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Risk of Kidney Stones With Surgical Intervention in Living Kidney Donors

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A kidney stone in a person with a solitary kidney requires urgent attention, which may result in surgical and/or hospital attention. We conducted a matched retrospective cohort study to determine if living kidney donors compared to healthy nondonors have a higher risk of: (i) kidney stones with surgical intervention, and (ii) hospital encounters for kidney stones. We reviewed all predonation charts for living kidney donations from 1992 to 2009 at five major transplant centers in Ontario, Canada, and linked this information to healthcare databases. We selected nondonors from the healthiest segment of the general population and matched 10 nondonors to every donor. Of the 2019 donors and 20 190 nondonors, none had evidence of kidney stones prior to cohort entry. Median follow-up time was 8.4 years (maximum 19.7 years; loss to follow-up <7%). There was no difference in the rate of kidney stones with surgical intervention in donors compared to nondonors (8.3 vs. 9.7 events/10 000 person-years; rate ratio 0.85; 95% confidence interval [CI] 0.47–1.53). Similarly there was no difference in the rate of hospital encounters for kidney stones (12.1 vs. 16.1 events/10 000 person-years; rate ratio 0.75; 95% CI 0.45–1.24). These interim results are reassuring for the safety of living kidney donation.

Keywords: Cohort study, health administrative data, health outcomes, kidney stones, living kidney donor, transplantation

Abbreviations: CI, confidence interval; CIHI-DAD, Canadian Institute for Health Information Discharge Abstract Database; ICES, Institute for Clinical Evaluative Sciences; IQR, interquartile range; NACRS, National Ambulatory Care Reporting System;; OHIP, Ontario Health Insurance Plan; RPDB, Registered Persons Database; SDS, Same Day Surgery

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Introduction

Every year, over 27 000 individuals worldwide choose to undergo living kidney donation to help someone in need (1). Knowledge of the long-term outcomes of living kidney donors is required to maintain public trust in the transplantation system, inform the choices of potential donors and recipients, and guide the follow-up care necessary to maintain optimal long-term health (2).

One outcome that remains poorly understood in past living kidney donors is the subsequent development of kidney stones. In September 2012, we performed a detailed search of bibliographic databases (PubMed, Google Scholar) and found only a few reports of living kidney donors being treated for kidney stones at the time of nephrectomy (3–6). However, these studies did not report the rate or

long-term risk of kidney stones in this unique population. We expanded the search to include kidney stones in those with a solitary kidney for any reason and again found only literature discussing the management of the stone at the time of its occurrence (7).

In the general population, kidney stones are common with an estimated lifetime risk of 10–15% (8–10). Most stones are small and pass through the urinary tract spontaneously within 4 weeks of initial symptoms (11). However, some stones may require surgical intervention including shockwave lithotripsy, ureteroscopy or percutaneous nephrolithotomy. There is no reason to suspect that living kidney donors would have a higher risk of kidney stones than members of the general population. Yet, a kidney stone in an individual with a solitary kidney can potentially obstruct the ureter, leading to acute renal failure, and may result in urgent hospital attention and even surgical intervention. This is also a concern because kidney stones can result in a decline in renal function, and this risk may be even higher in donors compared to nondonors (12,13). We conducted this matched retrospective cohort study to determine if living kidney donors compared to healthy nondonors have a higher risk of: (i) kidney stones with surgical intervention, and (ii) hospital encounters for kidney stones.

Methods

Design and setting

We conducted a population-based matched retrospective cohort study using Ontario's healthcare databases held at the Institute for Clinical Evaluative Sciences (ICES). The province of Ontario, Canada, currently has approximately 13 million residents who have universal access to hospital care and physician services (14). We conducted this study based on a prespecified protocol that was approved by the research ethics board at the Sunnybrook Health Sciences Centre (Toronto, Ontario, Canada). The reporting of this study follows guidelines set out for observational studies (Appendix A) (15).

Data sources

We ascertained baseline characteristics, covariate information and outcome data from the records in six databases. Trillium Gift of Life Network is Ontario's central organ and tissue donation agency, and collects information on living kidney donors in the province at the time of kidney donation. We used the Trillium database to identify all adult living kidney donors who had donated between 1992 and 2009 at one of the five major transplant centers in Ontario. We then manually reviewed each of the predonation medical charts of over 2000 living kidney donors to ensure accuracy of the information in the Trillium database to identify living kidney donors. The Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD), Same Day Surgery (SDS) and National Ambulatory Care Reporting System (NACRS) databases have demographic, diagnostic and procedural information for all inpatient, outpatient and emergency department visits. The Ontario Health Insurance Plan (OHIP) database contains information on inpatient, outpatient and laboratory services based on billing claims from Ontario physicians. We used OHIP diagnostic codes to identify baseline conditions and procedural codes to identify surgical interventions for kidney stones. The Registered Persons Database (RPDB) contains demographic information on Ontario residents including their sex, date of birth, postal code and vital status. These databases have been used extensively to research health outcomes and health services including outcomes of living kidney donors (16–21). These databases were complete for variables used in this study.

Population

Donors: We included all living kidney donors who were permanent residents of Ontario and donated between July 1, 1992 and March 31, 2009 at any of the five major transplant centers in Ontario. The date of nephrectomy served as the start date for follow-up and was designated the index date.

Healthy nondonors: Choosing the best type of nondonors to whom donors can be compared is central to any study of relative risks associated with nephrectomy (22). Donors undergo a detailed selection process and are inherently healthier than the general adult population. We used techniques of restriction and matching to identify the healthiest segment of the general population allowing us to create our nondonor cohort. We randomly assigned an index date to the entire adult general population according to the distribution of index dates in donors. We then identified comorbidities and measures of access to healthcare from the beginning of available records (July 1, 1991) to the index date. This provided an average of 11 years of medical records for baseline assessment, with 99% of individuals having at least 2 years of baseline data for review. Among the general population we excluded any adult with any medical condition before the index date that could preclude donation. This included diagnostic, procedural or hospital visit codes for any genitourinary disease, diabetes, hypertension, cancer, cardiovascular disease, pulmonary disease, liver disease, rheumatologic conditions or chronic infections. We excluded anyone with evidence of nephrectomy, renal biopsy or nephrology consultation. We also excluded individuals with evidence of either frequent physician visits (more than four visits in the previous 2 years) or infrequent physician visits (less than one visit in the previous 2 years), given that Ontario has a shortage of physicians and to ensure that nondonors had evidence of access to routine healthcare). From a total of 17 792 616 adult Ontarians during the period of interest, our selection process resulted in the exclusion of 92% of adults, leaving 1 434 439 individuals available for matching.

Matching: Historically, a history of kidney stones (symptomatic or seen on imaging) precluded an individual from becoming a living kidney donor. More recently, centers have accepted individuals with small unilateral stones as living kidney donors, and data are needed to guide this practice. However, in this study, before matching we excluded 13 donors and 4420 healthy nondonors who had evidence of a kidney stone before their index date. We did this to ensure we assessed *de novo* kidney stones in follow-up. Also there were too few donors ($n = 13$) to meaningfully look at outcomes for those with a predonation history of kidney stones. From the remaining adults in the general population we matched 10 nondonors to each donor. We matched on age (within 2 years), sex, index date (within 6 months), rural (population $<10\,000$) or urban residence and income (five categories representing average neighborhood income on the index date).

Outcomes

The primary outcome was evidence of a kidney stone with surgical intervention (i.e. shockwave lithotripsy, ureteroscopy or percutaneous nephrolithotomy; see Appendix B for codes used to define this outcome; these codes are listed in claims that result in surgeon reimbursement, with expected high sensitivity and positive predictive value as shown with other service payment codes (23)). The secondary outcome was a hospital encounter with kidney stone (emergency room or hospital admission as recorded in our data sources, Appendix B; similar codes have a high positive predictive value [95.9%] but a low expected sensitivity underestimating the true number of events (24)).

All participants were followed up from index date until: (i) death, (ii) emigration from the province or (iii) the end of study period (March 31, 2012). Of the individuals who reached the end of the study, those whose most recent healthcare encounter was more than 3 years before the end of study were classified as having emigrated from the province. These individuals were censored at 1 year following their last healthcare encounter.

Statistical analysis

We assessed differences in baseline characteristics between donors and matched nondonors using standardized differences (25). This metric describes differences between group means relative to the pooled standard deviation with differences >10% reflecting the potential for meaningful imbalance (25). We used a negative binomial model stratified on matched sets to estimate the rate ratio and 95% confidence interval (CI). This model also accounts for the possibility of a person having more than one stone event in follow-up (defined by events separated by at least 90 days). We repeated the primary analysis in three prespecified subgroups defined by age (≤40 vs. >40 at index date), sex and index date (1992–2001 [median follow-up 13.3 years, interquartile range (IQR) 11.4–15.8] vs. 2002–2009 [median follow-up 5.9 years, IQR 4.3–7.8]). We examined whether subgroup-specific rate ratios differed among subgroups using a series of pair-wise standard *z*-tests. We repeated the primary analysis using Cox proportional-hazards regression stratified on matched sets to examine the first stone event in follow-up for both the primary and secondary outcomes. We examined the characteristics associated with stone events separately in donors and nondonors using negative binomial regression models. All analyses were performed at ICES with SAS software version 9.2 (SAS Institute Inc., Cary, NC).

Results

Baseline characteristics

Table 1 shows the baseline characteristics of the selected 2019 donors and 20 190 matched nondonors. Donors and nondonors had similar baseline characteristics. The median age was 43 years (IQR 34–50), and 60% were women. As expected, donors had more physician visits in the year before the index data than nondonors. These visits are a necessary part of the donor evaluation process. Other characteristics of the donors, including relationship to the recipient, predonation kidney function and the type of procedure used to remove the kidney, are reported elsewhere (17).

Table 1: Characteristics of donors and healthy nondonors at the time of cohort entry

	Donors (n = 2 019)	Nondonors (n = 20 190)
Age, years	43 (34–50)	43 (34–50)
Women	1 213 (60%)	12 130 (60%)
Rural town	270 (13%)	2 700 (13%)
Income quintile		
Lowest	308 (15%)	3 080 (15%)
Middle	423 (21%)	4 230 (21%)
Highest	463 (23%)	4 630 (23%)
Physician visits in prior year[1]	11 (8–15)	1 (0–2)
Year of cohort entry		
1992–1997	391 (19%)	3 915 (19%)
1998–2003	729 (36%)	7 285 (36%)
2004–2009	899 (45%)	8 990 (45%)

Data presented as median (interquartile range) or as number (percent). The time of cohort entry is also referred to as the index date. This was the date of nephrectomy in donors and was randomly assigned to nondonors to establish the time follow-up began.

[1]Indicates a standardized difference between donors and nondonors >10%. Standardized differences are less sensitive to sample size than traditional hypothesis tests. They provide a measure of the difference between groups divided by the pooled standard deviation; a value >10% is interpreted as a meaningful difference between the groups. As expected, donors had more physician visits in the year prior to index date compared to nondonors, as such visits are a necessary part of the donor evaluation process.

The median length of follow-up was 8.4 years (8.8 years in donors, 8.4 years in nondonors, maximum 19.7 years). A total of 856 donors and 8128 nondonors had over 10 years of follow-up. The median age at the time of last follow-up for the entire cohort was 52 years (IQR 44–60). Of the 22 209 individuals (2019 donors, 20 190 nondonors), 20 084 (90.4%) reached the end-of-study follow-up (March 31, 2012), 1499 (6.7%) were censored at emigration from the province, 480 (2.2%) were censored at the time of death and the remainder received at least one intervention for kidney stones. Total person-years of follow-up were 204 199 (19 118 donors, 185 081 nondonors).

Outcomes

The main outcomes are presented in Table 2 and Figure 1A and B. There were 195 events of kidney stones with surgical intervention (16 in donors, 179 in nondonors). The rate of this event was no different in donors compared to nondonors (8.3 vs. 9.7 events per 10 000 person-years; rate ratio, 0.85; 95% CI 0.47–1.53). There were a total of 323 events of hospital encounters for kidney stones (23 in donors, 300 in nondonors) recorded in our data sources. The rate of this event was no different in donors compared to nondonors (12.1 vs. 16.1 events per 10 000 person-years; rate ratio 0.75; 95% CI 0.45–1.24). The results for both outcomes were the same when we assessed the time to first event (kidney stone with surgical intervention: hazard ratio 1.04, 95% CI 0.60–1.80; hospital encounter for kidney stone: hazard ratio 0.81, 95% CI 0.51–1.30; see Figure 1A and B for Kaplan–Meier curves).

Subgroup analyses are shown in Figure 2A and B. Older age at study enrollment, sex and earlier date of enrollment (longer follow-up) did not influence the association between living kidney donation and risk of kidney stones with surgical intervention (*p*-value for interaction ranged from 0.40 to 0.80). Subgroup results were similar for the secondary outcome of hospital encounters of kidney stones, with one exception: the rate ratio between living donation and outcome was lower in men compared to women. In the subgroup of men, donors had a lower (not higher) risk of the outcome than nondonors.

Table 2: Primary and secondary outcome events among donors and nondonors

	Kidney stones with surgical intervention		Hospital encounter for kidney stones	
	Donors (n = 2 019)	Nondonors (n = 20 190)	Donors (n = 2 019)	Nondonors (n = 20 190)
Median follow-up, years (IQR)	8.8 (5.6–12.9)	8.4 (5.3–12.6)	8.8 (5.6–12.9)	8.4 (5.3–12.6)
Range follow-up, years (min, max)	0.55, 19.7	0.34, 19.7	0.55, 19.7	0.34, 19.7
Total follow-up, person-years	19 118	185 080	19 118	185 080
No. (%) of events				
0	2 005 (99%)	20 058 (99%)	2 000 (99%)	19 965 (99%)
1	12 (0.6%)	105 (0.5%)	15 (0.7%)	182 (0.9%)
2	≤5[1]	12 (0.1%)	≤5[1]	23 (0.1%)
≥3	≤5[1]	15 (0.1%)	≤5[1]	20 (0.1%)
No. of events per 10 000 person-years	8.3	9.7	12.1	16.1
Model based rate ratio[2]	0.85 (0.47–1.53)	1.00 (reference)	0.75 (0.45–1.24)	1.00 (reference)

Data presented as number (percentage) or value (95% confidence interval) unless otherwise specified. IQR, interquartile range.
[1]Cell counts ≤5 have been suppressed for reasons of privacy.
[2]*p*-Values = 0.58 and 0.27, respectively.

When donors and nondonors were examined separately, the 95% CIs of risk factor rate ratios were more precise in nondonors (expected as there were 10 times as many nondonors as donors). In donors, no significant associations were observed between various risk factors (age, sex, rural residence, income quintile and year of index date) and the primary or secondary outcomes (Table 3). In nondonors, older age and male sex were associated with an increased risk of kidney stones with surgical intervention and hospital encounters for kidney stones.

Discussion

We hypothesized that a donor with one kidney might receive surgical intervention for a stone more frequently than a nondonor with two kidneys presenting with a stone. Similarly, we expected that donors with stones might be more likely to present to hospital. In this study, we found that the rates of (i) kidney stones with surgical intervention and (ii) hospital encounters for kidney stones were no different between donors and nondonors. Most donors (99.3%) did not experience a kidney stone intervention or hospital encounter over a median follow-up of 8.8 years (maximum follow-up 19.7 years). There was also no evidence that donation increased the risk of either kidney stone event when examined in subgroups defined by age, sex or index date (length of follow-up). The Kaplan–Meier curves after 10 years of follow-up did not suggest any higher risk of stone events in donors compared to nondonors.

Our study has a number of strengths. To the best of our knowledge, this is the first study to report on a donor's long-term risk of kidney stones after living kidney donation. The universal healthcare benefits available to all Ontario residents allowed us to study all living donation activity in the largest province of Canada, minimizing both information and selection biases. We ensured the accuracy of donor data through the manual review of over 2000 predonation medical charts. We matched donors and nondonors on risk factors associated with the stone events such as older age and male sex (8,10). Loss to follow-up, which is a concern in most long-term donor studies, was minimal in our study with <7% censored in follow-up at the time of emigration from the province.

Our study does have some limitations. The retrospective nature of the study prevented us from controlling the assessment of the exposure and outcome, meaning we relied on administrative data collected for nonresearch purposes. The use of administrative data limited us with regard to: the types of data and variables that were available to us, how we ascertained our outcomes and our inclusion and exclusion criteria for the selection of the donor and healthy nondonor cohorts. Our administrative data sources also prevented us from addressing some potential confounders. We had no baseline or follow-up information in our data sources on dietary risk factors for stones such as water intake, salt consumption and calcium supplementation (26,27). We did not take other known risk factors for kidney stones including race and body mass index into account because they could not be accurately ascertained using our data sources. However, given that 75% of the Ontario population is Caucasian, we expect our results to generalize well to Caucasian donors but not to other races. Previous literature has observed a higher prevalence of kidney stones in American Caucasians when compared to African Americans and Hispanics in the United States (28). Additionally, given Ontario's relatively uniform climate, the observed rates would not be comparable to regions within the kidney stone belt that are typically higher because of elevated temperatures. Unlike the donors, most nondonors did not have routine imaging to rule out the presence of baseline asymptomatic kidney stones. Residual confounding, which is inherent to any observational study, may affect

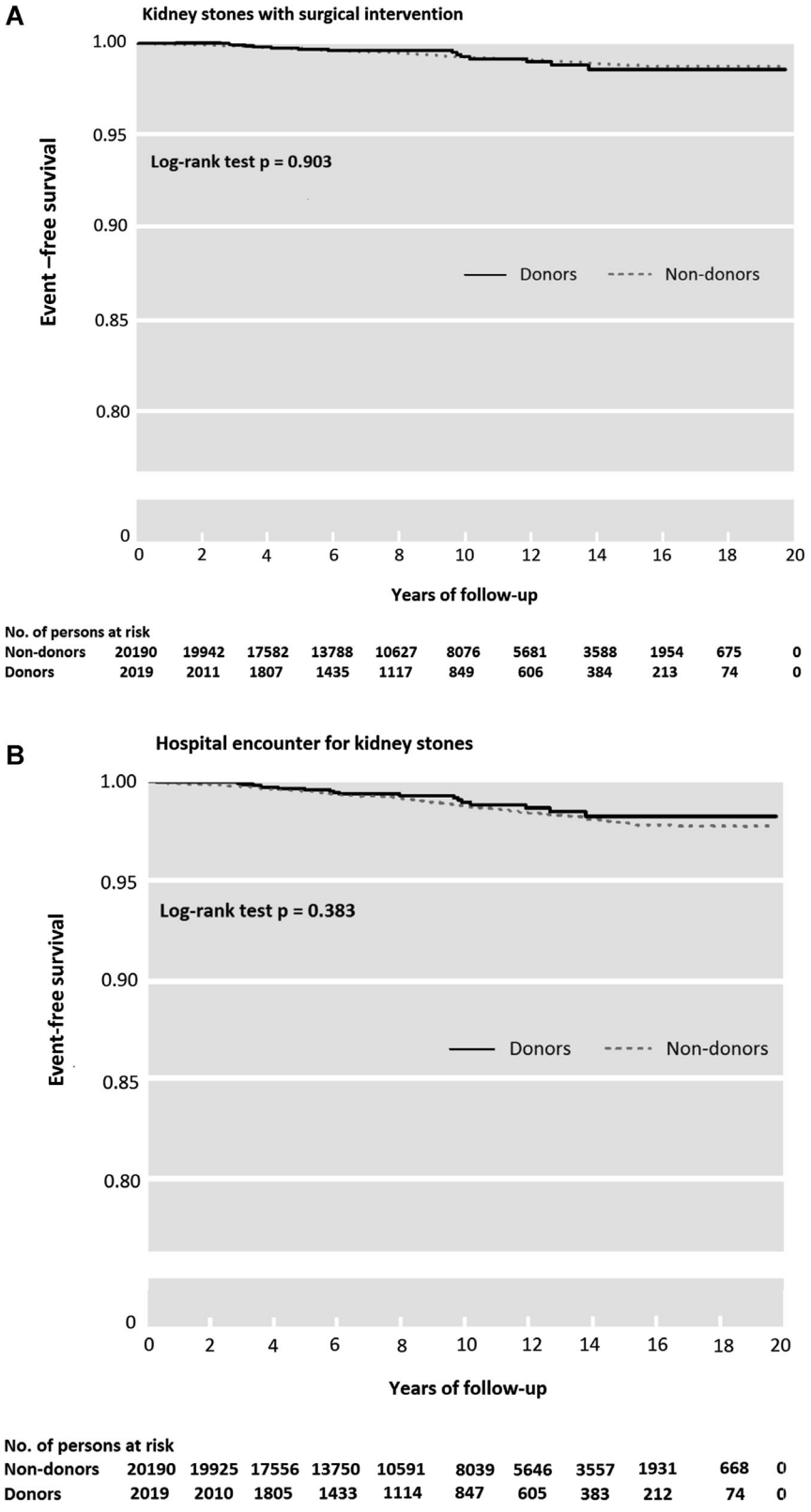

Figure 1: (A) Kaplan–Meier curve of time to first kidney stone with surgical intervention. (B) Kaplan–Meier curve of time to first hospital encounter for a kidney stone.

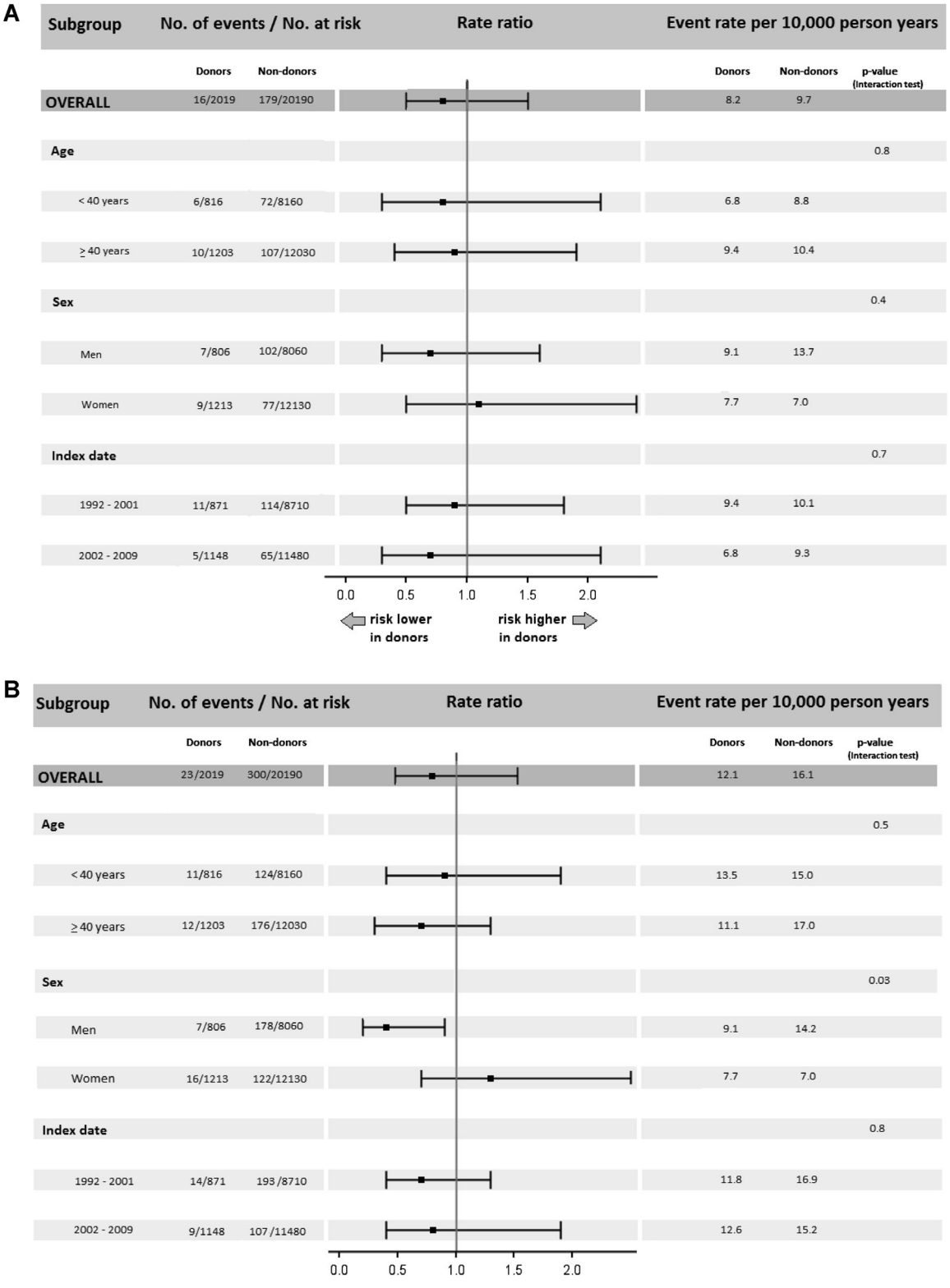

Figure 2: (A) Influence of age, sex and index date (length of follow-up) on primary outcome of kidney stones with surgical intervention. (B) Influence of age, sex and index date (length of follow-up) on secondary outcome of hospital encounters for kidney stones. Individuals with index date of 1992–2001 had median follow-up of 13.3 years, interquartile range (IQR) 11.7–16.0; individuals with index date of 2002–2009 had median follow-up of 5.9 years, IQR 4.3–7.8.

Table 3: Risk factors for kidney stones in donor and nondonors when each group was analyzed separately

	Donors	Nondonors
Kidney stones with surgical intervention		
Older age (per 5 years)	1.15 (0.90–1.50)	1.12 (1.02–1.23)
Women (vs. men)	0.92 (0.30–2.85)	0.49 (0.34–0.73)
Rural residence (vs. urban residence)	2.49 (0.29–21.65)	1.04 (0.59–1.84)
Higher income quintile	0.87 (0.59–1.29)	0.95 (0.82–1.10)
More recent year of index date	0.97 (0.85–1.11)	0.99 (0.94–1.04)
Hospital encounters for kidney stones		
Older age (per 5 years)	1.02 (0.82–1.26)	1.08 (1.01–1.15)
Women (vs. men)	1.60 (0.56–4.58)	0.46 (0.34–0.61)
Rural residence (vs. urban residence)	1.74 (0.33–9.06)	1.08 (0.70–1.67)
Higher income quintile	1.00 (0.70–1.43)	0.92 (0.82–1.02)
More recent year of index date	1.01 (0.91–1.13)	0.98 (0.95–1.02)

Separate negative binomial models were created for donors and nondonors. Presented are the rate ratios and 95% confidence intervals.

the association between living kidney donation and the outcome of interest seen in our study. We relied on clinical expertise and knowledge of billing practices to define our outcomes, as the codes were either not validated or partially validated. There are no reliable codes to detect kidney stones that do not present to hospital attention. Also, codes to detect kidney stones presenting to hospital are insensitive and underestimate the true incidence of the event (29). However, this is not the case for kidney stones requiring surgical intervention and we do not anticipate coding inaccuracies in stones presenting to hospital were differential between donors and nondonors (i.e. estimates of relative risk are valid).

While these results are reassuring for the practice of living kidney donation, it is possible that the risk may take longer to manifest. For this reason we will continue to study and follow this cohort. Finally, these results should not be used to justify expansion of donor eligibility to those with risk factors for stones, such as obesity or a prior history of stones (9,10,30). Rather, other studies are needed to establish whether it is safe for such individuals to become donors.

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Disclosure

The authors of this manuscript have conflicts of interest to disclose as described by the *American Journal of Transplantation*. Dr. Amit X. Garg and colleagues received investigator-initiated grants from Astellas and Roche to support a Canadian Institutes of Health Research (CIHR) funded prospective study on living kidney donation.

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Appendix A: Checklist of Recommendations for Reporting of Observational Studies Using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Guidelines

	Item no.	Recommendation	Reported
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction
Methods			
Study design	4	Present key elements of study design early in the paper	Methods
Setting	5	Describe the setting, locations and relevant dates, including periods of recruitment, exposure, follow-up and data collection	Methods
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Methods
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Methods
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders and effect modifiers. Give diagnostic criteria, if applicable	Methods
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods
Bias	9	Describe any efforts to address potential sources of bias	Methods
Study size	10	Explain how the study size was arrived at	Methods
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Methods
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Methods
		(b) Describe any methods used to examine subgroups and interactions	Methods
		(c) Explain how missing data were addressed	Not applicable
		(d) If applicable, explain how loss to follow-up was addressed	Not applicable
		(e) Describe any sensitivity analyses	Not applicable
Results			
Participants	13	(a) Report numbers of individuals at each stage of study—e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed	Results
		(b) Give reasons for nonparticipation at each stage	Results
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14	(a) Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		(c) Summarize follow-up time (e.g. average and total amount)	Table 2
Outcome data	15	Report numbers of outcome events or summary measures over time	Results, Table 2
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g. 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Results, Table 2
		(b) Report category boundaries when continuous variables were categorized	Table 1
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses	Results, Table 3
Discussion			
Key results	18	Summarize key results with reference to study objectives	Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion
Generalizability	21	Discuss the generalizability (external validity) of the study results	Discussion
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Acknowledgments

Appendix B: Kidney Stones Codes

Kidney stones with surgical intervention		
OHIP fee codes	CCI	CCP
Z630 (extracorporeal shock wave lithotripsy)	Stone destruction	67.03 (percutaneous nephrostomy without fragmentation)
E773 (stent with stone)	1pe59 (renal pelvic, ureteropelvic junction)	
Z629 (perinephrium percutaneous nephrostomy)		67.04 (percutaneous nephrostomy with fragmentation)
Z623 (kidney, perinephrium insertion of stent)	1pg59 (ureter, ureterovesical junction)	
J046 (diagnostic radiology, percutaneous nephrostomy)		68.95 (ureteroscopy)
Z624 (kidney perinephrium dilation of tract)	1pm59 (urinary stoma, cystomy, nephrostomy, ureterostomy)	
Z627 (kidney-removal of renal calculi)		71.96 (ultrasonic stone fragmentation)
E759 (disintegrated by US. add to removal renal calculi)	1pv59 (surgically created urinary tract)	
E772 (percut rem. staghorn calc. renal pelvis, add)		
Z628 (ureteroscopy/cystoscopy above intramural ureter)		
E760 (ureter-removal of stone add cysto and ureteroscopy)	Stone extraction	
E761 (ureter-if disintegrat. by US add to cysto and ureterosc.)	1pe57 (renal pelvic, ureteropelvic junction)	
Z627 (kidney-removal of renal calculi)		
S430 (kidney-litholapaxy-staghorn calculus, incl. X-ray)	1pg57 (ureter, ureterovesical junction)	
S405 (nephrolithotomy)		
S408 (pyelolithotomy)	1pm57 (urinary stoma, cystomy, nephrostomy, ureterostomy)	
S445 (ureterotomy removal of calculus upper 2/3)		
S446 (ureterotomy removal of calculus lower 1/3)	1pv57 (surgically created urinary tract)	
Nonsurgical hospital encounters for kidney stones		
ICD-9: 592, 592.0, 592.1, 592.9 ICD-10: N20		

CCI, Canadian Classification of Health Interventions; CCP, Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures.