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Long-term renal function in living kidney donors with simple renal cysts: A retrospective cohort study

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Abstract

Simple (Bosniak I) renal cysts are considered acceptable in living kidney donor selection in terms of cancer risk. However, they tend to increase in number and size over time and might compromise renal function in donors. To clarify their implications for long-term renal function, we characterized the prevalence of renal cysts in 454 individuals who donated at our center from 2000 to 2007. We estimated the association between the presence of cysts in the kidney remaining after nephrectomy (ie, retained cysts) and postdonation eGFR trajectory using mixed-effects linear regression. Donors with retained cysts (N = 86) were older ($P < .001$) and had slightly lower predonation eGFR (median 94 vs 98 mL/min/1.73 m^2, $P < .01$) than those without cysts. Over a median 7.8 years, donors with retained cysts had lower baseline eGFR ($_{-8.7}$ −5.6 $_{-2.3}$ mL/min/1.73

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AUTHORS' CONTRIBUTIONS

MMW, AGT, SO, JGW, and ABM: involved in concept/design; MMW, AGT, YY, DLS, and ABM: involved in data analysis/interpretation; MMW, AGT, YY, CMH, and ABM: drafted article; MMW, AGT, YY, CMH, AQN, SHE, SO, ADM, MLH, KLL, FAA, DCB, JMG, DLS, and ABM: critically revised the article; AGT, YY, DLS, and ABM: involved in statistics; AGT, CMH, JMG, DLS, and ABM: secured funding; MMW, AQN, SEH: collected data.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

CONFLICT OF INTEREST

The authors of this manuscript have no conflicts of interest to disclose as described by Clinical Transplantation.

m^2, $P < .01$) but similar yearly change in eGFR ($_{-0.4}$ 0.02 $_{0.4}$ mL/min/1.73 m^2, $P = .2$) compared to those without retained cysts. Adjusting for predonation characteristics, there was no difference in baseline eGFR ($P = .6$) or yearly change in eGFR ($P > .9$). There continued to be no evidence of an association when we considered retained cyst(s) ≥10 mm or multiple retained cysts (all $P > .05$). These findings reaffirm current practices of accepting candidates with simple renal cysts for donor nephrectomy.

Keywords

donors and donation; glomerular filtration rate; living; renal cyst; renal function

1 | INTRODUCTION

Living kidney donors undergo rigorous evaluation and selection to minimize the risks of adverse postdonation outcomes.[1,2] This evaluation includes cross-sectional imaging, typically by abdominal computed tomography (CT) or magnetic resonance imaging (MRI), which sometimes uncovers incidental findings, such as asymptomatic simple renal cysts. Simple (Bosniak I) renal cysts are common in the general population and increase in prevalence with age.[3,4] A single-center study of potential kidney donors (N = 1948) found that 39% of candidates aged 18–49 and 63% of candidates aged 50–75 had at least one renal cyst.[5] Simple renal cysts are generally considered acceptable in donor selection in terms of cancer risk, as their potential for malignant transformation is extremely low.[1,4,6] However, prior work suggests that simple cysts may grow in number and size over time,[7–10] which might cause alterations in renal structure and function, obstruction of tubules, renal ischemia, and ultimately reduced renal function (estimated glomerular filtration rate, eGFR).[6,11] Reduced eGFR is particularly relevant to donors since they lose 50% of their nephron mass at nephrectomy. Because of this, they have reduced renal reserve relative to healthy nondonors, which may promote progression to chronic kidney disease and end-stage renal disease.[12–20] Quantifying postdonation renal function in donors with renal cysts might provide insight into whether these structural abnormalities represent a subclinical risk factor for clinically significant renal impairment after donation.

There is a paucity of evidence about how cysts impact renal function over time, and this is likely to persist due to ethical, practical, and cost challenges associated with screening healthy or low-risk individuals for asymptomatic renal cysts in routine practice.[21] In the general population, some cross-sectional studies have reported inferior kidney function in individuals with renal cysts compared to those without cysts,[22–26] while others have reported no association between cysts and renal function.[27–29] Evidence regarding postdonation renal function among donors with cysts is limited to a single German study, which found no difference in serum creatinine among 25 donors with renal cysts compared to those without cysts (N = 243) after a mean follow-up time of 2.8 years (1.37 vs 1.33 mg/dL in donors with and without cysts, respectively).[30] However, given the slow growth rate of renal cysts (approx. 4% per year),[8] increases in cyst number and size might not exert structural and functional changes that reach clinical significance for many years. Furthermore, findings from this small sample might not generalize to different settings. In the United States, for

instance, the donor population might differ substantially by demographics and comorbidity burden, which have been shown to impact postdonation outcomes.[15,18–20,31–34]

The goals of this study were to describe the prevalence and characteristics of renal cysts in donors at a single center and to elucidate the long-term clinical implications of renal cysts in donors. To this end, we compared postdonation renal function trajectories among donors with vs without renal cysts present in the remaining kidney remaining after donor nephrectomy using mixed-effects linear regression.

2 | METHODS

2.1 | Study population

The Wellness and Health Outcomes in Live Donor (WHOLE-Donor) cohort is an ongoing retrospective, multi-center cohort study of living kidney donors. Participants are routinely surveyed on demographic, medical, and social history and consent to medical record abstraction throughout the course of their routine postdonation care, including postdonation records at the transplant hospital. From a cohort of 610 WHOLE-Donor participants who underwent nephrectomy at the Johns Hopkins Hospital between 2000 and 2007, we identified 482 who had postdonation medical records. We excluded donors who had no reported postdonation serum creatinine measurements (n = 1) or who had no predonation CT imaging (n = 7), serum creatinine (n = 10), or systolic blood pressure measurements (n = 3) in the transplant hospital electronic health record (EHR), resulting in a final cohort of 454 donors (Figure 1).

2.2 | Data collection and management

Study data were collected and managed using REDCap electronic data capture tools hosted at Johns Hopkins University.[35] REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies. The Johns Hopkins Medicine Institutional Review Board (NA_00044282) approved this study. The clinical and research activities being reported are consistent with the Declaration of Helsinki and Declaration of Istanbul.[36,37]

2.3 | Predonation characteristics and presence of renal cysts

Predonation characteristics were ascertained through retrospective chart review using the transplant hospital EHR, including predonation clinic notes and laboratory measurements. Presence of renal cysts was determined from predonation CT reports. Cysts were characterized by number (single vs two or more cysts) and size of the largest cyst (0–5 mm, 5–10 mm, 10–20 mm, >20 mm). Cysts described as “tiny” in the radiology report were categorized as <5 mm in size. All participants in this study were approved for donation; thus, donor candidates with non-benign-appearing cysts were excluded from the study population. All cysts were characterized as simple (Bosniak I) cysts.

2.4 | Postdonation eGFR trajectory by presence of retained renal cyst

Our primary analysis compared donors with one or more renal cysts present in the remaining kidney after nephrectomy (ie, retained cysts, ascertained by comparing cyst laterality to the

laterality of the kidney removed for donation) to donors who did not retain a renal cyst (ie, donors with no cysts and donors with one or more cysts only present in the donated kidney). Serum creatinine measurements obtained from postdonation medical records were used to compute eGFR using the 2009 CKD-EPI equation[38] Participants had a median of 11 (interquartile range [IQR]: 7–18) eGFR measurements over the study period were followed for a median of 7.8 (IQR: 4.8–10.3) years.

We visually assessed longitudinal trends in eGFR using local estimated scatterplot smoothing (LOESS). We used three mixed-effect linear regression models to compare postdonation eGFR trajectory among donors with vs without retained cysts. The first model was univariate. The second model adjusted for age at donation (centered at 40, per 10 years), sex, African American race, predonation body mass index (BMI, categorized as <18.5, 18.5–24.9, 25–29.9, ≥30 kg/m^2), and year of donation. The third model adjusted for predonation eGFR (centered at 60 mL/min/1.73 m^2, continuous) and predonation systolic blood pressure (SBP, mmHg, continuous) in addition to the characteristics included in the second model. All models accounted for time since donation using a random slope for each individual and included an interaction term between cyst and time to assess whether there was a difference in the rate of eGFR change over time among donors with and without a retained cyst. Given the association between prevalence of renal cysts and age,[3,4] we conducted a post hoc analysis comparing postdonation eGFR trajectory between donors with and without retained cysts adjusting only for age at donation.

2.5 | Postdonation eGFR trajectory by retained cyst characteristics

In two separate mixed-effect linear regression models, we considered the impact of retained cyst characteristics on postdonation renal function. These models reclassified the primary exposure as the presence of (a) retained cyst(s) ≥10 mm and (b) two or more retained cysts. Both models adjusted for predonation donor characteristics (age, sex, African American race, eGFR, BMI, SBP, and year of donation) and accounted for time since donor nephrectomy using a random slope for each individual. Both models also included an interaction term between the characteristic of interest and time in order to assess whether there was a difference in the rate of eGFR change over time among donors who retained a cyst with the characteristic of interest and donors without a retained cyst.

2.6 | Sensitivity analyses

Our primary analysis studied donors who had one or more retained cysts after nephrectomy, compared to those who had no cysts in their remaining kidney. However, it is possible the presence of a renal cyst in either kidney could indicate underlying disease or renal impairment which might impact postdonation renal function among donors. Therefore, we compared donors with at least one predonation cyst in either kidney to donors with no cysts in either kidney in a sensitivity analysis. We used mixed-effect linear regression to compare eGFR trajectory among donors with vs without predonation cysts, adjusting for age at donation, African American race, sex, predonation BMI, predonation eGFR, predonation SBP, and year of donation.

2.7 | Statistical analysis

All statistical analyses were performed using Stata 15/SE for Linux (StataCorp). We compared donors with and without cysts using the chi-square tests for categorical variables and Mann-Whitney ranksum tests for continuous variables. All tests were two-sided, and a *P*-value of .05 was considered statistically significant. Confidence intervals (CI) are reported as per the method of Louis and Zeger.[39]

3 | RESULTS

3.1 | Study population

Among the 454 donors in our study, we identified 138 (30%) donors with at least one renal cyst (Table S1). Of these, 86 (62%) retained at least one cyst after nephrectomy. Compared to donors with no retained cysts (ie, cyst removed during donor nephrectomy or no predonation cyst), donors with retained cysts were older (median age 53 vs 45 years, $P < .001$) and more likely to be at least 50 years old (62% vs 32%, $P < .001$), had lower predonation eGFR (median 94 vs 98 mL/min/1.73 m^2, $P < .01$), had higher predonation SBP (median 122 vs 120 mm Hg, $P < .01$), and were less likely to be a first-degree biological relative of the recipient (36% vs 48%, $P = .04$; Table 1). There were no differences between donors with and without retained cysts by sex ($P = .2$), African American race ($P = .3$), BMI ($P = .7$), predonation diastolic blood pressure ($P = .1$), college education ($P = .4$), history of smoking ($P = .3$), history of hypertension at the time of donation ($P > .9$), or laterality of kidney donated ($P = .4$).

3.2 | Characteristics of retained renal cysts

Among the 86 donors with a retained cyst, 26 (30%) had multiple cysts. The size of the largest cyst for a given donor ranged from 2 to 60 mm. Among 71 donors with a cyst size reported in predonation CT reports, 16 (23%) had a cyst ≥10 mm in size. A single cyst <5 mm was the most common radiological finding among donors in our cohort (n = 26, 30%), followed by a single cyst between 5 and 10 mm (N = 14, 16%), multiple cysts <5 mm (n = 11, 13%), and a single cyst between 10 and 20 mm (n = 8, 9%). A small number of donors had multiple cysts with a largest cyst between 5 and 10 mm (n = 4, 5%) and 10 and 20 mm (n = 4, 5%). Of the 4 donors with a largest cyst >20 mm in size, 3 had a single cyst (Table 2).

3.3 | Postdonation eGFR trajectory by presence of retained renal cyst

On average, postdonation eGFR was lower among donors with retained cysts over time (Figure 2A). In an unadjusted mixed-effect linear regression model, presence of a retained cyst was associated with a $_{2.3}$ 5.6 $_{8.7}$ mL/min/1.73 m^2 lower average eGFR at baseline (ie, predonation; $_{55.5}$ 58.2 $_{60.8}$ mL/min/1.73 m^2 in donors with retained cysts vs $_{62.4}$ 63.6 $_{64.9}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-8.4}$ −5.6 $_{-2.3}$, $P < .01$) but no difference in the change in eGFR per year ($_{0.1}$ 0.4 $_{0.7}$ mL/min/1.73 m^2 per year in donors with retained cysts vs $_{0.2}$ 0.4 $_{0.5}$ mL/min/1.73 m^2 per year in donors without cysts, difference = $_{-0.4}$ 0.02 $_{0.4}$, $P = .2$; Table 3).

After adjustment for age at donation, African American race, sex, predonation BMI, and year of donation, presence of a retained cyst was not associated with a difference in average eGFR at baseline ($_{60.5}$ 63.9 $_{67.4}$ mL/min/1.73 m^2 in donors with retained cysts vs $_{62.3}$ 64.8 $_{67.2}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-3.5}$ −0.8 $_{1.8}$, $P = .5$) or in the change in eGFR per year ($_{0.6}$ 0.9 $_{1.2}$ mL/min/1.73 m^2 per year in donors with retained cysts vs $_{0.7}$ 0.9 $_{1.0}$ mL/min/1.73 m^2 per year in donors without cysts, difference = $_{-0.3}$ −0.004 $_{0.3}$, $P > .9$). The results of the regression did not meaningfully change after additional adjustment for predonation eGFR and SBP (average eGFR at baseline: $_{59.9}$ 66.5 $_{73.0}$ mL/min/1.73 m^2 in donors with retained cysts vs $_{60.9}$ 67.1 $_{73.2}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-2.7}$ −0.6 $_{1.6}$, $P = .6$; change in eGFR per year: $_{0.3}$ 0.6 $_{0.9}$ mL/min/1.73 m^2 per year in donors with and $_{0.4}$ 0.6 $_{0.8}$ mL/min/1.73 m^2 per year in donors without retained cysts, difference = $_{-0.4}$ −0.02 $_{0.4}$, $P > .9$).

In a post hoc model adjusting only for age, presence of a retained cyst was not associated with a difference in average eGFR at baseline ($_{62.0}$ 64.6 $_{67.2}$ mL/min/1.73 m2 in donors with retained cysts vs $_{64.7}$ 65.9 $_{67.1}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-4.0}$ −1.3 $_{1.4}$, $P = .4$) or in the change in eGFR per year ($_{0.6}$ 0.9 $_{1.2}$ mL/min/1.73 m^2 per year in donors with retained cysts vs $_{0.8}$ 0.9 $_{1.1}$ mL/min/1.73 m^2 per year in donors without cysts, difference = $_{-0.4}$ −0.01 $_{0.4}$, $P > .9$).

3.4 | Postdonation eGFR trajectory by cyst characteristics

After adjustment for predonation donor characteristics, presence of a retained cyst ≥10 mm in size was not associated with a difference in average eGFR at baseline ($_{60.6}$ 68.8 $_{77.0}$ mL/min/1.73 m^2 in donors with a retained cyst ≥10 mm vs $_{60.7}$ 67.8 $_{74.9}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-3.6}$ 1.0 $_{5.6}$, $P = .7$) or in the change in eGFR per year ($_{-0.2}$ 0.5 $_{1.2}$ mL/min/1.73 m^2 per year in donors with a retained cyst ≥10 mm vs $_{-0.4}$ 0.6 $_{0.8}$ mL/min/1.73 m^2 per year in donors without cysts, difference = $_{-0.8}$ −0.1 $_{0.6}$, $P = .8$; Table 4).

After adjustment for predonation donor characteristics, the presence of multiple retained cysts was not associated with a difference in average eGFR at baseline ($_{58.7}$ 66.7 $_{74.6}$ mL/min/1.73 m^2 in donors with multiple retained cysts vs $_{59.9}$ 66.9 $_{73.8}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-3.8}$ −0.2 $_{3.4}$, $P > .9$; Figure 2B). Donors with multiple retained cysts experienced an increase in eGFR of $_{0.6}$ 1.1 $_{1.7}$ mL/min/1.73 m^2 per year, compared to an increase of $_{0.4}$ 0.6 $_{0.8}$ mL/min/1.73 m^2 per year in donors without cysts; however, the difference in the change in eGFR over time did not reach statistical significance (difference = $_{-0.1}$ 0.5 $_{1.1}$, $P = .06$; Table 5).

3.5 | Sensitivity analyses

In a sensitivity analysis where the exposure of interest was reclassified to include donors with any renal cyst in either kidney on predonation CT imaging (n = 113), presence of any predonation cyst was not associated with a difference in average eGFR at baseline ($_{60.8}$ 67.3 $_{73.9}$ mL/min/1.73 m^2 in donors with any predonation cyst vs $_{61.0}$ 67.1 $_{73.3}$ mL/min/1.73 m^2 in donors without cysts, difference = $_{-1.7}$ 0.2 $_{2.1}$, $P = .8$) or over time ($_{0.3}$ 0.6 $_{0.8}$ mL/min/1.73 m^2 per year in donors with any predonation cyst vs $_{0.5}$ 0.6 $_{0.8}$ mL/min/1.73 m^2 per year in donors without cysts, difference = $_{-0.3}$ −0.1 $_{0.2}$, $P = .7$; Table 6).

4 | DISCUSSION

In this retrospective, single-center cohort study of 454 living kidney donors, we found no difference in postdonation eGFR trajectory among donors with and without a cyst present in the remaining kidney after donor nephrectomy over a median 7.8 years of follow-up (adjusted difference in change in eGFR per year among donors with vs without retained cysts: = $_{-0.3}$ 0.02 $_{0.4}$, $P > .9$). There continued to be no evidence of an association between presence of retained cysts and postdonation eGFR trajectory when we reclassified our primary exposure to consider the impact of retained cyst(s) ≥10 mm in size or multiple retained cysts (all $P > .05$).

Our finding that donors with retained renal cysts had slightly lower eGFR at baseline than donors without cysts (median 94 vs 98 mL/min/1.73 m^2, $P < .01$) is consistent with a recent study of 716 living donor transplants performed in China, which found that donors with renal cysts (N = 91) had lower predonation eGFR (100 vs 106 mL/min/1.73 m^2).[40] While donors with retained cysts had a lower average eGFR than those without cysts at baseline (difference = −5.6, $P < .001$) and throughout the follow-up period, this association was confounded by donor age at donation: When adjusting for age alone, the association between retained cysts and eGFR was not significant ($P = .4$). This is not surprising given that the incidence of simple cysts in the general population increases with age[3,4] and is consistent with a study of older (age ≥ 60 years) donors, which found that older donors had lower preand postdonation eGFR than younger donors (age < 60 years) on average, but no long-term difference in renal function trajectory over a median 5.5 years of follow-up.[41] This finding is also consistent with a German study of 25 donors with cysts, which found that donors with and without cysts had similar serum creatinine (1.37 vs 1.33 mg/dL in donors with and without cysts, respectively) after a mean 2.8 years postdonation.[30] Our study extends upon this work by examining trends in eGFR trajectory among donors with and without retained renal cysts over a median (IQR) 7.8 (4.8–10.3) years. In addition, we used mixed-effects linear regression to quantify the difference in the change in eGFR per year among donors with and without cysts, while adjusting for donor characteristics that might influence postdonation outcomes.

To our knowledge, this is the largest study of renal cysts in living kidney donors, with the longest follow-up, to date. Having said that our study has several limitations, first, we limited our study population to donors from a single transplant center in order to access predonation radiology reports. Despite the single-center design of our study, we were able to include participants that demographically differ from previous studies of renal cysts and postdonation renal function. Furthermore, our single-center study design might increase the uniformity of the CT reports, which were used to ascertain the presence and characteristics of predonation renal cysts. Second, we limited our study to donors who did undergo donor nephrectomy. As such, our study population does not include individuals with non-benign-appearing cysts, and it is enriched with sub-centimeter cysts (55/86, 64%), which are often considered clinically insignificant. We therefore cannot comment on potential donors who might have been ruled out due to renal cysts that were greater in size or number, or for other contraindications to donation. However, our study did include participants with cysts up to 60 mm in size.

In conclusion, we found no association between the presence of one or more retained renal cysts and postdonation eGFR trajectory among donors at a single center in the United States over 8 years of follow-up. Additionally, there was no association between larger (≥10 mm) or multiple retained cysts and postdonation eGFR trajectory. Our findings reaffirm current practices as described in the current KDIGO guidelines,[1] which allow for the selection of donor candidates with non-malignant or low-risk renal cysts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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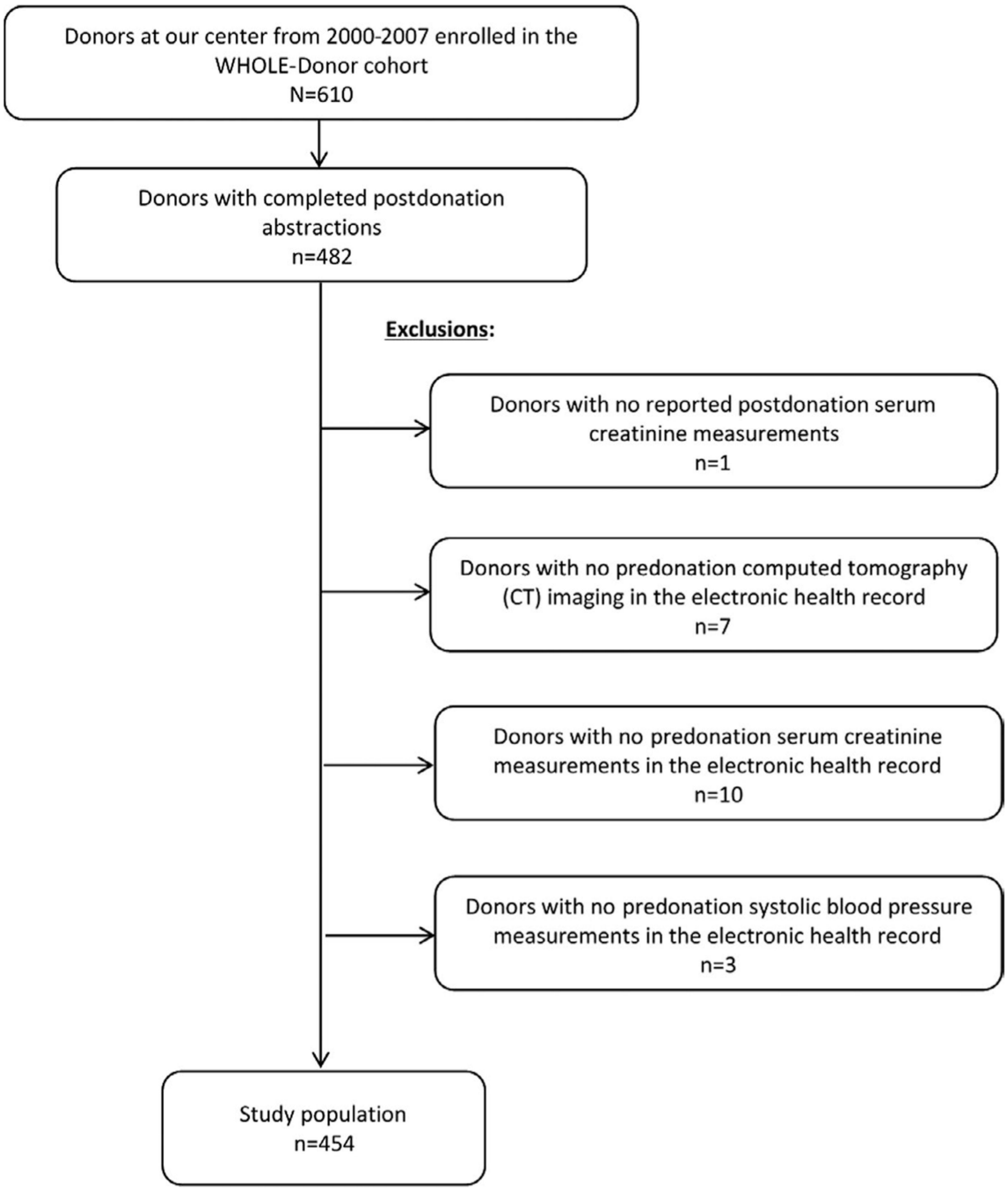

FIGURE 1.
Flow chart of study population

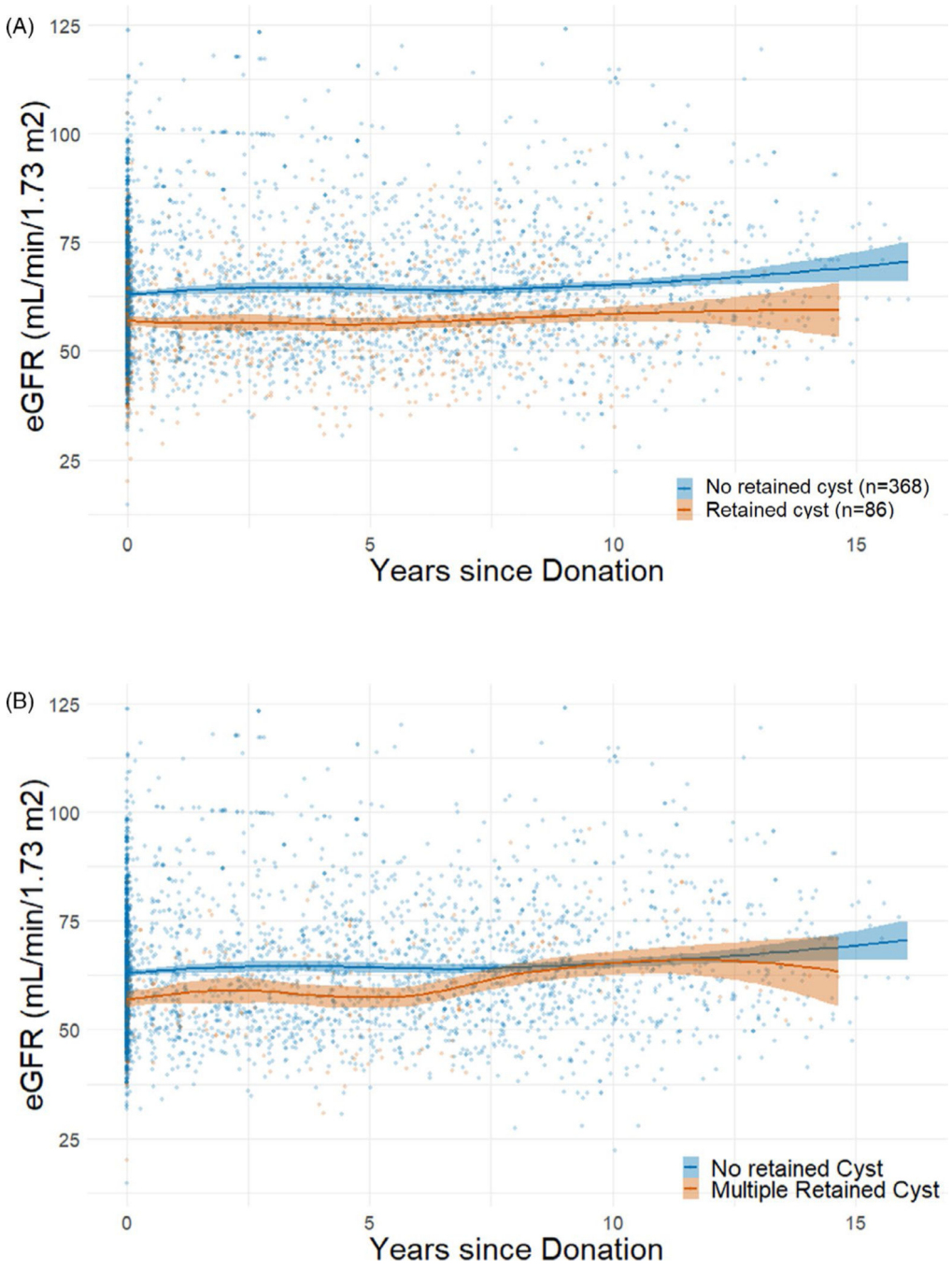

FIGURE 2.

A, Postdonation estimated glomerular filtration rate (eGFR) trajectory among donors with vs without retained renal cysts. B, Postdonation estimated glomerular filtration rate (eGFR) trajectory among donors with vs without multiple retained renal cysts

TABLE 1

Donor characteristics by presence of retained renal cyst (ie, cyst in kidney remaining after nephrectomy)

	No Retained Renal Cyst (n = 368)	Retained Renal Cyst (n = 86)	*P*-value
Age at donation (y)[a]	45 (36, 52)	53 (46, 59)	**<.001**
Age ≥ 50 at donation[b]	32%	62%	**<.001**
Female	67%	60%	.2
African-American	9.5%	5.8%	.3
BMI	26.6 (24.0, 30.2)	26.4 (24.3, 29.5)	.7
Predonation systolic blood pressure	120 (110, 128)	122 (110, 136)	**.004**
Predonation diastolic blood pressure	70 (62, 78)	72 (67, 80)	.1
Predonation eGFR (mL/min/1.73 m^2)	98 (87, 109)	94 (83, 103)	**.003**
Current or former tobacco smoker	32%	38%	.3
College education	57%	51%	.4
Year of donation	2004 (2002, 2006)	2005 (2003, 2006)	**.001**
Left kidney donated	95%	93%	.4
First-degree biological relative of recipient	48%	36%	.04
Hypertension at time of donation	3.5%	3.5%	>.9

Note: Donors with retained cysts were older ($P < .001$), had slightly higher systolic blood pressure ($P < .01$), and had slightly lower estimated glomerular filtration rate ($P < .01$).

Abbreviations: BMI, body mass index (mkg/m^2); eGFR, estimated glomerular filtration rate.

[a]Continuous variables are reported as median (Interquartile Range [IQR]).

[b]categorical variables are reported in percentages (%).

Statistically significant p-values were bolded a nominal significance threshold of 95% (alpha=0.05).

TABLE 2

Distribution of cyst number and largest cyst size

		Number of cysts	
		Single cyst (n = 60)	**Multiple cysts (n = 26)**
Largest Cyst Size	0–5 mm	26	11
	5–10 mm	14	4
	10–20 mm	8	4
	>20 mm	3	1
	Missing	9	6

Note: A single cyst <5 mm in size was the most common radiological finding among donors in our cohort (n = 26), followed by a single cyst between 0 and 5 mm (n = 14).

Statistically significant p-values were bolded a nominal significance threshold of 95% (alpha=0.05).

TABLE 3

Association between presence of a retained renal cyst and postdonation estimated glomerular filtration rate (eGFR) trajectory

	Model 1		Model 2		Model 3	
	Coefficient	***P***	**Coefficient**	***P***	**Coefficient**	***P***
Retained cyst (baseline)	55.5 58.2 60.8	**<.01**	60.5 63.9 67.4	0.5	59.9 66.5 73.0	.6
No retained cyst (baseline)	62.4 63.6 64.9		62.3 64.8 67.2		60.9 67.1 73.2	
Retained cyst (change per year)	0.1 0.4 0.7	.2	0.6 0.9 1.2	>.9	0.3 0.6 0.9	>.9
No retained cyst (change per year)	0.2 0.4 0.5		0.7 0.9 1.0		0.4 0.6 0.8	
Age per 10 y, centered at 40			−5.9 −5.1 −4.2	**<.001**	−3.1 −2.4 −0.6	**<.001**
African American			2.4 5.7 9.0	**.001**	−3.5 0.6 2.2	.7
Female			1.2 3.2 5.1	**.001**	1.4 3.0 4.6	**<.001**
Year of donation, centered at 2000			−0.9 −0.4 0.02	.06	0.7 −0.3 0.1	.1
Predonation eGFR, centered at 60					0.4 0.4 0.5	**<.001**
Predonation SBP					−0.07 −0.02 0.02	.4

Note: In an unadjusted model, retained cysts were associated with a lower average eGFR at baseline (difference: −8.7 −5.6 −2.3, $P < .01$) but no difference in the change in eGFR per year (difference: −0.4 0.02 0.4, $P > .9$). After adjustment for predonation characteristics, however, there was no difference in average eGFR at baseline or change in eGFR per year (all $P > .5$).

Abbreviations: eGFR, estimated glomerular filtration rate (mL/min per 1.73 m^2); SBP, systolic blood pressure (mm Hg).

Statistically significant p-values were bolded a nominal significance threshold of 95% (alpha=0.05).

TABLE 4

Association between presence of a retained cyst ≥ 10 mm in size and postdonation estimated glomerular filtration rate (eGFR) trajectory

	Coefficient	*P*
Retained cyst > 10 mm (baseline)	$_{60.6}$ 68.8 $_{77.0}$	.7
No retained cyst (baseline)	$_{60.7}$ 67.8 $_{74.9}$	
Retained cyst > 10 mm (change per year)	$_{-0.2}$ 0.5 $_{1.2}$	.8
No retained cyst (change per year)	$_{0.4}$ 0.6 $_{0.8}$	
Age per 10 y, centered at 40	$_{-3.2}$ −2.3 $_{-1.5}$	**<.001**
African American	$_{-3.8}$ 0.7 $_{2.3}$	.6
Female	$_{1.5}$ 3.4 $_{5.2}$	**<.001**
Year of donation, centered at 2000	$_{-0.8}$ −0.4 $_{0.2}$	.1
Predonation eGFR, centered at 60	$_{0.4}$ 0.4 $_{0.5}$	**<.001**
Predonation SBP	$_{-0.09}$ −0.02 $_{0.03}$	.3

Note: There was no difference between donors with a retained cyst ≥ 10 mm in size (n = 16) and no retained cyst (n = 368) in average eGFR at baseline ($P = .7$) or change in eGFR per year ($P = .8$).

Abbreviations: eGFR, estimated glomerular filtration rate; SBP, systolic blood pressure.

Statistically significant p-values were bolded a nominal significance threshold of 95% (alpha=0.05).

TABLE 5

Association between presence of two or more (ie, multiple) retained cysts and postdonation estimated glomerular filtration rate (eGFR) trajectory

	Coefficient	*P*
Multiple retained cysts (baseline)	$_{58.7}$ 66.7 $_{74.6}$	>.9
No retained cyst (baseline)	$_{59.9}$ 66.9 $_{73.8}$	
Multiple retained cysts (change per year)	$_{0.6}$ 1.1 $_{1.7}$	.06
No retained cyst (change per year)	$_{0.4}$ 0.6 $_{0.8}$	
Age per 10 years, centered at 40	$_{-2.1}$ −2.3 $_{-1.4}$	**<.001**
African American	$_{-3.4}$ 0.5 $_{2.5}$	.8
Female	$_{2.1}$ 3.9 $_{5.6}$	**<.001**
Year of donation, centered at 2000	$_{-0.7}$ −0.3 $_{0.1}$	.1
Predonation eGFR, centered at 60	$_{0.4}$ 0.4 $_{0.5}$	**<.001**
Predonation SBP	$_{-0.08}$ 0.03 $_{0.03}$	.4

Note: There was no difference between donors with multiple retained cysts (n = 26) and no retained cyst (n = 368) in average eGFR at baseline (*P* > .9). Donors with multiple retained cysts experienced an increase in eGFR of $_{0.6}$ 1.1 $_{1.7}$ mL/min/1.73 m^2 per year, compared to an increase of $_{0.4}$ 0.6 $_{0.8}$ mL/min/1.73 m^2 per year in donors without cysts; however, the difference in the change in eGFR over time did not reach statistical significance (*P* = .06).

Abbreviations: eGFR, estimated glomerular filtration rate; SBP, systolic blood pressure.

Statistically significant p-values were bolded a nominal significance threshold of 95% (alpha=0.05).

TABLE 6

Association between presence of renal cyst in either kidney on predonation computed tomography (CT) imaging and postdonation estimated glomerular filtration rate (eGFR) trajectory

	Coefficient	*P*
Any predonation cyst (baseline)	$_{60.8}$ 67.3 $_{73.9}$	.8
No cyst (baseline)	$_{61.0}$ 67.1 $_{73.3}$	
Any predonation cyst (change per year)	$_{0.3}$ 0.6 $_{0.8}$	.7
No cyst (change per year)	$_{0.5}$ 0.6 $_{0.8}$	
Age per 10 y, centered at 40	$_{-3.2}$ −2.4 $_{-1.6}$	**<.001**
African American	$_{-3.5}$ −0.6 $_{2.2}$	.7
Female	$_{1.5}$ 3.0 $_{4.6}$	**<.001**
Year of donation, centered at 2000	$_{-0.6}$ −0.3 $_{0.06}$	.1
Predonation eGFR, centered at 60	$_{0.4}$ 0.4 $_{0.5}$	**<.001**
Predonation SBP	$_{-0.07}$ −0.02 $_{0.03}$	.4

Note: There was no difference between donors with any predonation cyst (n = 138) and no cyst (n = 316) in average eGFR at baseline (*P* = .8) or change in eGFR per year (*P* = .7).

Abbreviations: eGFR, estimated glomerular filtration rate; SBP, systolic blood pressure.

Statistically significant p-values were bolded a nominal significance threshold of 95% (alpha=0.05).