2	90,3 ±49,7	95,5 ±30,9	116,8 ±52,5	94,6 ±36,2	127 ±59,1	95,1 ±32,7
Median (AIQ)	95,5 (70,9-128,1)	97,2 (78,6-143,9)	102,3 (85,7-130,6)	76,9 (48,7-125,8)	92,3 (53,2-123,1)	91,9 (81,7-117,9)	113,7 (80,7-150,2)	87,1 (71-110,9)	108,5 (88,4-181,2)	91,2 (65,2-115,6)
Proteinuria (mg/ 24h)										
N	120	18	11	17	28	12	4	5	9	16
Mean ± Standard Deviation	1357,4± 1521,6	858,9 ± 765,5	1794,7 ±1638,9	1179,4 ±1492,6	1558,4 ±1574,0	1983,6 ±2582,5	1836,9 ±1667,9	730,4 ±906,2	1653,8 ±1640,1	821,2 ±706,8
Median (AIQ)	888 (408,6-1585)	586,2 (450,-1218,1)	1393,2 (475,1-3043,8)	720 (230,3-1474,2)	996 (656,8-1710,2)	1213,8 (363,5-1984,9)	1896 (666,7-3066,1)	460,2 (285,4-530,4)	1330 (347,5-241,6)	646,2 (241,6-1276,3)
Creatinine clearance (ml/min/1.73 m²)										
N	111	19	8	19	23	10	2	2	3	15
Mean ± Standard Deviation	6,8 ± 5,6	4,9 ±5,0	7,6 ± 5,3	6,9 ±6,1	7,3 ±5,2	5,1 ±4,4	0,9 ±1,0	0,6 ±0,1	2,6 ±3,4	7,6 ±6,1
Median (AIQ)	5,2 (2-11)	3 (1,3-6,9)	6,6 (3,8-9,3)	5 (2,3-10,6)	6,2 (4,2-9,1)	3,7 (1,7-7,8)	0,9 (0,6-1,3)	0,6 (0,5-0,6)	0,7 (0,7-3,7)	8 (2,4-11,1)

AIQ: interquartile range

respectively, 42.9%, 100% and 50%.[20] The average age of the patients was, respectively, 50 years, 54 years and 49 years.[20] These values are like those found in the present study, referring to the semesters in which data were collected and which correspond to the pre-pandemic period.

During the pandemic, considered more evident from the second half of 2020, according to Hermosa et al, the frequency of male patients undergoing the procedure was 53.3%, with an average age of 50.8 years.[20] Other studies performed during the same semesters of the pandemic also showed a pre-eminence in the number of male patients undergoing kidney transplantation.[21,22] In a study evaluating kidney transplants in a center in Turkey, in which 38 transplants were performed between March and September 2020, with an average age of 38.3 years, however, pediatric patients were included in the study.[22] In the present study, the sex of individuals undergoing surgery remained predominantly male throughout the analyzed period, though; a statistical difference was observed regarding the age group of the patients. Probably, due to the increased waiting time for the transplant, patients who underwent the procedure after January 2020 were in a higher age group when compared to patients who underwent the procedure before the year that began the pandemic. It is suggested that men are, in fact, most kidney transplant recipients, probably due to greater carelessness with their own health, which is reflected in low adherence to treatments and lower attendance at routine medical appointments. Furthermore, other studies indicate a higher prevalence of CKD in male patients, mainly due to conditions such as diabetes mellitus and high blood pressure.[23] Therefore, male patients may more easily become candidates for kidney transplantation.

Regarding the type of renal replacement therapy, hemodialysis was the most used by patients undergoing kidney transplantation in the periods analyzed, both in the semesters before and during the pandemic, according to the study developed by Hermosa et al. (2021), corroborating other studies carried out.[19,20] Peritoneal dialysis was used in only 6.7% of patients who were transplanted during the pandemic, that is, from the first half of 2020, and in around 23.5% of those transplanted before the pandemic. Preemptive cases represented 33.3% of cases before 2020 and 17.6% from the year the pandemic began.[20]

About the duration of these therapies, the most frequent, considering all the patients in the study, was between 1 and 3 years (32%). The same occurred for patients transplanted before 2020, a group in which 33.1% also had this duration. However, among patients who underwent transplantation from the first half of 2020, the duration of 3 to 5 years predominated (25.4%). This increase in the duration of replacement therapy was possibly due to the longer waiting time for transplantation, as many were postponed in the context of the pandemic. The results of Ribeiro et al. (2018) are in line with pre-pandemic findings, before 2020, as in this study, which involved 51 patients, the most frequent time for hemodialysis (for 45.1% of patients) was up to 30 months, that is, two and a half years, 35.3% spent 31 to 60 months, 7.8% spent 61 to 90 months and 11.8% spent 91 to 120 months.[18] Nga et al. (2017), revealed that patients underwent, on average, 39 months of dialysis, a higher value than what was found before 2020 in the present study.[19]

In a recent study, which assesses the global impact of the pandemic on transplants, it was observed that the transplant activity of deceased kidney donors decreased by 11.91% during the pandemic, while, for living donors, this drop was even greater, with 40.19%

reduction.[24] According to data from ABTO, in Brazil, there was a 24.5% drop in the rate of kidney transplants throughout 2020, being 17.2% in transplants with a deceased donor and 59.6% with a living donor. In 2021, also according to ABTO, kidney transplants with a living donor remained 48% below the number of transplants registered in 2019, while the number of procedures performed with a deceased donor was 21% below the rate in 2019.[25,26] Machado et al. (2022) found that the living donor/deceased donor ratio was 1:4.8 in 2018 and in 2019. During the pandemic, in 2020 and 2021, there was a sharp decrease in living donors when compared to deceased donors: 2020 (1:9.8) and 2021 (1:7.1).[27] These findings corroborate the results of the current study, which showed a drop in transplants performed by living donors compared to those from deceased donors. This may be related to individuals' fear of becoming living donors and exposing themselves to potential SARS-CoV-2 contamination in hospital environments, leading to a significant reduction in live transplants.

Another aspect analyzed in the present study was the patients' laboratory data, prior to the transplants, including levels of creatinine, urea, proteinuria, and creatinine clearance in the semesters before and during the pandemic. The mean creatinine value was higher among patients before 2020 (pre-pandemic), while the mean urea, proteinuria and microalbuminuria values were higher in patients after the first half of 2020 (during the pandemic). It is reasonable to relate the increase in these parameters to the clinical deterioration of patients who underwent transplantation during the pandemic, since they had a longer waiting time for the procedure, as many were postponed in the context of the global infection that was taking place. According to the assessment of renal function in Brazilian adult population, based on laboratory criteria from the National Health Survey, the reference values for creatinine are 0.6 mg/dL to 1.1 mg/dL for women and 0.7 mg/dL to 1.3 mg/dL for men.[28] Even though the study did not separate the results by sex, the average values for creatinine and glomerular filtration rate were well above the normal range. Urea has a reference value between 10 and 50 mg/dL, and pre-transplant results were almost double the reference values. Normal daily protein excretion in urine is less than 150 mg (generally 40 to 80 mg).[29] The average value found in the present study was 1365.8 mg in 24 hours, that is, more than 9 times the reference value, pointing to serious kidney damage in patients who underwent transplantation. About creatinine clearance, it has a normal value of 90 to 140 mL/minute/1.73 m^2.[30] Although, among patients who underwent preoperative tests, an average value of 6.8 mL/min was obtained minute/1.73 m^2, demonstrating once again, in another laboratory analysis, the severe renal impairment of these individuals.

The clinical outcome of most patients evaluated in this study was discharge (97.3%). Deaths during hospitalization represented only 2.7% of cases, being caused by hemorrhagic shock due to acute humoral rejection or by septic shock caused by contamination by the SARS-Cov-2 virus. The other studies that evaluated the clinical outcome of transplant patients found that there were no deaths.[21,22] This difference was due to a reduced number of individuals who underwent the procedure, compared to the present study.

It is necessary to resume the volume of kidney transplants. This is to compensate for the intense decrease observed during the pandemic period of 2020. Resuming transplants will reduce the impact on the age group of patients, as well as the duration of replacement therapies. Kidney replacement therapies increased due to the waiting time for elective surgeries that had to be canceled during the pandemic. Patients have severe renal failure, and most of themhas chronic diseases such as hypertension. This highlights the

urgency in performing these necessary procedures. Furthermore, greater care must be taken to prevent septicemia due to SARS-CoV-2 and avoid deaths during the perioperative period.

The broad impact on kidney transplants caused by the COVID-19 pandemic was evident. The university hospital where the study was performed was the fourth hospital in the region where it is located that performed the most kidney transplants in 2020 and 2021. In this center, a percentage of the region's total kidney transplants of approximately 9% was performed and 8%, in 2020 and 2021, respectively. In this perspetive, its relevance to the regional context is observed.[31] However, this is a local study, with a small sample, which limits possible generalizations. The limitations inherent to cross-sectional and retrospective studies must be considered, such as definitively establishing cause and effect relationships between the conditions of the patients analyzed and the possibility of bias when evaluating risk factors.

CONCLUSION

There was a significant decline in the performance of kidney transplants during the COVID-19 pandemic, in the years 2020 and 2021, with the resumption of activities beginning in the first half of 2022. The prevalence, during the pandemic, of male patients, aged 40 to 49 years, who underwent hemodialysis pre-transplant, with a slightly longer duration of this replacement therapy, among those transplanted during the pandemic. There was an increase in the proportion of deceased donors, to the detriment of living donors, along the pandemic period. The laboratory parameters were slightly divergent, with lower mean creatinine values, higher urea, proteinuria, and creatinine clearance, among those who underwent kidney transplantation during the pandemic.

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