Medical Suitability and Willingness for Living Kidney Donation Among Older Adults

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Rationale & Objective: The benefits of kidney transplantation compared with treatment with dialysis, including in older adults, are primarily limited by the number of donated kidneys. We studied the potential to expand the use of older living kidney donors.

Study Design: Secondary analysis of the Berlin Initiative Study, a population-based cohort.

Setting & Participants: 2,069 adults aged ≥70 years in Germany.

Exposure: Age and sex.

Outcome: Suitability for living donation assessed by the absence of kidney-related exclusions for donation including albuminuria and low estimated glomerular filtration rate (eGFR) as well as absence of other medical exclusions. Willingness for living and deceased kidney donation assessed by participant survey.

Analytical Approach: Descriptive analysis.

Results: Among the 2,069 participants (median age 80 years, 53% women, median eGFR 63 mL/min/1.73 m^2), 93% had ≥1 medical contraindication for living donation at study entry unrelated to eGFR or albuminuria. Using 2 published eGFR and albuminuria thresholds for donor acceptance, 38% to 54% of participants had kidney-related exclusions for donation. Among the 5% to 6% of participants with neither medical nor kidney-related exclusions for living donation at baseline, 11% to 12% remained suitable for donation during 8 years of follow-up. Willingness for living or deceased donation was high (73% and 60%, respectively).

Limitations: GFR was not measured, and medical exclusions unrelated to eGFR and albuminuria were assessed using a cohort database complemented by claims data.

Conclusions: One in 20 older adults were potentially suitable for living kidney donation, and willingness for living donation was high. Further studies are warranted to define the feasibility of expanding living kidney donation among older adults.

Visual Abstract online

Complete author and article information provided before references.

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Am J Kidney Dis. 85(2):205-214. Published online October 1, 2024.

doi: 10.1053/j.ajkd.2024.07.010

The incidence of kidney failure is increasing most rapidly among older patients ≥65 years of age.[1,2] The benefits of transplantation including longer survival and better quality of life compared with treatment with dialysis extend to the highly selected group of older patients with kidney failure who undergo transplantation.[3-6] However, transplantation remains infrequent among older candidates in part because the waiting time for a deceased donor kidney often exceeds the patient's life expectancy on dialysis or the patients develop transplant contraindications during their time on the wait-list.[7] Therefore, for many older patients a living donor transplant is often the only option for transplantation.

Living donor transplantation also provides medical advantages for older recipients, including elective surgery and early allograft function, that lead to a lower risk of perioperative mortality compared with deceased donor transplantation.[3] However, few older patients receive living donor transplants. Between 2015 and 2017 in the United States, only 13.8% of transplant candidates aged 65-74 years received a living donor transplant within 3 years of being on the wait-list.[1] The factors contributing to the low use of living donor transplantation in older patients include conscious and unconscious bias by health care providers related to concern about poor outcomes, health provider and patient concerns about acceptance of younger donors for older patients, and uncertainty about the suitability of older persons to donate and receive organs due to the observational nature of the data about donation and transplantation among older adults.[8] Expanding living donation among older adults may help meet the need for transplantation especially among older patients.

Allograft survival in transplant recipients from living donors aged ≥65 years is excellent and comparable to that of similar aged transplant recipients who undergo transplantation from deceased donors younger than 55 years.[9,10] Because information about the long-term safety of living donors is limited to the first 2 decades after donation, there is increased interest in the use of older living donors based on the rationale that older donors have fewer life years at risk to develop postdonation health concerns.[11,12] However, donors aged ≥65 years still account for only 9% to 11% of living donors in the United Kingdom and Germany; only 2% of donors in the United Kingdom were ≥70 years.[13,14] In the United States, living donors aged ≥65 years nearly tripled between 2012 and 2022, but still accounted for <1% of all living donors.[15]

Older living donors may have a higher risk of minor postoperative complications compared with younger

PLAIN-LANGUAGE SUMMARY

Although potentially beneficial, kidney transplantation remains infrequent among older adults aged ≥70 years with kidney failure. Study evaluated the potential to increase living kidney donation among older adults, including their medical suitability as well as willingness to donate. Among 2,069 community-dwelling older adults (median age 80 years), 5% to 6% had no exclusion to donation. Among these individuals, 11% to 12% remained suitable for donation during 8 years of follow-up. Most exclusions were not related to eGFR and albuminuria. Willingness to living donation was high (73%). These findings highlight the potential benefits from expanding the pool of transplantable kidneys through the use of living donation in older adults.

donors.[16] They may also experience a greater postdonation decline in glomerular filtration rate (GFR) than younger donors.[16-18] Compared with healthy nondonor controls, older living donors have a similar or lower risk of death and cardiovascular disease and an absolute risk of kidney failure after 15 years that is <1%.[19,20]

Most studies define old living donors when the age at donation is 60 or 65 years, and only a few studies report living donors aged ≥70 years.[21,22] Existing guidelines do not define an upper age limit for living donation, and limited studies suggest support for donation among older adults.[23-25] To our knowledge, no study has examined the potential to increase living donation among older adults. It is known that multimorbidity increases with age, and a recent meta-analysis found that multimorbidity occurs in two-thirds of persons aged ≥74 years.[26] Therefore, a high prevalence of medical comorbidities may limit living donation in older adults. The purpose of this study is to examine the potential to increase living kidney donation among older adults, including medical suitability and willingness to donate.

Methods

The study protocol was approved by our hospital ethics committee (Charité–Universitätsmedizin Berlin, Germany; EA2/009/08) and is in accordance with the Helsinki declaration. The research is consistent with the principles outlined in the Declaration of Istanbul on Organ Trafficking and Transplant Tourism.

Data Source

This is an analysis of data collected in the Berlin Initiative Study (BIS), a population-based prospective cohort study initiated in November 2009 in Berlin, Germany, to evaluate the course of kidney function in older people.[27,28] The BIS was supported by the Allgemeine Ortskrankenkasse–Nordost (AOK), the largest health insurance provider for older adults in Berlin. The criteria for study inclusion were AOK membership and age ≥70 years. Exclusion criteria included treatment with dialysis, kidney transplantation, or need for high level of nursing care at baseline (Fig S1). All participants gave written informed consent. The BIS has been shown to be a representative sample of older members of the AOK.[28] The participants were followed biennially until November 2019. Study visits included a standardized face-to-face questionnaire with information assessed on sociodemographic characteristics, comorbidities, medication, and anthropometric measures as well as blood and urine samples. Linkage to the individual claims data of the AOK enabled complementary and detailed phenotyping. Detailed information about the design of the BIS is provided in Item S1 and has been described elsewhere.[27,28] All BIS participants were included in the study.

Suitability for Donation

We applied the Kidney Disease: Improving Global Outcomes (KDIGO) and the British Transplantation Society (BTS) guidelines for living kidney donation.[24,25] Medical (ie, non-kidney-related) exclusions for living kidney donation included body mass index ≥ 30 kg/m^2, use of ≥3 antihypertensive drugs, diabetes, current smoking, HIV or hepatitis B or C virus infections, history of cancer, heart failure, coronary artery disease, history of stroke, peripheral artery disease, cirrhosis, chronic obstructive pulmonary disease, and dementia (details on variable definitions and *International Classification of Diseases, Tenth Revision* [ICD-10], code selection criteria are shown in Item S1).[24,25]

Kidney suitability for donation was assessed in accordance with the KDIGO and BTS guidelines.[24,25] The European Kidney Function Consortium (EKFC) equation based on serum creatinine and cystatin C was used to estimate GFR, which has high precision in people aged over 70 years.[29] With regard to predonation kidney function, the KDIGO guidelines recommend a predonation measured or estimated GFR (eGFR) using serum creatinine and cystatin C of at least 90 mL/min/1.73 m^2 as suitable for donation irrespective of donor age and sex; donation is contraindicated when GFR is below 60 mL/min/1.73 m^2, and donation may be considered between 60 and 90 mL/min/1.73 m^2.[24] The BTS defines age- and sex-specific predonation GFR thresholds for donation.[25] However, because no participants presented with an eGFR ≥ 90 mL/min/1.73 m^2 at baseline, we defined a suitable predonation eGFR using the KDIGO lower bound of 60 mL/min/1.73 m^2 (KDIGO eGFR threshold) as well as the BTS age- and sex-specific cutoffs (BTS eGFR threshold, detailed in Table S1).

With regard to albuminuria, the KDIGO and BTS guidelines suggest variable thresholds. Both guidelines suggest a urinary albumin-creatinine ratio (UACR) of <30 mg/g for donation (with adaptation due to conversion from mg/mmol to mg/g).[24,25] The KDIGO and BTS guidelines suggest a UACR of >100 mg/g

and >300 mg/g as a contraindication for donation, respectively.[24,25] For study purposes, we examined both a low threshold of 30 mg/g as well as 2 high thresholds of 100 mg/g (KDIGO UACR threshold) and 300 mg/g (BTS UACR threshold).

Support for Donation

Donation willingness was assessed by 3 self-reported survey questions, at the first follow-up visit. Participants were asked if they agreed or disagreed with the following statements: (1) "I would agree to have a kidney removed for a close family member or my spouse/life partner for the purpose of a living donation if they needed dialysis," (2) "Should I be considered an organ donor in the event of my death, I could imagine donating my kidney for transplantation to someone on the waiting list," and (3) "I would agree to accept a live kidney donation from my child if I needed dialysis and if my child could donate from a medical point of view and would be willing to do so."

Statistical Analyses

Participant characteristics were described using descriptive statistics. In a first step, the prevalence of nonkidney exclusions and the number of such exclusions per patient, as well as the prevalence of kidney exclusions to donation using combinations of eGFR and UACR thresholds, were described at baseline. We then assessed the prevalence of suitability for donation by combining the nonkidney and kidney exclusions. Prevalence of exclusion and suitability for donation were stratified according to age (<80 and ≥80 years) and sex. Sociodemographic characteristics between suitable and unsuitable donors were compared.

Among participants suitable for donation at baseline, we determined changes in suitability during follow-up in the BIS. The proportion of participants who remained suitable, developed nonkidney or kidney exclusions to donation, and died or were lost to follow-up were described. Finally, we studied the association between the agreement with the statements related to kidney donation and several sociodemographic and medical characteristics using univariate logistic regression models. We also provided the percentages of suitability to donate a kidney to a relative at the first follow-up visit as a function of participant willingness to donate.

Missing values were taken into account by computing multiple imputations using multiple chained equations, assuming that the data were missing at random. All missing data were imputed, except for missing responses to the survey questions about support for kidney donation. For each missing value, 20 imputations were computed, leading to 20 different datasets, using the available information for each noncomposite variable included in the analyses and each participant. The results of the 20 datasets were pooled according to Rubin's rules.[30] Statistical analyses were performed using R software (version 4.1.2; R Foundation). All statistical analysis were performed in an exploratory manner.

Results

At baseline, the median age was 80.4 years, and 1,088 participants (53%) were women. The median eGFR was 63 mL/min/1.73 m^2, and median UACR was 11 mg/g. No participant had undergone nephrectomy. The participants' characteristics are presented in Table 1.

Nonkidney and Kidney-related Medical Exclusions to Donation at Baseline

The prevalence of nonkidney exclusions to donation at the baseline BIS visit are shown in Figure 1. At least 1 exclusion to donation was present in 1,915 (93%) of participants and ranged from 86% in women aged 70-79 years to 97% in men aged ≥80 years. The number of exclusions per participant was 1 for 297 (14%) participants; 2 for 410 (20%); 3 for 418 (20%); 4 for 370 (18%); and 5 or more for 420 (20%) participants. Coronary artery disease, heart failure, and cancer were the most frequent exclusions. Most exclusions had a higher prevalence in men and in participants aged ≥80 years.

The prevalence of kidney exclusions to donation at study entry are shown in Figure 2. Applying the BTS eGFR and UACR thresholds, 38% of participants had kidney exclusions to donation. When applying the KDIGO eGFR threshold and the UACR > 30 mg/g threshold, 54% of participants had kidney exclusions to donation. When applying both the KDIGO and BTS eGFR thresholds, and the UACR > 30 mg/g threshold, 56% of participants had kidney exclusions to donation.

Initial suitability for donation assessed by the absence of nonkidney and kidney-related exclusions to donation is shown in Figure 3. Suitability for donation ranged from 5% to 6%, depending on the acceptance criteria, and was highest among women aged 70-79 years (ranging from 10% to 13%, depending on the criteria used). A comparison of sociodemographic variables by suitability for donation is shown in Table S2. The participants suitable for donation were younger, more likely to be women, more likely to be married, and less likely to have low educational level and moderate to poor self-rated health as compared with the unsuitable participants. When applying both the KDIGO and BTS eGFR thresholds, the UACR > 30 mg/g threshold, and nonkidney exclusions to donation, 5% of participants were suitable for donation.

Follow-up of Participants Suitable to Living Kidney Donation at Baseline

After 2 years of follow-up, 42% to 46% of participants suitable at baseline were still suitable for donation (Fig 4): 35% to 37% developed at least 1 nonkidney exclusion to donation while 11% to 12% had a decline in kidney function that would exclude them from donation based on the criteria used. After 8 years of follow-up, 11% to 16%

Table 1. Characteristics of the Study Population at Baseline

Variables (Available Data)	BIS (n = 2,069)	Age 70-79 y (n = 1,049)	Age ≥80 y (n = 1,020)
Sociodemographic Variables			
Age, y	79.9 [74.5-85.8]	74.6 [72.5-76.8]	85.9 [82.6-89.1]
Women	1,088 (53%)	586 (56%)	502 (49%)
Married	1,091 (53%)	657 (63%)	434 (43%)
Missing values, n	1	0	1
CASMIN educational level			
Low	1,250 (60%)	661 (63%)	588 (58%)
Middle	413 (20%)	216 (21%)	196 (19%)
High	407 (20%)	171 (16%)	236 (23%)
Missing values, n	9	7	2
Kidney Parameters			
eGFR, mL/min/1.73 m^2	63 [50-72]	70 [61-76]	54 [44-64]
Missing values, n	1	1	0
eGFR categories			
≥90 mL/min/1.73 m^2	0 (0)	0 (0)	0 (0)
60-89 mL/min/1.73 m^2	1,161 (56%)	794 (76%)	367 (36%)
45-59 mL/min/1.73 m^2	560 (27%)	194 (19%)	366 (36%)
30-45 mL/min/1.73 m^2	273 (13%)	49 (5%)	224 (22%)
<30 mL/min/1.73 m^2	75 (3%)	12 (1%)	63 (6%)
Missing values, n	1	1	0
UACR, mg/g	11 [5-31]	8 [4-20]	15 [6-44]
Missing values, n	17	7	10
KDIGO categories for albuminuria			
A1	1,535 (74%)	848 (81%)	686 (67%)
A2	463 (22%)	173 (17%)	289 (28%)
A3	72 (3%)	27 (3%)	44 (4%)
Missing values, n	17	7	10
Comorbidities			
Body-mass index, kg/m^2	27 [25-30]	28 [25-31]	27 [24-29]
Missing values, n	1	1	0
Hypertension	1,636 (79%)	781 (74%)	855 (84%)
Missing values, n	6	6	0
No. of antihypertensive agents	2 [1-3]	1 [0-2]	2 [1-3]
Charlson Comorbidity Index	4 [2-6]	3 [1-5]	4 [2-7]
Missing values, n	17	15	2
No. of drugs per patient	5 [3-7]	4 [2-6]	5 [3-7]
Missing values, n	4	3	1

Values are expressed as absolute (relative) frequencies for categorical variables and median [IQR] for continuous variables. Sums of sample size can slightly differ between variables due to the multiple imputation process. Abbreviations: BIS, Berlin Initiative Study; CASMIN educational level: general and vocational education level defined using the Comparative Analysis of Social Mobility in Industrial Nations scale; eGFR, estimated glomerular filtration rate using the European Kidney Function Consortium equation based on serum creatinine and cystatin C; KDIGO, Kidney Disease, Improving Global Outcomes; UACR, urinary albumin-creatinine ratio.

of initially suitable participants remained suitable for donation depending on the kidney criteria used: 49% to 52% had developed at least 1 nonkidney exclusion to donation, and 6% to 11% had died. None of the participants who were suitable for donation at baseline developed chronic kidney disease (CKD) stage 4 or 5 during follow-up.

Willingness to Donate and Acceptance of Transplantation

Among the 1,699 participants evaluated at the first follow-up visit, 1,674 had available data about willingness to donate a kidney to a relative; 1,673 had information on kidney donation in case of death; and 1,313 had information regarding willingness to receive a kidney from one's child (lower sample size due to the participants without children). Among respondents, 1,223 (73%) agreed to donate a kidney to a relative during life, 1,001 (60%) agreed to donate a kidney to someone on the waiting list in case of death, and 471 (36%) agreed to receive a kidney from a child in the event of kidney failure. The factors associated with agreement to donate or receive a kidney are shown in Table S3. Participants aged ≥80 years were less willing to donate a kidney. Women were less

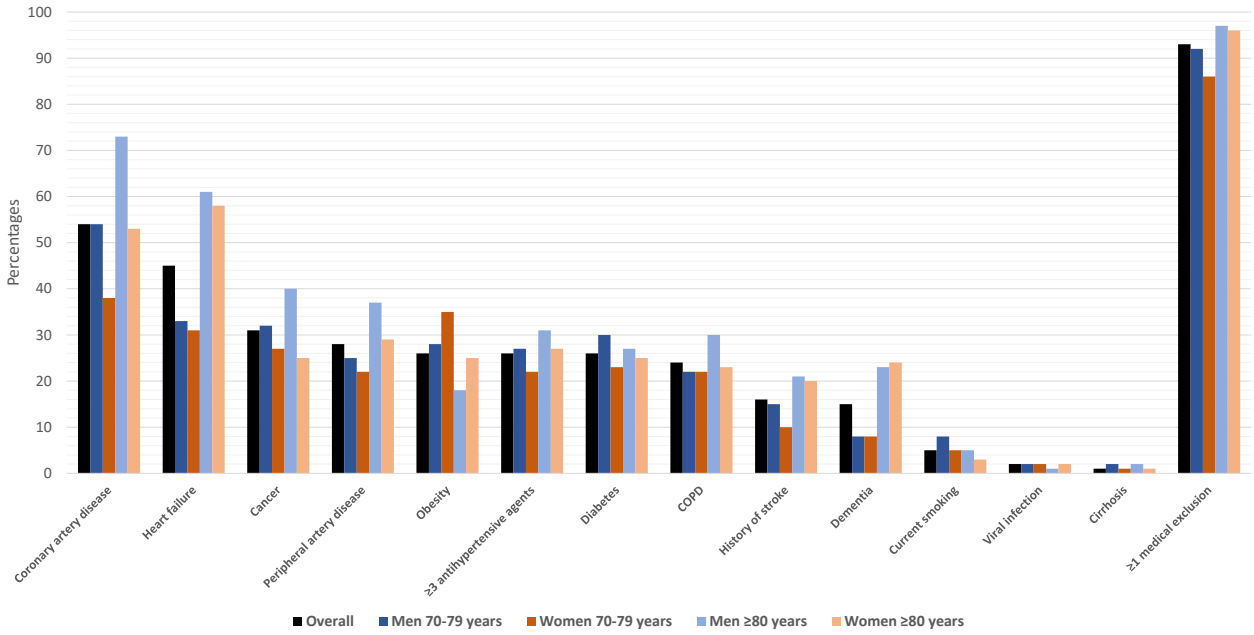

Figure 1. Prevalence of non-kidney-related exclusions to living kidney donation in a cohort of older adults by age and sex at baseline. Abbreviation: COPD, chronic pulmonary obstructive disease.

likely to accept a kidney from a child. Married participants were more likely to donate or receive a kidney. Participants unsuitable for living donation were also less willing to donate a kidney to a relative during life. Among participants suitable to donate, 85% to 87% would agree to donate a kidney to a relative. Suitability for donation at the first follow-up visit according to the willingness to donate a kidney to a relative is shown in Figure S2.

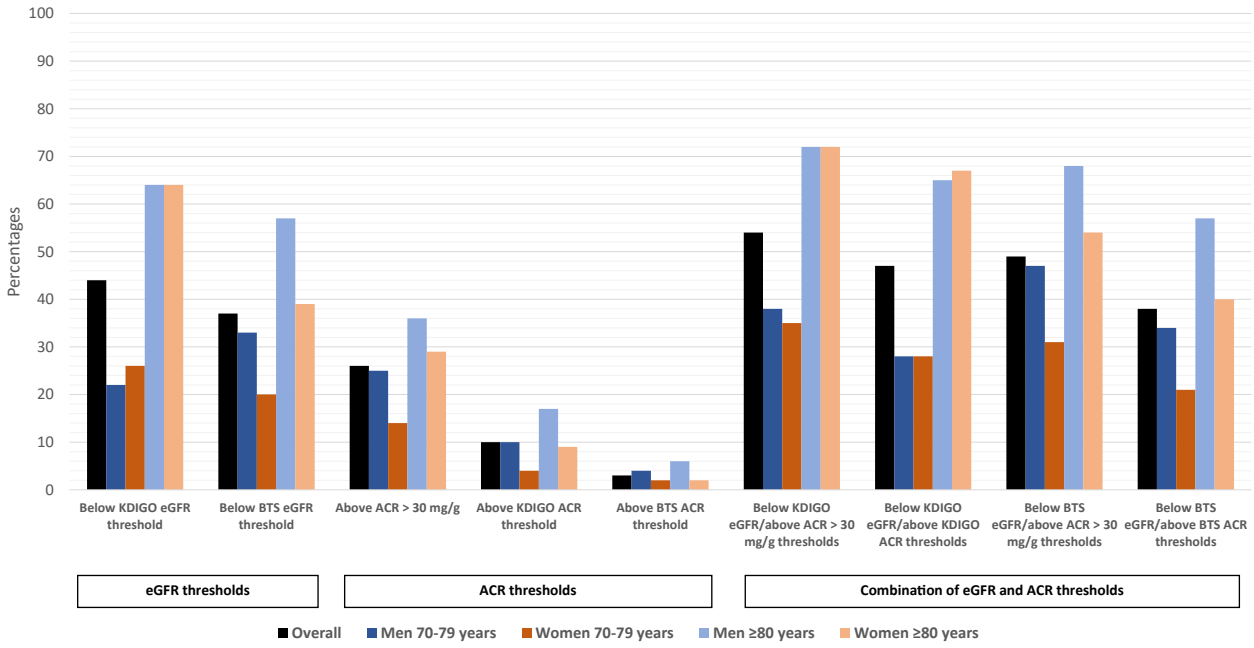

Figure 2. Prevalence of kidney-related exclusions to living kidney donation in a cohort of older adults by age and sex at baseline. KDIGO GFR threshold is 60 mL/min/1.73 m^2; BTS GFR thresholds are age- and sex-specific; KDIGO ACR threshold is 100 mg/g; BTS ACR threshold is 300 mg/g. Abbreviations: ACR, urinary albumin-creatinine ratio; BTS, British Transplantation Society; eGFR: glomerular filtration rate estimated by the European Kidney Function Consortium (EKFC) equation based on serum creatinine and cystatin C; KDIGO, Kidney Disease, Improving Global Outcomes.

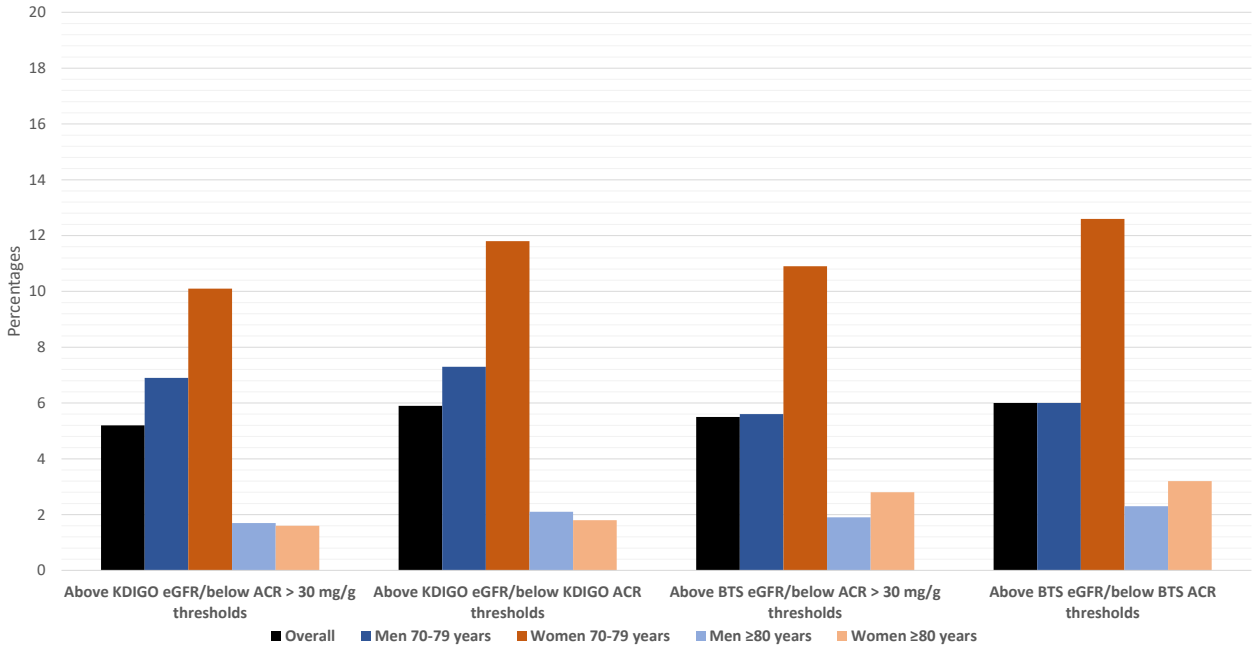

Figure 3. Prevalence of suitability to living kidney donation in a cohort of older adults by age and sex at baseline. KDIGO GFR threshold is 60 mL/min/1.73 m^2; BTS GFR thresholds are age- and sex-specific; KDIGO ACR threshold is 100 mg/g; BTS ACR threshold is 300 mg/g. Abbreviations: ACR, urinary albumin-creatinine ratio; BTS, British Transplantation Society; eGFR, glomerular filtration rate estimated by the European Kidney Function Consortium (EKFC) equation based on serum creatinine and cystatin C; KDIGO, Kidney Disease, Improving Global Outcomes.

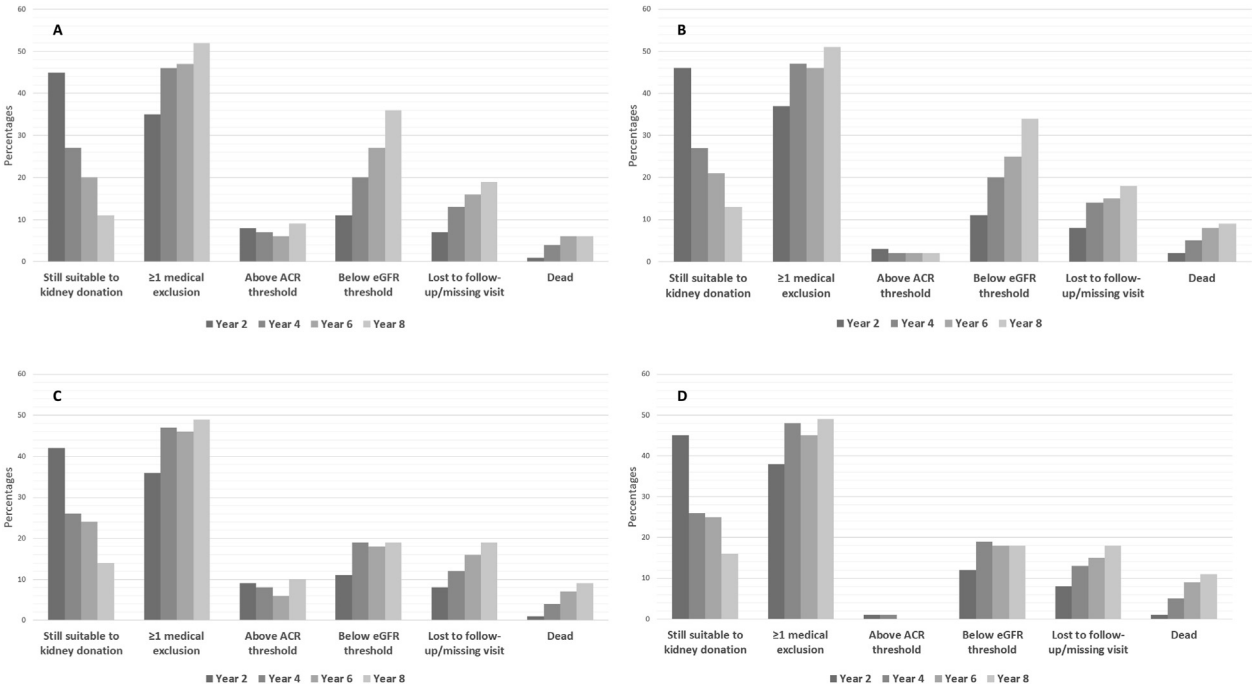

Figure 4. Development of nonkidney and kidney-related exclusions to donation among those initially suitable for donation during follow-up. (A) Below KDIGO eGFR (60 mL/min/1.73 m^2)/above ACR > 30 mg/g thresholds (n = 108). (B) Below KDIGO eGFR (age- and sex-specific eGFR thresholds)/above KDIGO ACR (100 mg/g) thresholds (n = 123). (C) Below BTS eGFR/above BTS ACR (300 mg/g) thresholds (n = 114). (D) Below BTS eGFR/above BTS ACR thresholds (n = 130). Abbreviations: ACR, urinary albumin-creatinine ratio; eGFR: glomerular filtration rate estimated by the European Kidney Function Consortium (EKFC) equation based on serum creatinine and cystatin C; KDIGO, Kidney Disease: Improving Global Outcomes.

Discussion

Novel strategies to increase living kidney donation are desperately needed. Recent publications have highlighted the limited information about the long-term safety of living donors and have prompted interest in shifting living donor practice to increased acceptance of older living donors.[11,12,31,32] We found that for every 100 study participants aged ≥70 years, 5 to 6 would be potentially medically suitable for donation. Fewer than 5% of study participants aged ≥80 years were suitable for living donation, and <10% of men aged 70-79 years were suitable for living donation. By contrast, suitability for living kidney donation ranged from 10% to 13% among women aged 70-79 years. A minority of those initially suitable for donation remained suitable during the 8-year study follow-up period, and there was strong support for living kidney donation.

Our findings should be interpreted in the context of a recent review of 38 studies including potential donors of all ages that reported the proportion of donor candidates who ultimately donated ranged from 8% to 86%, with an average of only 37%.[33] The reasons why potential donors did not donate were variable and included loss of the intended recipient due to illness or death and receipt of a deceased donor transplant. Although the proportion of older adults potentially suitable for donation in our study was low, the findings suggest expanding living donation among older adults may be a feasible strategy to help meet the need for kidney transplantation and thus warrants further study.

Our findings also suggest that a different approach to the current practice of evaluation and follow-up of living donors will likely be required in older adults. The major barrier to donation in our study was the presence of nonkidney medical exclusions for donation by current guidelines. However, some exclusions, including multidrug-requiring hypertension, diabetes, or remote cancer, if well managed, may be compatible with donation. Of note, because a significant proportion of participants had multiple medical exclusions at initial testing, our study's estimates of donation suitability are likely indicative of the challenges of expanding donation in older adults. Transplant programs wanting to evaluate older living donors will likely require robust screening protocols that allow efficient and accurate triage of medically unsuitable candidates. Programs will also need to consider implementation of protocols and access to resources to ensure new medical conditions diagnosed during the donor evaluation process are appropriately evaluated, even for candidates excluded from donation.

Our finding that over half of the study participants who were potentially medically suitable to donate at baseline developed new conditions that would preclude donation during the follow-up period challenges the concept that old donors who are free of comorbid disease at the time of donation are unlikely to subsequently develop significant medical concerns later in life.[12] This finding and the fact that some older donors will have a postdonation GFR of <60 mL/min/1.73 m^2 indicate that older donors may require direct postdonation specialist surveillance and care.[18] Although opinion-based guidelines recommend annual follow-up of living donors, it is unlikely that most transplant programs are directly following previous donors.[24] Although there is increasing recognition of the need for health surveillance and health maintenance after living donation, dedicated postdonation care programs remain an unfunded mandate in most countries.[34,35] Advancing living donation in older adults may help advance the changes in postdonation care paradigms for all donors that many practitioners of living donation have advocated for.[36,37]

In the absence of controlled data, the field of living donation has necessarily relied on observational studies and opinion-based guidelines to inform donor evaluation and acceptance practices. Accordingly, living donor programs have employed conservative donor acceptance practices that result in low absolute rates of death and kidney failure after donation. Expanding living donation among older adults would likely require less stringent donor acceptance criteria, which should be informed by prospective data, ideally from controlled studies. Our findings highlight the need for prospective studies, especially since existing registry-based analyses can only inform the outcomes of death and kidney failure after donation and single center reports are too small to inform clinical practice.[34]

Due to the variation in existing guidelines for donor acceptance, we used both the KDIGO and BTS guidelines. It is notable that none of the study participants would be accepted for donation using the KDIGO suggested criterion of a predonation GFR of ≥90 mL/min/1.73 m^2. With the exception of men aged 70 to 79 years, the lower KDIGO GFR threshold led to more exclusions than the BTS age- and sex-specific GFR thresholds, which contrasts with a previous study.[38] Moreover, the BTS guidelines provide a higher threshold for UACR, which led to fewer kidney-related exclusions when BTS GFR and high UACR thresholds were combined.

Measured GFR is recommended to assess kidney function by the BTS guidelines but KDIGO also mentions the possibility to use eGFR based on serum creatinine and cystatin C.[24,25] Creatinine-based eGFR equations have been found to misclassify 5% of donor candidates compared with measured GFR when using the 60 mL/min/1.73 m^2 and age-specific thresholds.[38] Therefore, we cannot completely exclude the possibility of some bias in our results because we did not include information on measured GFR.[39] In addition to accurate assessment of GFR, biomarkers of renal senescence, physiological tests of renal functional reserve, and even native kidney biopsies may be useful in the evaluation of potential older living donors and should be further studied.[40,41]

The question of whether expansion of living donation in old adults is feasible should also be evaluated from an economic perspective. The median costs of a living donor evaluation were 3,115 (IQR, 2,305-4,843) in Canadian dollars (CAD).[42] Therefore, considering our finding that 20 older persons may require evaluation to identify 1 suitable donor, donor evaluation costs may total 50,000 to 100,000 CAD per donor. A formal cost-analysis including the costs of direct postdonation follow-up would be needed to inform the cost-effectiveness of expanded utilization of older living donors.

We found that 73% of participants were willing to donate a kidney to a relative, which is slightly lower than previous reports among persons >65 years.[23,43] Participants aged ≥80 years were less likely willing to donate a kidney to a relative or to a person on the waiting list in case of death, suggesting the older age of our study population may explain the observed lower willingness to donate. The finding that older age was associated with lower willingness to donate has been previously described and may reflect donor concerns about their fitness for donation or viability of the donated kidney.[44] Consistent with these observations, we found that participants who were unwilling to donate were more likely to have poor self-rated health and more likely to be unsuitable to donate. Married participants were more likely to both donate and accept a kidney from a child. Previous studies have highlighted the importance of family supports and willingness to donate among older adults.[23,45,46]

Suitability for living kidney donation in old and very old adults has been insufficiently investigated to date. Our study provides unique insights about the potential and challenges of advancing living kidney donation in persons ≥70 years of age and may prompt discussion about whether expanded utilization of older living donors is feasible. These findings also inform changes to current living donor evaluation and follow-up practices that may be needed to safely expand living donation in older adults.

Readers should consider the following limitations when interpreting our findings: First, GFR was estimated not measured. Suitability during follow-up was assessed in the absence of kidney donation. Medical exclusions to donation were assessed using detailed data of a cohort database complemented by claims data that are insensitive to disease activity or severity and may not necessarily capture fitness for surgery. Accordingly, some conditions may or may not exclude older persons from donation. Although we previously reported that the BIS is representative for the AOK insurance fund,[28] our findings may not be applicable to more ethnically and culturally diverse populations.

In summary, in this homogenous community-based study, we found that there was modest potential for living organ donation especially among participants 70 to 79 years of age. The participants continued to accumulate comorbid conditions during the follow-up period, suggesting there is a narrow time frame for donation and or the need for donor follow-up. These findings highlight several challenges with expanding living donation in older adults and the need for prospective studies to inform the evaluation, acceptance, and follow-up of older donors.

Supplementary Material

Supplementary File (PDF)

Figure S1: Flow diagram of the Berlin Initiative Study.

Figure S2: Prevalence of suitability to living kidney donation in a cohort of older adults according to the willingness to donate at the first follow-up visit.

Item S1: Supplementary methods.

Table S1: British Transplantation Society thresholds of glomerular filtration rate (in mL/min/1.73 m^2) to allow living kidney donation.

Table S2: Comparison of sociodemographic variables according to suitability to living kidney donation using various renal criteria.

Table S3: Factors associated with older adults' opinion on kidney donation.

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Authors' Contributions: Study design: all authors; statistical analyses: CV. Each author contributed important intellectual content during manuscript drafting or revision and agrees to be personally accountable for the individual's own contributions and to ensure that questions pertaining to the accuracy or integrity of any portion of the work, even one in which the author was not directly involved, are appropriately investigated, and resolved, including with documentation in the literature if appropriate.

Support: The Berlin Initiative Study is funded by the KfH Foundation for Preventive Medicine and the DDnÄ Institut für Disease Management. The sponsors had no role in study design, collection, analysis, and interpretation of data or in the writing of the report and the final decision to submit the article.

Financial Disclosure: Dr Villain received a postdoctoral stipend from Caen University Hospital. Dr Ebert is member of an editorial advisory board for Bayer AG Leverkusen. Prof Gill is supported by a Foundation Award from the Canadian Institutes of Health Research. Prof Schaeffner receives honorarium from the National Kidney Foundation. The other authors declare that they have no relevant financial interests.

Peer Review: Received March 27, 2024 as a submission to the expedited consideration track with 3 external peer reviews. Evaluated by a statistician, with editorial input from an Acting Editor-in-Chief (Editorial Board Member Shuchi Anand, MD, MS). Accepted in revised form July 17, 2024. Further information on expedited consideration (AJKD Express) is available in the Information for Authors & Journal Policies. The involvement of an Acting Editor-in-Chief to handle the peer-review and decision-making processes was to comply with AJKD's procedures for potential conflicts of interest for editors, described in the Information for Authors & Journal Policies.

References

1. Johansen KL, Chertow GM, Gilbertson DT, et al. US Renal Data System 2022 annual data report: epidemiology of kidney disease in the United States. *Am J Kidney Dis*. 2023;81(3):A8-A11. doi:10.1053/j.ajkd.2022.12.001
2. Kramer A, Boenink R, Noordzij M, et al. The ERA-EDTA Registry annual report 2017: a summary. *Clin Kidney J*. 2020;13(4):693-709. doi:10.1093/ckj/sfaa048
3. Gill JS, Schaeffner E, Chadban S, et al. Quantification of the early risk of death in elderly kidney transplant recipients. *Am J Transplant*. 2013;13(2):427-432. doi:10.1111/j.1600-6143.2012.04323.x
4. Rao PS, Merion RM, Ashby VB, Port FK, Wolfe RA, Kayler LK. Renal transplantation in elderly patients older than 70 years of age: results from the Scientific Registry of Transplant Recipients. *Transplantation*. 2007;83(8):1069-1074. doi:10.1097/01.tp.0000259621.56861.31
5. Perlman RL, Rao PS. Quality of life of older patients undergoing renal transplantation: finding the right immunosuppressive treatment. *Drugs Aging*. 2014;31(2):103-109. doi:10.1007/s40266-013-0149-x
6. Humar A, Denny R, Matas AJ, Najarian JS. Graft and quality of life outcomes in older recipients of a kidney transplant. *Exp Clin Transplant*. 2003;1(2):69-72.
7. Schold J, Srinivas TR, Sehgal AR, Meier-Kriesche HU. Half of kidney transplant candidates who are older than 60 years now placed on the waiting list will die before receiving a deceased-donor transplant. *Clin J Am Soc Nephrol*. 2009;4(7):1239-1245. doi:10.2215/CJN.01280209
8. Courtney AE, Moorlock G, Van Assche K, et al. Living donor kidney transplantation in older individuals: an Ethical Legal and Psychological Aspects of Transplantation (ELPAT) view. *Transpl Int*. 2023;36:11139. doi:10.3389/ti.2023.11139
9. Gill J, Bunnapradist S, Danovitch GM, Gjertson D, Gill JS, Cecka M. Outcomes of kidney transplantation from older living donors to older recipients. *Am J Kidney Dis*. 2008;52(3):541-552. doi:10.1053/j.ajkd.2008.05.017
10. Gill JS, Gill J, Rose C, Zalunardo N, Landsberg D. The older living kidney donor: part of the solution to the organ shortage. *Transplantation*. 2006;82(12):1662-1666. doi:10.1097/01.tp.0000250715.32241.8a
11. Wainright JL, Robinson AM, Wilk AR, Klassen DK, Cherikh WS, Stewart DE. Risk of ESRD in prior living kidney donors. *Am J Transplant*. 2018;18(5):1129-1139. doi:10.1111/ajt.14678
12. Steiner RW. "Normal for now" or "at future risk": a double standard for selecting young and older living kidney donors. *Am J Transplant*. 2010;10(4):737-741. doi:10.1111/j.1600-6143.2010.03023.x
13. Sommerer C, Bougioukou Z, Georgiou VL, Mehrabi A, Zeier M. Shift in living kidney donor demographics over the past 50 years in a German transplant center. *Ann Transplant*. 2021;26:e929693. doi:10.12659/AOT.929693
14. Bailey PK, Wong K, Robb M, et al. Has the UK living kidney donor population changed over time? A cross-sectional descriptive analysis of the UK living donor registry between 2006 and 2017. *BMJ Open*. 2020;10(6):e033906. doi:10.1136/bmjopen-2019-033906
15. Organ Procurement and Transplantation Network. Accessed September 2024. https://optn.transplant.hrsa.gov/
16. Bellini MI, Nozdrin M, Pengel L, Knight S, Papalois V. Risks for donors associated with living kidney donation: meta-analysis. *Br J Surg*. 2022;109(8):671-678. doi:10.1093/bjs/znac114
17. Young A, Storsley L, Garg AX, et al. Health outcomes for living kidney donors with isolated medical abnormalities: a systematic review. *Am J Transplant*. 2008;8(9):1878-1890. doi:10.1111/j.1600-6143.2008.02339.x
18. Barri YM, Parker T, Daoud Y, Glassock RJ. Definition of chronic kidney disease after uninephrectomy in living donors: what are the implications? *Transplantation*. 2010;90(5):575-580. doi:10.1097/TP.0b013e3181e64237
19. Lam NN, Garg AX. Acceptability of older adults as living kidney donors. *Curr Opin Nephrol Hypertens*. 2016;25(3):245-256. doi:10.1097/MNH.0000000000000215
20. Reese PP, Bloom RD, Feldman HI, et al. Mortality and cardiovascular disease among older live kidney donors. *Am J Transplant*. 2014;14(8):1853-1861. doi:10.1111/ajt.12822
21. Berger JC, Muzaale AD, James N, et al. Living kidney donors ages 70 and older: recipient and donor outcomes. *Clin J Am Soc Nephrol*. 2011;6(12):2887-2893. doi:10.2215/CJN.04160511
22. Englum BR, Schechter MA, Irish WD, et al. Outcomes in kidney transplant recipients from older living donors. *Transplantation*. 2015;99(2):309-315. doi:10.1097/TP.0000000000000607
23. Febrero B, Ros I, Almela-Baeza J, et al. Attitude of older people toward living donation. *Transplant Proc*. 2020;52(2):500-502. doi:10.1016/j.transproceed.2019.09.022
24. Lentine KL, Kasiske BL, Levey AS, et al. Summary of Kidney Disease: Improving Global Outcomes (KDIGO) clinical practice guideline on the evaluation and care of living kidney donors. *Transplantation*. 2017;101(8):1783-1792. doi:10.1097/TP.0000000000001770
25. Andrews PA, Burnapp L. British Transplantation Society/Renal Association UK guidelines for living donor kidney transplantation 2018. *Transplantation*. 2018;102(7):e307. doi:10.1097/TP.0000000000002253
26. Ho ISS, Azcoaga-Lorenzo A, Akbari A, et al. Variation in the estimated prevalence of multimorbidity: systematic review and meta-analysis of 193 international studies. *BMJ Open*. 2022;12(4):e057017. doi:10.1136/bmjopen-2021-057017
27. Schaeffner ES, van der Giet M, Gaedeke J, et al. The Berlin Initiative Study: the methodology of exploring kidney function in the elderly by combining a longitudinal and cross-sectional approach. *Eur J Epidemiol*. 2010;25(3):203-210. doi:10.1007/s10654-010-9424-x
28. Ebert N, Jakob O, Gaedeke J, et al. Prevalence of reduced kidney function and albuminuria in older adults: the Berlin Initiative Study. *Nephrol Dial Transplant*. 2017;32(6):997-1005. doi:10.1093/ndt/gfw079
29. Pottel H, Björk J, Rule AD, et al. Cystatin C-based equation to estimate GFR without the inclusion of race and sex. *N Engl J Med*. 2023;388(4):333-343. doi:10.1056/NEJMoa2203769
30. Rubin DB. *Multiple Imputation for Nonresponse in Surveys*. John Wiley & Sons; 2004.
31. Muzaale AD, Massie AB, Wang MC, et al. Risk of end-stage renal disease following live kidney donation. *JAMA*. 2014;311(6):579-586. doi:10.1001/jama.2013.285141

32. Mjøen G, Hallan S, Hartmann A, et al. Long-term risks for kidney donors. *Kidney Int*. 2014;86(1):162-167. doi:10.1038/ki.2013.460
33. Habbous S, Woo J, Lam NN, et al. The efficiency of evaluating candidates for living kidney donation: a scoping review. *Transplant Direct*. 2018;4(10):e394. doi:10.1097/TXD.0000000000000833
34. Newell KA, Formica RN, Gill JS. Engaging living kidney donors in a new paradigm of postdonation care. *Am J Transplant*. 2016;16(1):29-32. doi:10.1111/ajt.13524
35. Gill JS, Delmonico F, Klarenbach S, Capron AM. Providing coverage for the unique lifelong health care needs of living kidney donors within the framework of financial neutrality. *Am J Transplant*. 2017;17(5):1176-1181. doi:10.1111/ajt.14147
36. Kasiske BL, Asrani SK, Dew MA, et al. The Living Donor Collective: a scientific registry for living donors. *Am J Transplant*. 2017;17(12):3040-3048. doi:10.1111/ajt.14365
37. Living Kidney Donor Follow-Up Conference Writing Group, Leichtman A, Abecassis M, et al. Living kidney donor follow-up: state-of-the-art and future directions, conference summary and recommendations. *Am J Transplant*. 2011;11(12):2561-2568. doi:10.1111/j.1600-6143.2011.03816.x
38. Gaillard F, Courbebaisse M, Kamar N, et al. Impact of estimation versus direct measurement of predonation glomerular filtration rate on the eligibility of potential living kidney donors. *Kidney Int*. 2019;95(4):896-904. doi:10.1016/j.kint.2018.11.029
39. Glassock RJ. Evaluation of living donors: quo vadis for GFR criteria? *Kidney Int*. 2019;95(4):738-740. doi:10.1016/j.kint.2019.01.015
40. Ronco C, Chawla LS. Glomerular and Tubular Kidney Stress Test: new tools for a deeper evaluation of kidney function. *Nephron*. 2016;134(3):191-194. doi:10.1159/000449235
41. Ebert T, Pawelzik SC, Witasp A, et al. Inflammation and premature ageing in chronic kidney disease. *Toxins*. 2020;12(4):227. doi:10.3390/toxins12040227
42. Habbous S, Sarma S, Barnieh LJ, et al. Healthcare costs for the evaluation, surgery, and follow-up care of living kidney donors. *Transplantation*. 2018;102(8):1367-1374. doi:10.1097/TP.0000000000002222
43. Tong A, Chapman JR, Wong G, Josephson MA, Craig JC. Public awareness and attitudes to living organ donation: systematic review and integrative synthesis. *Transplantation*. 2013;96(5):429-437. doi:10.1097/TP.0b013e31829282ac
44. Kurleto P, Tomaszek L, Milaniak I, Mędrzycka-Dąbrowska W. Factors associated with the willingness to become a living kidney donor: a national cross-sectional study. *Int J Environ Res Public Health*. 2022;19(3):1313. doi:10.3390/ijerph19031313
45. Febrero B, Almela J, Febrero R, et al. Importance for the elderly of discussion in the family and society about attitude toward organ donation. *Transplant Proc*. 2018;50(2):523-525. doi:10.1016/j.transproceed.2017.09.056
46. Lee CY, Lin MH, Lin HY, et al. Survey of factors associated with the willingness toward living kidney donation. *J Formos Med Assoc Taiwan Yi Zhi*. 2022;121(11):2300-2307. doi:10.1016/j.jfma.2022.06.007

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