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Coronavirus Pandemic

COVID-19 mortality among solid organ transplant recipients and candidates before specific vaccine availability in Colombia

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Abstract

Introduction: Coronavirus disease 2019 (COVID-19) is a life-threatening disease that was declared a pandemic in March 2020. Organ transplant recipients are vulnerable to infection and complications from COVID-19. The objective of this study was to investigate the rates of infection, mortality, and case-fatality ratios (CFR) in solid organ transplant recipients and patients on the waiting list for organ allocation in the period prior to the availability of specific vaccines.

Methodology: This was an observational study of official sources that are used to report information on COVID-19. Quantitative variables were described with arithmetic means and categorical variables with proportions. Percentages of positivity to infection, number of deaths, CFR, and all-cause mortality were calculated for each group and subgroup.

Results: There were 2,551 eligible subjects; 602 (26.2%) were positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). There were 265 (10.4%) deaths from all causes during the follow-up period; 119 (44.9%) of them were associated with COVID-19, which indicated a COVID-19-related mortality rate of 4.7 %. CFRs were 21.4% and 17.1% in transplant recipients and waitlisted patients, respectively. CFR was significantly higher in transplant recipients (23.8%) than in patients waitlisted for kidney (16.5%; $p = 0.044$) Among SARS-CoV-2-positive patients, the probability of dying from COVID-19 was higher in the first group (87.3% and 73%, respectively; $p = 0.034$).

Conclusions: COVID-19 had a significant impact on the deaths of transplant patients and patients on the solid organ waiting list during the first year of the pandemic in Colombia, before the availability of vaccines.

Key words: COVID-19; waiting lists; organ recipients; mortality; transplants.

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Introduction

Coronavirus disease 2019 (COVID-19) is a life-threatening disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. According to official data provided by the World Health Organization (WHO), China reported the first cases related to the COVID-19 pandemic on 31 December 2019. More than two months later, WHO declared the new infection a pandemic on 11 March 2020 [2].

SARS-CoV-2 infection was diagnosed for the first time in Colombia in a young woman who returned from Italy on 6 March 2020. Since that day and until 28 February 2021 (end date of follow-up in this study), the country had 2,251,690 accumulated laboratory-confirmed cases, of which 59,766 (2.6%) had died, and 36,659 (1.6%) were still active [3]. The virus infects host cells and produces clinical complications such as pneumonia, acute myocardial injury, and chronic damage to the cerebral system [4].

Solid organ transplant recipients are considered a high-risk group for developing COVID-19-related complications [5,6]. Several studies showed poor clinical outcomes and an increased risk of death in these individuals than in those who were waitlisted to receive organ transplants [7–9]. An earlier investigation from the United States, however, found that waitlisted patients were more likely to require hospitalization (82% vs. 65%) and were at a higher risk of mortality (34% vs. 16%) than transplant patients [9].

The availability of information obtained through interinstitutional strategic collaboration as complimentary sources of data that is being developed

in Colombia can be used to, for example, study the impact of COVID-19 in the Colombian population. Under these considerations, the main objective of this study was to describe epidemiological measures such as positivity rates of infection, deaths, mortality, and case-fatality ratios (CFR) in both solid organ transplant recipients and waitlisted candidates during the first year from the identification of COVID-19 in Colombia. This was the period before specific viral vaccines were distributed around the country.

Methodology

Design and period of study

This is a nationwide observational study that uses the national databases of solid organ transplant recipients and waitlisted candidates as primary sources of subjects (National Donation and Transplant Information System, RedDataINS©). These databases are managed by the National Institute of Health (NIH) of Colombia. The analysis period was from 6 March 2020, the day of the first confirmed imported case in the country, to 28 February 2021 (cut-off day of the current analysis, also representing the total pandemic period before COVID-19 vaccines were available). The COVID-19 vaccines program in Colombia began at the end of February 2021; so, our results basically reflect the situation of solid organ transplant recipients and waitlisted candidates before the introduction of specific COVID-19 vaccines in the Colombian population. A previous paper showed preliminary data based on the first four months of COVID-19 in Colombia [10].

Selection of subjects

The complete list of potentially eligible subjects was obtained from RedDataINS©. Of these subjects, we included those who had a known result (positive or negative) of a SARS-CoV-2 test by using the National COVID-19 Data Repository (SISMUESTRAS), which is the official dataset of the laboratory results of the COVID-19 tests, also managed by the NIH. There were no exclusion criteria for the selected subjects.

Definition of a positive case of SARS-CoV-2 infection

In this study the presence of an infection was defined as a positive result on real-time polymerase chain reaction (PCR) assay of nasal and/or pharyngeal swab specimens and/or a positive result on a serological or antigen test as reported by authorized clinical laboratories throughout the country, either public or private, as part of their function for supporting the clinical diagnostic process or as screening before surgical procedures.

Data collection

Baseline sociodemographic and clinical variables related to history of chronic conditions, type of organ affected, results of the COVID-19 test, vital status at the time of cut-off, and immediate cause of death were included in the study. An additional variable was created for this study to identify those waitlisted candidates who changed their status to transplant recipient after the COVID-19 test. In accordance with this variable, we established three categories of subjects for the study: those who were transplant recipients before the diagnostic test; those who were on the waiting list both before and after the diagnostic test until death or the cut-off date, and those who received a transplant after the diagnostic test.

The RedDataINS© system let us select subjects and obtain clinical information for each of them. It was complemented, if available to a specific individual, with that from the National Public Health Surveillance System (SIVIGILA).

On the other hand, information on deaths was obtained from the provisional information of a National System of Vital Statistics (RUAF-ND), which is based on medical death certificates and allowed us to identify if deaths were due to COVID-19 or not. This database may be subject to updating (in our case, it was verified on 30 June 2021).

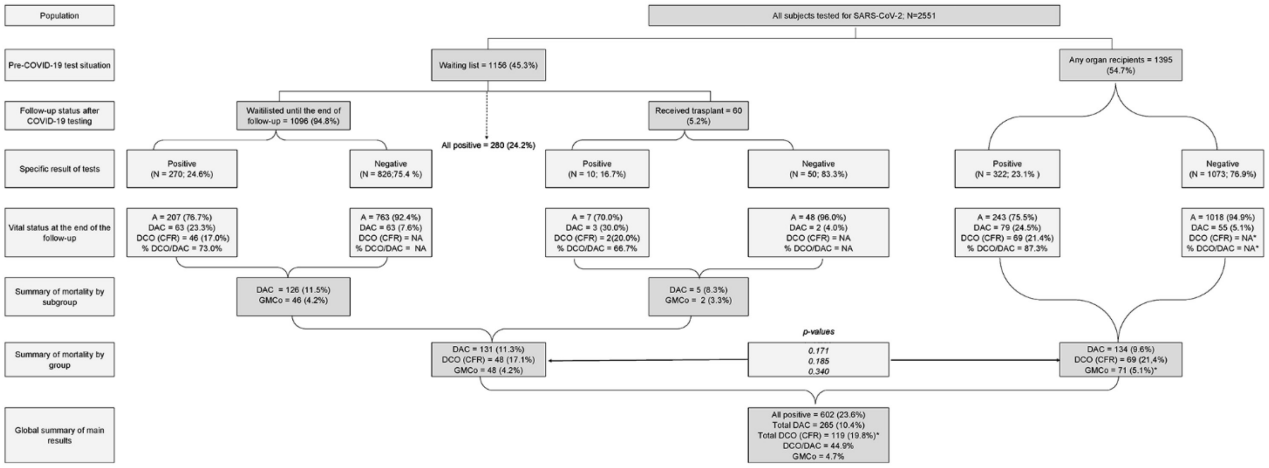
Statistical analysis

We summarized quantitative variables with arithmetic means (standard deviation) or medians (interquartile ranges, IQR) and categorical variables with proportions. We calculated percentages (%) of positivity to infection, number of deaths, CFR, and all-cause mortality for each group and subgroup of analysis. Differences between means were evaluated using the t test statistics, and the differences between proportions by using the Chi square and the Fisher exact test, when appropriate. p values ≤ 0.05 were considered significant. Stata SE version 15.1 (StataCorp LP, College Station, Texas) was used for analysis.

Ethical aspects

This research used data derived from pre-existing databases in the country. The subjects were not directly interviewed or exposed to any clinical intervention; and consequently, this study had no risk or negative consequence for the subjects. This study was classified as risk-free research in accordance with national regulations of ethics and approved by the Public Health Network Office, NIH.

Figure 1. Distribution of solid organ transplant recipients and candidates according to the result of SARS-CoV-2 test, vital status at the end of follow-up and cause of death.



A, alive; COVID-19, coronavirus disease 2019; DAC, total deaths (deaths from all causes); DCO, deaths attributable to COVID-19; CFR, case-fatality ratio (%); % DCO/DAC, percentage of deaths attributable to COVID-19, GMCo, general mortality of each subgroup/group attributable to COVID-19; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2. * Two additional deaths in patients with negative results for COVID-19 were attributed to that infection in their medical certificates of cause of death (n = 71). The specific reason of this finding is not known but the authors think is due to the lack of updating of the results for these patients (e.g., collection of a postmortem specimen).

Results

Basic demographic and clinical information

A total of 9,779 persons were registered in the RedData-INS© database at the cut-off date. The analysis included 2,551 (26%) of them, who were tested for SARS-CoV-2 and whose results were reported. Most of the subjects included were men (57.9%), aged between 50 and 59 years (23.4%), and lived in a low socioeconomic status (i.e., the first two levels of six: 45.8%), in Bogotá (32.9%), and were affiliated to the contributive regime of health insurance (56.9%) (Table 1). Baseline patient characteristics stratified by the situation of transplant (transplant receiver or waitlisted patient) at the time of COVID-19 test are shown in Table 1. Compared with waiting list candidates, transplant recipients tended to have a better socioeconomic status (37.3% and 47.4%, respectively, $p < 0.001$), paid for his/her health insurance (68.7% and 73.5%, respectively, $p = 0.017$), and lived in a city other than Bogotá D.C. (61.7% and 71.6%, respectively, $p < 0.001$). In comparison, waitlisted candidates were most likely to have a significantly higher prevalence of high blood pressure ($p < 0.001$) and autoimmune conditions ($p < 0.001$). The other socioeconomic and clinical conditions were similar across groups (Table 1).

The distribution of subjects according to the test results, history of transplant on the testing day, and vital status at the end of follow-up, both grouped and by specific organ is shown in Figure 1 and Table 2, respectively. About 55% of the subjects were transplant recipients before the COVID-19 test.

Positivity rates to SARS-CoV-2

A total of 602 (23.2%) subjects was diagnosed with COVID-19, as indicated by a positive test. The positive percentages were similar in both transplant recipients (23.1%) and in waitlisted subjects (24.2%). A positive test was found in 25.6%, 16.3%, 10.4% and 22.4% of the kidney, liver, heart, and lung subjects (for both transplant and waitlisted subjects of each specific organ), respectively.

The positivity to infection was similar in transplant and non-transplant subjects of kidney (~25%), but clinically higher in transplant recipients of liver and heart, and in those waitlisted for lung, than in those of the respective complementary group (Table 2).

The total number of patients (grouped by organ) included in this study ranged from 1,908 (kidney) to 49 (lung). Organs such as bowel, pancreas, and a combined need of them had an even lower number of patients than lung, and thus were not included in the analysis shown in Table 2. The proportion of patients who were infected by COVID-19 was similar in both groups (transplanted and waiting list) for each solid organ evaluated.

Time of follow-up, deaths and mortality-related measures

Table 1. Distribution of subjects based on of SARS-CoV-2 test and selected demographic and clinical conditions, Colombia, March 6, 2020, to February 28, 2021.

Characteristic	Waiting list candidates (n = 1,156)		Transplant recipients (n = 1,395)		*p* value	Total (n = 2,551)	
	N	%	N	%		N	%
Male/Female (% male)	665/491	57.5	813/582	58.3	0.701	1,478/1,073	57.9
Age, years							
Mean (SD)	45.7 (16.1)		45.3 (18.6)		0.504	45.5 (17.6)	
Median (IQR)	48 (34–58)		48 (33–60)		0.588	48 (34–59)	
Socioeconomic status							
Low (levels 1 and 2)	592	51.2	577	49.3	< 0.001*	1,169	45.8
Medium/high (levels 3 to 6)	431	37.3	661	47.4		1,092	42.8
Unknown	133	11.5	157	11.3		290	11.4
Ethnicity							
Afro-Colombian	55	4.8	74	5.3	0.120**	129	5.1
Indigenous	9	0.8	21	1.5		30	1.1
Gypsies	1	0.1	1	0.1		2	0.1
Other (white/ other)	1061	91.8	1211	86.8		2272	89.1
Unknown	30	2.6	88	6.3		118	4.6
City of residence							
Bogotá D.C.	443	38.3	396	28.4	< 0.001	839	32.9
Cali	82	7.1	150	10.8		232	9.1
Medellín	50	4.3	155	11.1		205	8.0
Any other	581	50.3	694	49.8		1275	50.0
Regime of health insurance							
Contributive	678	58.6	773	55.4	0.017***	1451	56.9
Subsidized	319	27.6	288	20.6		607	23.8
Other	23	2.0	24	1.7		47	1.8
Unknown	136	11.8	310	22.2		446	17.5
Chronic comorbidities prevalence (yes, %)							
High blood pressure	881	76.2	906	64.9	< 0.001	1787	70.1
Diabetes	209	18.1	238	17.1	0.500	447	17.5
Dyslipidemia	148	12.8	218	15.6	0.043	366	14.4
Coronary artery disease	69	5.9	106	7.6	0.105	175	6.9
Autoimmune condition****	375	32.4	287	20.6	< 0.001	662	25.9
Organ							
Kidney	962	83.2	946	67.8	N.A.	1,908	74.8
Liver	136	11.8	310	22.2		446	17.5
Heart	26	2.2	84	6.0		110	4.3
Lung	22	1.9	27	1.9		49	1.9
Kidney and liver	2	0.2	20	1.4		22	0.9
Kidney and pancreas	6	0.5	5	0.4		11	0.4
Pancreas	2	0.1	1	0.7		3	0.1
Kidney and heart	0	0.0	2	0.2		2	0.1

* *p* values were < 0.001 with or without including the "unknown" category in our analysis. ** *p* value was calculated as "any ethnic group" (i.e., Afro-Colombian, indigenous, or gypsies) vs. white/other, and excluding the "unknown" category. ***p* value was calculated as "contributive and other" (i.e., patients paid his/her own health insurance) vs. subsidized and excluding the "unknown" category. **** this variable includes one or both a history of autoimmune disease, and the exposure to conditions that could affect the immune system (previous blood transfusions, cancer, etc.). NA: *p* value was not calculated for this variable. SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

The median time elapsed from the day of the COVID-19 test to the end of the study (or death) was 184 days for all the subjects (IQR: 127–239), men (IQR: 127–236), and women (IQR: 126–241); 175 days (IQR: 108–223, range: 0–342) in those who tested positive; and 186 days (IQR: 130–246, range: 0–356) in those who tested negative for the infection.

There were 265 (10.4%) deaths from all causes during the follow-up period among all subjects of the study. In 119 (44.9%) of them, COVID-19 was the underlying cause of death, resulting in a COVID-19-specific mortality of 4.7% (119/2551) for all the subjects of the study, and about 1 death of each of five subjects who tested positive (119/602; CFR = 19.8%) (see Figure 1). Of patients who had a positive test for the virus, 28 (4.7%) died from causes other than COVID-19.

CFRs were 21.4% and 20% in those subjects who were transplanted before and in those who changed his/her status from waitlisted to transplanted after the COVID-19 test, respectively, and 17% in those who

Table 2. Infections, deaths and key mortality measures among transplant recipients and waitlisted patients by results of SARS-CoV-2 test, vital status at the end of follow-up, cause of death, and type of solid organ. Colombia, March 2020–February 2021.

Organ	Measure	Waitlisted patients	Transplant recipients	*p* value
Kidney	N	962	946	
N = 1,908 (74.8)	COVID-19 (+)	249 (25.9%)	240 (25.4%)	0.797
DAC = 184 (9.6%)	DAC	94 (9.8%)	90 (9.5%)	0.826
	DCO (CFR)	41 (16.5%)	57 (23.8%)	0.044
	DCO/DAC	43.6%	63.3%	0.007
	GMCo	4.3%	6.0%	0.081
Liver	N	136	310	
N = 446 (17.5)	COVID-19 (+)	21 (15.4%)	52 (16.8%)	0.726
DAC = 46 (10.3%)	DAC	23 (16.9%)	23 (7.4%)	0.002
	DCO (CFR)	6 (28.6%)	9 (17.3%)	0.281
	DCO/DAC	26.1%	39.1%	0.345
	GMCo	4.4%	2.9%	0.416
Heart	N	26	84	
N = 110 (4.3%)	COVID-19 (+)	4 (15.4%)	18 (21.4%)	0.586
DAC = 19 (17.3%)	DAC	6 (23.1%)	13 (15.5%)	0.370
	DCO (CFR)	1 (25.0%)	3 (16.7%)	1.000
	DCO/DAC	16.6%	23.1%	1.000
	GMCo	3.8%	3.5%	1.000
Lung	N	22	27	
N = 49 (1.9%)	COVID-19 (+)	5 (22.7%)	4 (14.8%)	0.713
DAC = 9 (18.4%)	DAC	7 (31.8%)	2 (7.4%)	0.060
	DCO (CFR)	0 (0.0%)	0 (0.0%)	---
	DCO/DAC	0.0%	0.0%	---
	GMCo	0.0%	0.0%	---

A, alive; COVID-19, coronavirus disease 2019; DAC, total deaths (deaths from all causes); DCO, deaths attributable to COVID-19; CFR, case-fatality ratio (%); % DCO/DAC, percentage of deaths attributable to COVID-19, GMCo, general mortality attributable to COVID-19; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

remained as waitlisted candidates to the end of follow-up or death.

On the other hand, among patients who tested positive for SARS-CoV-2, the probability of death due to COVID-19 as the underlying cause was significantly higher in transplant recipients than in those who remained on waiting list (87.3% and 72.7%, respectively; $p = 0.034$).

There were no differences (i.e., non-significant p values) in the number of deaths from all causes per 100 patients, the number of deaths from COVID-19 per 100 patients, and CFRs when comparing both groups (transplant recipients or waiting list patients) when grouped by all organs as shown in Figure 1. Similarly, there was no difference in most of the deaths from all causes per 100 patients when comparing both groups for each type of organ, except liver ($p = 0.002$). In the case of kidney, the CFR and the proportion of deaths attributable to COVID-19 were higher in transplant patients than in those on the waiting list ($p = 0.044$ and 0.007, respectively).

In patients who died after testing positive for COVID-19, and whose death was attributable to the infection, the median number of days from diagnosis to death was 22 (IQR: 12-37, range: 0–309). It was 23 days (IQR: 12–39, range: 2–309) for transplant recipients, and 21 days (IQR: 12–28, range: 0–176) for those on waiting lists ($p = 0.765$).

COVID-19, as a cause of death, was more frequent in kidney than in the other organs studied in both transplant recipients and waitlisted subjects. In fact, the percentage of COVID-19-related deaths was as high as 63.3% in kidney transplant patients; and ranging from 0.0% to 39.1% in the cases of lung, heart, and liver. Related to this finding, the CFR due to COVID-19 was also higher in kidney transplant recipients than in those who had a liver, heart, and lung transplant; but, in the case of patients on the waiting list, the CFR was higher for liver and heart than in kidney or lung patients. There were no observed deaths by COVID-19 in the cases of lung and pancreas patients (CFR = 0.0%).

In dead patients who had tested positive for COVID-19, and whose death was attributable to this infection, the median numbers of days from diagnosis to death were 21 days (IQR: 12–36.5; n = 96 deaths), 20 days (IQR: 14–28, n = 15), and 63.5 days (IQR: 45–70, n = 4), respectively, in the cases of kidney, liver, and heart transplant and nontransplant patients. Among those 28 patients who were infected and died during follow-up, but their underlying cause of death was other than COVID-19, the most common immediate causes of death were cardiogenic shock (21.4%), hemorrhagic

shock (10.7%), and acute myocardial infarction (10.7%) (Table 3).

Table 3. Immediate cause of death in infected transplant and nontransplant patients whose underlying cause of death was other than coronavirus disease 2019 (COVID-19). N = 28.

Type of cause	N	%
Cardiogenic shock	6	21.4
Hemorrhagic/hypovolemic shock	3	10.7
Acute myocardial infarction	3	10.7
Neurogenic shock	2	7.1
Septic shock	2	7.1
Distributive shock	1	3.6
Cerebral edema	1	3.6
Hypertensive emergency	1	3.6
Multiorgan failure	1	3.6
Severe hypoxemia	1	3.6
Severe respiratory insufficiency	1	3.6
Unspecified kidney failure	1	3.6
Sudden death	1	3.6
Other interstitial lung disease	1	3.6
Cardiac arrest	1	3.6
Intracranial hypertension syndrome	1	3.6
Ventricular tachycardia	1	3.6
Total	28	100.0

Immediate cause of death is the final disease or injury causing the death; while the underlying cause is the disease or injury that initiated the events resulting in death. Due to restrictions to accessing vital statistics database, specific underlying cause of death in these patients were not known to the authors.

Discussion

Our results are based on national data of a middle-income country and indicate that proportions of positivity to SARS-CoV-2 infection were basically the same for solid organ transplant (23.1%) and waitlisted (24.2%) subjects, among those with a known result of the COVID-19 real time reverse transcriptase polymerase chain reaction (RT-PCR) test. The proportions were also similar for kidney and liver transplant and waitlisted groups, the two most common solid organs needed in Colombia. These percentages are higher than those reported for solid organ transplant patients in other countries in a similar period of study ranging from 5% to 11% [11–12].

However, as in the general population [13], the true level of transmission of the virus in the transplant and waitlisted population in the country may be underestimated if we compare with the results of the participants in this study because of several reasons including the fact that a high proportion of individuals with the infection might be undetected (subclinical or asymptomatic presentation of the infection) [14,15], misdiagnosed (e.g., due to clinical- or diagnostic test-related failures) [16,17], or have a lower opportunity for access to healthcare [18], among others.

Solid organ transplant recipients are a very special population because their chronic immunocompromised state is linked to a higher risk for severe COVID-19 [19] but is counterbalanced by its beneficial effect on the cytokine storm. Waitlisted patients may also have a high risk of severe complications and death in the course of the infection due to aspects such as a high prevalence of chronic diseases [20]. Kidney (74.8%) was by far the most common organ both among patients on the waiting list and among those who had already been transplanted at the time of the COVID-19 test.

Among all the subjects included in our study, 10% died, and about 45% (119/2,551) of these deaths were attributable to COVID-19, which also means that 4.2% of subjects in waitlist and 5.1% of those who were transplanted before the index test died due to this infection. Solid organ transplant recipients have a high prevalence of comorbidities, and they are at increased risk of complications and death from COVID-19; and this has been described in other studies around the world [21–27]. However, our results show that a history of high blood pressure and/or autoimmune condition is significantly higher among waitlisted candidates. It was also noted that there was a high prevalence of chronic disease among all the subjects included in the study.

When comparing our results with those of France in the case of kidney patients, CFR was higher in our country for both recipients (23.8% and 20.1% (122/606), respectively) and waitlisted candidates (16.5% and 12.6% (60/478), respectively) [28]. However, a more realistic comparison between studies requires additional epidemiological analyses for studying the effects of factors such as age, gender, ethnicity, socioeconomic status, prevalence of comorbid conditions and duration of follow-up, among others.

During the follow-up, there were no detected COVID-19-attributable deaths for waitlisted or transplant patients of lung or pancreas, but their overall percentage of participation was very low. A study in Germany that included lung recipients found that the risk of complications and death from COVID-19 (Omicron variant) remained high with age at infection (Odds ratio, OR = 1.082; 95% confidence interval (95% CI): 1.015–1.153) and presence of kidney damage (OR: 3.175; 95% CI: 1.278–7.884) [29].

Our study included a general and specific analysis by organ of the effects of COVID-19 on deaths for both transplant and waitlisted population since COVID-19 report was mandatory for public health purposes. However, our study has some limitations that should be considered. The limitations are mainly focused on the

representativeness of the subjects whose COVID-19 test results were known with respect to the totality of the individuals who were waitlisted candidates or transplant recipients. Since we chose only patients with a known result of SARSCoV-2 test, overall and specific measures of mortality described here might be, overestimated compared to the behavior of the infection in the rest of subjects of the RedDataINS© national database. The 2020 report of statistics published by the Donation and Transplantation Network Group of the Colombian NIH established that there were 251 deaths (of any cause) among a total of 2,978 waitlisted patients, resulting in a mortality of 8.4% [30]. In our study, mortality was estimated in 11.3% for the same group, a difference of about 3 more deaths for each 100 patients, albeit this difference would be lower due the absence of pandemic virus in the country during the first 2 months of the year used for the 2020 annual report but not for our study. It is also noteworthy that the overall mortality among waitlisted patients had been reported as 4.78% in 2018 [31] and 4.87% in 2019 [32]. This means that, according to the 2020 report, there were 3–4 more deaths per 100 subjects compared to the pre-pandemic years, or 6 based on our results. If waitlisted subjects who had positive tests included in our study are ignored, the overall mortality reduces to 7.4% among waitlisted subjects (negative for SARS-CoV-2), meaning an unexplained excess of about 2.6 deaths for 100 subjects after discarding the effect of COVID-19 diagnosis.

These results show that COVID-19-attributtable mortality is high and it could explain why the number of deaths in our study increased, although a wide range of demographic characteristics of patients should be considered. The findings described here are important because these patients represent a vulnerable population and are often excluded from clinical trials of vaccines [33]. In addition, 134 cases of death were reported during the study period among patients with solid organ transplants, of which 69 were attributed to COVID-19. This means that more than half of the deaths (51.5%) that occurred among transplant recipients were secondary to COVID-19. We have included only subjects with a positive or negative result in the COVID-19 test; therefore, the total number of deaths are lower than they are for all solid organ transplant recipients or candidates. In fact, in the case of kidney recipients, another national source of health data shows 138 all-causes deaths (n = 138) reported among them in a year (July 2019–June 2020), which means about 53% more deaths than reported in our study [34].

Conclusions

In this study, one in five patients who were diagnosed with COVID-19 died of the infection. CFR was higher among transplant recipients than among patients waitlisted for kidney. In fact, there were seven more deaths per 100 infected subjects in the first group than in the second one. Thus, we found a very important role of COVID-19 on deaths of solid organ transplant recipients and candidates during the first year of the pandemic in Colombia, a period in which specific vaccines were unavailable around the country. Our findings support the need of designing combined preventive and therapeutic strategies from clinical and epidemiological perspectives, which should become an integral part of the approach to this special population in Colombia.

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