Nephrol Dial Transplant (2022) 37: 595–598
https://doi.org/10.1093/ndt/gfab305
Advance Access publication date 20 October 2021

Country-specific sex disparities in living kidney donation

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There are many sex (and gender) related considerations to be taken into account when providing care for patients awaiting an organ transplant. When on dialysis, women are less likely to be waitlisted for kidney transplantation and to receive a deceased [1, 2] or living donor organ [3], while in reverse, more women than men are living kidney donors [4]. Country-specific analysis might reveal further inequalities in the process of kidney donation that place women at a disadvantage. Here we analysed the sex distribution among living kidney donors and recipients in various countries and compared them with the countries' general population sex distribution.

SEX DISTRIBUTION OF DONORS AND RECIPIENTS IN LIVING KIDNEY DONATION

We examined 16 studies reporting the sex distribution in living kidney donation, mostly summarized in a review by Carrero *et al.* [4] and provided in Table 1. These were single-centre experiences (China, UK, Egypt, India, Iran, South Korea, Nepal, Russia and Turkey), national registries (Thailand, Norway, Oman and Switzerland), other sources (German Foundation of Organ transplantation, US Scientific Registry of Transplant Recipients) and an assembly from countrywide transplant centres (Nigeria). In the study from Russia, only related donors were analysed, while in the study from Norway, only first grafts were included. Donor sex was not reported in two studies (Egypt and Nigeria). Among 36 666 living kidney donations from 14 countries, 45.4% of donors were men and 54.6% were women, while for recipients, 59.7% were men and 40.3% were women. When weighted with the population size of each country [5], the donor distribution consisted of 35.9% men and 64.1% women, and for the recipients, of 78.3% men and 21.7% women, although not all studies were likely to be population representative. Six out of 14 studies reported a women donor proportion above 60%. Women donor rates equal to or below 50% were observed in Iran, South Korea, Thailand and Oman.

LIVING KIDNEY DONATION IS SHIFTED TOWARDS WOMEN AND VARIES BY COUNTRY

Based on the observed sex distribution of kidney donors in each study, we calculated intervals for the sex distribution of the 'expected donor pool', assuming equal donation rates of men and women within that pool. The obtained intervals represent ranges of sex distributions within which a chi-square test, testing a difference between expected and observed distribution, would be statistically insignificant, i.e. men and women in this theoretical 'expected donor pool' are equally likely to donate. If the sex distribution of the country's general population from the respective year [5] was within the intervals of the expected donor pool, we interpreted this result as unbiased kidney donation. Our analysis revealed that in 10 out of 14 studies, women were over-represented in the expected donor pool, compared with the proportion of women within the general population of the corresponding country (marked as red columns in Table 1). Oman was the only country where the expected donor pool was in line with the country's sex distribution, thus men and women were equally likely to donate. In only 3 out of 14 countries (Iran, South Korea and Thailand), we observed donation rates that were shifted towards men. The fact that financial compensation for kidney donation is legal in Iran is a possible explanation for this exception [6, 7].

Table 1. Sex distribution in living kidney donation by country

	China	UK	Egypt	Germany	India	Iran	South Korea	Nepal	Nigeria	Norway	Oman	Russia	Switzerland	Thailand	Turkey	USA
Reference	Liu, 2013	Peracha, 2016	Soliman, 2015	Biller-Andorno, 2002	Bal, 2007	Ghods, 2003	Kwon, 2004	Chalise, 2010	Arogundade, 2011	Øien, 2005	Mohsin, 2007	Goryainov, 2016	Thiel, 2005	Noppakun, 2015	Mıhçıokur, 2019	Kayler, 2003
Total donations, *N*	139	713	74	380	682	1500	614	35	143	1319	198	271	631	2063	1611	26 510
Female recipients, %	20	39	26	38	11	37	31	29	23	37	38	42	36	38	26	43
Female donors, %	69	55	n/a	64	66	22	42	71	n/a	58	50	60	65	49	58	56
Expected donor pool[a] (female, %)	61.0–76.0	51.4–58.6	n/a	59.1–68.6	62.4–69.4	20.0–24.1	38.2–45.9	54.8–83.2	n/a	55.4–60.6	43.2–56.8	54.2–65.6	61.3–68.6	46.9–51.1	56.0–60.0	55.4–56.6
General population (female, %)	48.6 2013	50.7 2016	49.5 2015	51.2 2002	48.0 2007	49.1 2003	49.8 2004	50.8 2010	49.4 2011	50.4 2005	43.4 2005	53.7 2016	51.1 2005	51.2 2015	50.6 2019	50.7 2003
Non-tobacco users (female, %)	65.6 2012	51.8 2016	62.7 2014	53.9 2007	59.4 2007	56.1 2007	66.1 2007	64.1 2010	51.9 2010	52.0 2007	48.1 2007	64.0 2016	53.9 2007	65.4 2014	59.1 2018	56.3 2007
Non-obese (female, %)	48.3 2013	50.0 2015	43.1 2016	51.1 2002	47.6 2007	45.9 2003	49.5 2004	50.3 2010	47.8 2011	49.9 2005	41.0 2005	49.8 2015	51.9 2005	49.5 2015	44.5 2015	46.0 2003
No CVD (female, %)	48.1 2013	50.9 2016	49.8 2016	51.2 2002	48.1 2007	49.4 2003	49.6 2004	51.0 2010	49.4 2011	50.2 2005	43.6 2005	52.7 2016	51.0 2005	51.1 2015	49.9 2019	50.5 2003
No diabetes mellitus (female, %)	48.9 2013	51.6 2016	49.5 2016	51.1 2002	48.1 2007	49.1 2003	50.0 2004	51.0 2010	49.4 2011	50.8 2005	43.6 2005	53.4 2016	51.3 2005	51.2 2015	50.1 2019	51.0 2003
No CKD (female, %)	47.6 2013	50.3 2016	49.0 2016	50.2 2002	48.0 2007	48.7 2003	49.3 2004	50.8 2010	49.3 2011	50.0 2005	43.1 2005	52.9 2016	50.0 2005	50.7 2015	49.4 2019	49.7 2003
Employed (female, %)	44.3 2013	46.8 2016	20.2 2015	44.5 2002	25.0 2007	16.8 2003	40.9 2004	49.6 2010	45.9 2011	47.8 2005	22.2 2005	48.6 2016	45.0 2005	45.7 2015	32.3 2019	46.0 2003
DOI	https://doi.org/10.1111/ctr.12003	https://doi.org/10.6002/ect.2015.0150	https://doi.org/10.7537/marslsj120315.03	https://doi.org/10.1023/a:1016053024671	https://doi.org/10.1016/j.transproceed.2007.08.089	https://doi.org/10.1016/j.transproceed.2003.09.019	https://doi.org/10.1016/j.transproceed.2004.07.046	PMID: 20427894	https://doi.org/10.1038/kisup.2013.23	https://doi.org/10.1093/ndt/gfh696	https://doi.org/10.1016/j.transproceed.2007.04.016	https://doi.org/10.17116/hirurgia2016662-67	https://doi.org/10.1016/j.transproceed.2004.12.279	https://doi.org/10.1111/nep.12378	https://doi.org/10.6002/ect.MESOT2018.P109	https://doi.org/10.1034/j.1600–6143.2003.00086.x

[a]Expected proportion of sex in the donor pool given as intervals (= expected sex distribution in the country's donor population, derived by the observed sex distribution of donors leading to an insignificant chi-squared test if the true, unknown distribution would be compared to the observed distribution). General population = sex distribution of the respective country in the year of the donor statistic. Red: the proportion of women in the general population was lower than the expected donor pool. Orange: the proportion of women in the general population was higher than the expected donor pool. Green: the proportion of women in the general population was compatible with the expected donor pool. Two studies were excluded because living and deceased donors were not discriminated (Tunisia: https://doi.org/10.1016/j.transproceed.2008.12.030 and Saudi Arabia: PMID: 18 202 511). CKD = chronic kidney disease; CVD = cardiovascular disease.

POTENTIAL MECHANISMS LEADING TO BIASED LIVING KIDNEY DONATION

Besides biological causes, socio-cultural, socio-economic and psychological factors are possible explanations for the observed sex disparity among kidney donors. The sex distributions of some potential biological causes for this disparity (and of smoking, which may be a socio-cultural risk factor for disease) are listed in Table 1 for each country. Although a thorough interpretation here is beyond the scope, the absence of biological risk factors that might prevent kidney donation was not genuinely shifted towards women. This observation was especially notable for kidney disease itself, which is generally more prevalent among women than men, although it is well known that more men than women undergo kidney replacement therapy by dialysis [4]. The absence of tobacco use was clearly shifted towards women in all countries, and women were much less frequently employed than men in all of the examined countries except Nigeria. The latter two disproportions might be important contributors to the preponderance of kidney donation by women.

Examining individual donor pools, Zimmerman *et al.* observed that among acceptable donors more women proceeded to donation, and that the excess of women donors was influenced by the predominance of women among spousal donors rather than immunological or medical exclusion criteria [8]. A greater imbalance among spousal donors was also seen in transplantation registries from the USA [9] and Norway [10]. It remains a possible explanation that fewer men are potential donors to their woman partners than the other way around due to economic reasons, sensitization to the husband's antigens or simply better health of women [11]. Examining the total donor pool, a previous population-based analysis showed that after adjusting for possible explanatory factors like differences in the need for kidney replacement therapy, women still had a 44% higher incidence of donation (31% in living related donation) and decline in income had a greater effect on donation from men than women [12].

The process of decision-making in living kidney donation is complex and includes, besides biological boundaries, also themes of compelled altruism, inherent responsibility, accepting risks, family expectation, personal benefit and spiritual confirmation [13]. It is possible that women's gender roles, empathy and altruistic behaviour contribute to greater living kidney donation in women [11]. Also, fewer men might proceed to kidney donation due to economic responsibility in the family, which might be influencing donation in Iran [14], where it can be financially compensated.

LIMITATIONS AND OUTLOOK

Our analysis is limited by the possibility that the sex distribution within a country might not accurately depict the distribution within the true donor pool and that the time period of different research studies from the 14 countries analysed ranges from 2003 to 2019. Equalling 16 years, such a large time span may make for an unfair comparison, especially with the increased public awareness and promotion of organ donation. However, we would like to point out that the purpose of the present analysis is not to judge any country's organ donation practice. As a further limitation, we also could not adjust our analysis for influential variables such as age, health and the varying comorbidity burden across the sexes, because we did not request access to the original datasets that we included in Table 1. In future research, it would be interesting to examine whether the most prominent modifiable variables that were identified for women (absence of smoking and employment) can perhaps partly explain some sex disparities in living kidney donation. Also, the psychological requirements for a kidney donor should be compared between the different countries in light of sex and gender topics.

In conclusion, the female-to-male donor rate was disproportionately high in relation to the sex distribution in most countries. We assume intertwined sex (biological) and gender (social/cultural) influences and a great impact of socio-economic, socio-cultural and psychological factors, as we identified greatly varying international proportions of woman kidney donors compared with men. Among the research opportunities that might be able to shed further light on sex and gender disparities in living kidney donation, we suggest that input from patients themselves could be the most promising and least explored so far.

FUNDING

We acknowledge support from the Austrian Science Fund (grant number KL754-B).

DATA SOURCES

General population: https://data.worldbank.org/indicator/SP.POP.TOTL.
Obesity: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/prevalence-of-obesity-among-adults-bmi-=-30-(crude-estimate)-(-).
Cardiovascular disease, diabetes, chronic kidney disease: http://ghdx.healthdata.org/gbd-results-tool.
Tobacco: https://apps.who.int/iris/rest/bitstreams/1263754/retrieve.
Employment: https://www.ilo.org/wesodata/.

CONFLICT OF INTEREST STATEMENT

None of the authors has any relevant conflict of interest to declare. The results presented in this paper have not been published previously in whole or part.

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Received: 28.5.2021; Editorial decision: 17.10.2021