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Of Kin and Kidneys: Do Kinship Networks Contribute to Racial Disparities in Living Donor Kidney Transplantation?

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Abstract

In the United States, racial disparities in kidney transplantation are large and especially stark for living donor transplants. Medical researchers frequently attribute this to the availability of medically compatible living kidney donors, who are usually kin. This paper evaluates this hypothesis by testing whether African American transplant candidates likely have lesser access to suitable living donors in their kinship networks than white candidates. This paper evaluates this hypothesis using a simulation design. Contrary to prior research on this topic, this simulation analysis concludes that black-white disparities in living donor kidney transplantation are unlikely to be the result of group differences in the availability of suitable donors. Although individual white kin are individually more likely to be suitable donors, African Americans' larger average kinship networks compensate for this difference.

Keywords

Racial disparities in health; kidney transplantation; kinship networks; contraindications; histocompatibility; United States

In the United States, large racial disparities mark the kidney transplantation system. Persons with end-stage renal disease (ESRD) who seek a kidney transplant may obtain one from deceased or living donors. African Americans are less likely to be enrolled in the kidney transplant waiting list than whites and are less than half as likely as whites to obtain a living donor kidney transplant (LDKT), which accounts for the majority of racial disparities in kidney transplantation (Ayanian et al., 1999; Norris & Agodoa, 2005). Racial disparities in deceased donor kidney transplants (DDKT) are present but less stark. Compared to white patients, black ESRD patients are less likely to have a potential donors evaluated for donation, and are less likely to obtain an LDKT if they do identify one (Weng et al., 2010).

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The causes of this racial disparity in LDKTs are in considerable dispute. Because most living donors are kin to the intended recipient (Matas et al., 2013; see Online Supplement Table ESM1), a prominent hypothesis (the ‘differential access hypothesis’) claims that racial disparities in LDKTs are rooted in the lesser availability of medically suitable living donors within African American kinship networks (Ladin & Hanto, 2010; Lunsford et al., 2007; Weng et al., 2010). To donate a kidney for transplantation, one must be sufficiently healthy to donate and, often, immunologically compatible with the recipient. This means that kinship structure, kin health, and immunological processes all fundamentally shape candidates' prospects of obtaining an LDKT. It also means that racial differences in these kinship network characteristics are a strong candidate explanation for disparities in LDKTs.

Although this hypothesis is plausible, however, it has not been studied employing population representative data, instead relying on the outcomes of single center evaluations of potential donors (Weng et al., 2010). As a result, these findings are potentially unrepresentative and conflate search processes with donor availability. It is important to differentiate between donor-candidate pairs which are *at risk* of successful donation from those which actually take steps to initiate or complete a donation. By studying only the outcomes of those candidate-donor pairs which enter a nephrology clinic for evaluation, the availability of potential kin donors who are not evaluated is missed entirely.

This paper assesses the differential access hypothesis by evaluating whether it is likely that African Americans have lesser access to suitable living kin donors than white transplant candidates outside of nephrology clinics. However, the *availability* of suitable donors for transplant candidates is not equivalent to studying completed transplants. Instead, this paper seeks to determine whether it is likely that patterns of suitable donor *access* by race are consistent with this hypothesis. Using a simulation analysis to combine administrative data on the kidney transplantation waiting list with survey data on the kinship structures of white and black families and demographic patterns of ill health, this analysis suggests that African Americans on the kidney transplantation waiting list have access to suitable living kidney donors at equal rates as whites, contradicting the differential access hypothesis.

Proximate Determinants of LDKT Access

The first task of this analysis is to define who is a suitable living kidney donor. The bedrock requirement for an LDKT is contact with another who might donate a kidney. Because most living donors are kin (Lennerling et al., 2003; Matas et al., 2013), kinship network size will be positively related to prospects for an LDKT. The second requirement for an LDKT is that the donor is sufficiently healthy to donate, which may prove important given well-documented racial disparities in health. A medical condition that precludes donation is called a contraindication.

Other factors may not be required for donation but positively influence the odds of a transplant's success. One such factor is donor-recipient immunological compatibility (histocompatibility). For kidney transplantation, two types of histocompatibility are relevant – red blood cell type (measured by one's *ABO* genotype), and white blood cell antigen type (measured by one's *HLA-A*, *HLA-B*, and *HLA-DR* genotypes). *ABO* histocompatibility is

much more important for transplant success than that for *HLA*, although even *ABO* incompatibility may now be overcome (Takahashi & Saito, 2013). Nonetheless, both of these criteria may influence racial disparities in access to suitable donors.

Having no antibodies pre-sensitized to the donor's mismatched antigens (a positive crossmatch) is another determinant of living donor suitability. Transplants between positively crossmatched pairs frequently trigger hyperacute kidney rejection, and although over time improvements in post-transplant therapies have reduced this risk, positively crossmatched transplants still suffer increased risk of post-transplant rejection (Bentall et al., 2013). Candidate probabilities of positive crossmatch are defined by Panel Reactive Antibody (PRA) scores. Given racial disparities in PRA scores (Cooper et al., 1995), this may also mediate racial disparities in LDKTs.

However, not all nephrologists employ identical definitions of potential donor suitability, and these have shifted over time. Given this ambiguity, supplemental analyses (not shown) employ a more limited simulation to assess the consistency of findings across alternative definitions of donor suitability. The results presented here define a suitable donor as one with no contraindications, compatible *ABO* type, no positive crossmatch, and two or more *HLA* matches. These results may be thought of as describing the 'ideal' donor. Finally, although unrelated donors comprise about 13% of the living donor pool, the approach taken here is necessarily limited to kinship networks due to the absence of representative data on the full social networks of U.S. adults.

Methods

Data and Measures

In order to assess the differential access hypothesis, three types of data are needed – information on the composition of the kidney transplant waiting list, black and white kinship structures, and demographic patterns of medical contraindications for donation. Although it would be preferable to study this topic with a single dataset, this is not available. Instead, the following data will be combined via simulation to begin to evaluate this hypothesis. Because fully describing the methods involved requires more space than is available, the reader is urged to consult the Online Supplement for full details of this simulation design. This analysis of secondary data was approved by the Institutional Review Board at the University of North Carolina-Chapel Hill.

Transplant Candidates—First, information on the transplant waiting list was employed. Since 1987, the United Network for Organ Sharing (UNOS) has collected detailed information on every organ transplant candidate in the U.S. Whites and black candidates observed between 1999 and early 2010 were analyzed in this analysis.

Ten different imputations were produced from this file using hotdeck imputation methods (Allison, 2001; Reilly, 1993) based on patient age, ethnicity, gender, and education, and ten simulations were conducted on each imputed dataset for a total of 100 simulations. Race was measured as non-Hispanic white or black. Education is measured in six categories: no education, less than high school education, high school or equivalent, some college, 4-year

degree, graduate education. Rates of missingness were low, and nearly nonexistent for demographic variables. The missingness rate for HLA genes was 6.4%. Missing genetic data were not imputed; following UNOS procedure, missing values were assumed homozygous at that locus. However, PRA had a 58.7% missingness rate. Additionally, this dataset was used to measure the distribution of *ABO* and *HLA* and transplant candidates' PRA scores.

Kinship Structures—I employ information on the distribution of genetically-defined kinship structures in the general population using the Panel Study of Income Dynamics (PSID), a large longitudinal study following the descendants of the originally sampled households since 1968. Because of this, the PSID can be used to build relatively complete kinship networks between respondents, distinguishing kin with different genetic relationships. These ties can then be combined to describe full kinship networks.

Kin Health Status—Although there is no official list of contraindications and practices vary, in 2007 an OPTN committee made a set of recommendations for ‘absolute’ contraindications, which is used for the simulation.¹ This study uses National Health and Nutrition Examination Surveys (NHANES) 1999-2009 data to measure demographic patterns of contraindications for use in the simulation.

Analytical Strategy

These disparate datasets are combined via simulation to evaluate the differential access hypothesis. Figure 1 illustrates how the UNOS, PSID, and NHANES datasets are employed: in short, UNOS provides information on the population of transplant candidates; PSID provides information on the distribution of kinship structures in the U.S. by race; and NHANES provides data on population patterns of medical contraindications for kidney donation. These data are combined repeatedly, and this simulated dataset is employed to analyze racial differences in access to suitable living kin donors.

The simulation proceeds in seven steps. First, the PSID FIMS data is converted to detailed biological kinship networks, defined by relationship category. Non-biological kin are included in the analysis but are not separately characterized (i.e., spouses are considered to be equivalent to uncles-by-marriage). Second, these biological kinship ties from the PSID are then probabilistically assigned to members of the kidney transplant waiting list as a function of race, gender, and age categories, employing an exact matching algorithm and PSID sampling weights. This matching process operates by matching every member of the waiting list to a demographically identical member of the PSID proportional to the latter's sampling weights.

Third, each member of each kinship network besides the transplant candidate is then assigned medical contraindication status proportional to the probability thereof for members of their race, age, and gender group in the NHANES dataset. Fourth, the probability of genetic histocompatibility with the transplant candidate is calculated for each member of their kinship network as a function of the pair's genetic relationship and race. Fifth, the

¹http://optn.transplant.hrsa.gov/PublicComment/pubcommentPropSub_208.pdf, accessed 5/1/2012. This is not an authoritative list of contraindications.

probability of an immunological crossmatch between the recipient and the donor is calculated as a function of the simulated number of *HLA* matches and the transplant candidate's PRA score.

Sixth, this information is combined to determine the number of kin simulated to be suitable living donors. Seventh, a series of counterfactual simulations were produced, in which the distributions of each proximate determinant of suitable donor access are redistributed at random across all kidney transplant candidates and then re-simulated. The results of this exercise are expressed as the estimated percentage of the race gap in access to suitable kin donors explained by redistributing this characteristic.

Results

Access to Suitable Kin Donors by Race

Table 1 presents the simulated distribution of suitable living donors within waitlisted candidates' kinship networks. Contrary to the differential access hypothesis, the results suggest that whites are less likely than blacks to have at least one suitable living donor in their kinship networks (58.2% and 62.5% respectively). Furthermore, among those simulated to have a suitable kin donor, blacks on average have more potential donors than whites. For both whites and blacks, children are the most common relationship type for suitable kin donors, followed by non-biological kin, full siblings, parents, and grandchildren.

Supplemental analyses (not shown) incorporating additional matching variables (Census region and year groups) into the simulation did not substantively influence these findings. Additionally, supplemental analyses were conducted to assess whether this finding was an artifact of the definition of a suitable donor. Dropping the requirement of 2 HLA matches did not substantively affect this finding. However, doing so has the result that nearly every member of the waiting list is simulated to have access to a suitable donor within their kinship networks (although African Americans have access to more on average).

Probability that Individual Kin are Suitable Living Donors

Whereas Table 1 characterizes the simulated distribution of suitable donor counts across the candidate's *entire kinship network*, Table 2 describes the probability that each *individual* member of a kinship network will be a suitable living donor for the candidate, stratified by race and relationship type. These are not equivalent because kinship structures vary systematically by race among transplant candidates. Table 2 also provides the probabilities of living donor exclusions for HLA histocompatibility, ABO histocompatibility, medical or age contraindication, or positive crossmatch reasons. (These outcomes do not add up to 100% because a donor can be excluded for more than one reason.)

This table shows that children, full siblings, parents, and aunts/uncles show the highest probability of being a suitable living donor. They also show that, conditional on relationship, members of a white transplant candidates' kinship network are more likely to be a suitable living donor than a member of a black person's kinship network. On average, 6.4% of white kin are simulated to be a suitable living donor for the transplant candidate, while this is true for only 5.4% of black kin. Black kin are more likely than white kinship alters to be

excluded for *HLA*, *ABO*, medical contraindication, and positive crossmatch reasons. The probability of living donor suitability varies proportionately with the genetic relationship degree.

Counterfactual Effects

What accounts for racial differences in access to suitable living kin donors? Counterfactual effect calculations (Table 3) show that whites are advantaged by their higher probability of histocompatibility and lower probability of positive crossmatching, whereas blacks are advantaged by their larger typical kinship network size. (This table includes '90% Interval' columns, which provide the 5th and 95th percentile values across 100 simulations, capturing cross-simulation variance. These are not equivalent to traditional confidence intervals or p-values.) Equalizing the probability of histocompatibility by race results in a 14.5% increase in the race gap in the access to suitable kin donors, and a 40.6% increased disparity in the number of suitable donors. In other words, if whites did not have higher histocompatibility probabilities with their kin, the black advantage in suitable kin donor access would be 14.5% larger. Kin health is a negligible determinant of racial disparities in suitable donor access, as equalizing this factor adds only .8% and 1.5% to the race gap in, respectively, access to, and number of, suitable donors. PRA differences by race are also a source of white advantage in suitable donor access. Equalizing this factor results in an 18.7% and 20.4% increase in the race gap in access and number of suitable donors, respectively. Finally, the larger average kinship networks of African Americans entirely explains their advantage in suitable donor access compared to whites – equalizing this factor explains 123% of the gap in access to any donors and 151% of the gap in average donor counts. In other words, if white and black candidates had kinship networks from the same distributions, black candidates would have lower rates of access to suitable donors than whites.

Supplemental analyses (not shown) dropping the HLA matching requirement also find that kinship network size is responsible for African Americans' greater access to suitable living donors. Modifying the simulation to incorporate a homophily odds' ratio of 2 for kin contraindications (reflecting the possibility that transplant candidates' kin are more likely to be ill than demographically similar persons in the general population) produces similar results as well.

Discussion and Conclusion

The results of this simulation study suggest that the differential access hypothesis that racial disparities in LDKTs are due to properties of white and black kinship networks is unlikely to be true – if anything, African American transplant candidates are simulated to have *greater* access to suitable kin donors than whites. Although individual white kin are more likely to be suitable donors, the larger average size of African American kinship networks more than compensates for this difference.

What then accounts for racial disparities in LDKTs? Although there are likely a variety of reasons, the fact that transplant candidates pursuing an LDKT typically have relatively few potential donors evaluated (Weng et al., 2010) suggests a potential, partial explanation. If most transplant candidates who have a donor evaluated for donation do so with two or fewer

donors, the probability of individual kin suitability for donation becomes the more important factor than network-level access to suitable donors. For instance, suppose that a typical white and black transplant candidate each brought in a parent, child, and sibling to be evaluated as a donor. Assuming independence in outcomes, the results in Table 2 indicate that on average the white candidate would find a suitable donor 46.3% of the time whereas a black candidate would find a suitable donor 41.3% of the time.² Although this difference is not as large as the difference in the rate of LDKTs by race, it is consistent with the direction of the disparity.

However, it is likely that non-kinship-based explanations also play a large role. For instance, it may be that race differences in candidates' willingness to accept a kidney donation from kin contribute to this disparity. The only qualitative investigation of this question (Gordon, 2001) found that only 39% of those receiving offers of donation accepted the offer. Previous work on racial differences in reciprocity norms (Miller-Cribbs & Farber, 2008), and the "tyranny of the gift" in transplantation (Fox & Swazey, 1978) suggest the possibility that African Americans are likely to decline kidney donation offers at higher rates than whites.

Other aspects of the living donor search process may also play a role. It may also be that whites pursue LDKTs at higher rates than African Americans, search more extensively within their kinship networks, or employ different search patterns. The difference may also stem in part from differential search within non-kin social networks. Additionally, kin who would otherwise be willing to donate a kidney may not be able to if doing so would endanger their employment or they could not forgo a paycheck; given the strong association of race and socioeconomic status, this may mediate the race-LDKT relationship as well. Furthermore, racial disparities in rates of incarceration, which would typically preclude kidney donation, are large and may also contribute to these disparities.

Finally, it is important to consider the fraught history of relations between medical institutions and African Americans. Bias in treatment of African Americans has not been eliminated, as suggested by the greater difficulty African Americans face in enrolling in the kidney transplant waiting list (Ayanian et al., 1999; Norris & Agodoa, 2005). Accordingly it is unsurprising that African Americans generally exhibit greater levels of mistrust of the medical establishment than whites (LaVeist et al., 2000), and are less likely to be willing to donate organs or blood (Boulware et al., 2003). This legacy of bias and mistrust may also help to explain racial disparities in LDKTs.

This analysis is subject to a number of limitations. First, the PSID kinship data is somewhat incomplete - because it relies on household co-residence to build this network, relatives who are not connected to the focal person by chains of household co-residence will be excluded. However, while the estimate of access to suitable kin donors may be downwardly biased, the estimate of racial *differences* in suitable kin donor access is less likely to be heavily biased. Additionally, non-kin provide about 13% of living donor transplants (Table ESM1, Online

² $P(D_A) = P(D_p) + P(D_C) + P(D_S) - P(D_p D_C) - P(D_p D_S) - P(D_C D_S) + P(D_p D_C D_S)$, where $P(D_A)$ is the probability of any evaluated kin being a suitable donor, and the P, C, and S subscripts indicate the parent, child, and sibling respectively. Following Table 2 to obtain these estimates, for whites, $P(D_p)=.2100$, $P(D_C)=.1345$, and $P(D_S)=.2230$; for blacks, $P(D_p)=.1818$, $P(D_C)=.1288$, and $P(D_S)=.1887$.

Supplement), but non-kin social networks are not accounted for in this analysis. Because a greater proportion of LDKTs for white candidates are from non-kin than for black candidates, this limitation may yield an incomplete understanding of the determinants of racial disparities in LDKTs.

The present analysis is also limited by the absence of certain medical contraindication measures in the NHANES data. Namely, measures of thrombosis, embolism, symptomatic valvular disease, and urologic kidney abnormalities were not available in the data. Additionally, transplant centers vary in the list of contraindications used to exclude potential donors, and criteria may have changed over time. Without direct data on center-level variation in these practices, it is difficult to say what implications this variation may have for the present findings.

Finally, if black and white transplant candidates develop ESRD via divergent underlying diseases, it is possible that the differential genetic etiologies of these diseases could skew these calculations. A related concern is that this simulation assumes that the criteria for suitable donors may be specified in one of the ways examined and that the distribution of kinship structures and kin odds of contraindications are identical to those of demographically similar individuals. However, supplemental analyses found that including an odds ratio multiplier of 2 in the probability of kin contraindications did not change the substantive findings.

In short, it is unlikely that black-white disparities in rates of living donor kidney transplantation are attributable to differences in access to suitable kin donors. Future research should investigate whether the factors just discussed may mediate this disparity. Furthermore, because this simulation study combined datasets on the determinants of living kidney donor access, and did not measure these properties in the networks of kidney transplant candidates, future research should also confirm these findings through more direct investigations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Allison, P. Missing Data. Sage Publications; 2001.

- Ayanian JZ, Cleary PD, Weissman JS, Epstein AM. The effect of patients' preferences on racial differences in access to renal transplantation. *New England Journal of Medicine*. 1999; 341:1661–1669. [PubMed: 10572155]
- Bentall A, Cornell LD, Gloor JM, Park WD, Gandhi MJ, Winters JL, et al. Five-Year Outcomes in Living Donor Kidney Transplants With a Positive Crossmatch. *American Journal of Transplantation*. 2013; 13:76–85. [PubMed: 23072543]
- Boulware LE, Cooper LA, Ratner LE, LaVeist TA, Powe NR. Race and trust in the health care system. *Public Health Reports*. 2003; 118:358–365. [PubMed: 12815085]
- Cooper TY, Jordan CL, Willimon CM, Land GA. Comparison of Panel-Reactive Antibody-Levels in Caucasian and African-American Renal-Transplant Candidates. *Transplantation*. 1995; 60:327–330. [PubMed: 7652759]
- Fox, RC.; Swazey, JP. *The Courage to Fail: A Social View of Organ Transplants and Dialysis*. Chicago: University of Chicago Press; 1978.
- Gordon EJ. “They don't have to suffer for me”: Why dialysis patients refuse offers of living donor kidneys”. *Medical Anthropology Quarterly*. 2001; 15:245–267. [PubMed: 11452630]
- Ladin K, Hanto DW. Understanding Disparities in Transplantation: Do Social Networks Provide the Missing Clue? *American Journal of Transplantation*. 2010; 10:472–476. [PubMed: 20055801]
- LaVeist TA, Nickerson KJ, Bowie JV. Attitudes about racism, medical mistrust, and satisfaction with care among African American and white cardiac patients. *Medical Care Research and Review*. 2000; 57:146–161. [PubMed: 11092161]
- Lennerling A, Forsberg A, Nyberg G. Becoming a living kidney donor. *Transplantation*. 2003; 76:1243–1247. [PubMed: 14578765]
- Lunsford SL, Simpson KS, Chavin KD, Mensching KJ, Miles LG, Shilling LM, et al. Can family attributes explain the racial disparity in living kidney donation? *Transplantation Proceedings*. 2007; 39:1376–1380. [PubMed: 17580143]
- Matas AJ, Smith JM, Skeans MA, Lamb KE, Gustafson SK, Samana CJ, et al. OPTN/SRTR 2011 Annual Data Report: Kidney. *American Journal of Transplantation*. 2013; 13:11–46. [PubMed: 23237695]
- Miller-Cribbs JE, Farber NB. Kin networks and poverty among African Americans: Past and present. *Social Work*. 2008; 53:43–51. [PubMed: 18610820]
- Norris KC, Agodoa LY. Unraveling the racial disparities associated with kidney disease. *Kidney International*. 2005; 68:914–924. [PubMed: 16105022]
- Reilly M. Data-Analysis Using Hot Deck Multiple Imputation. *Statistician*. 1993; 42:307–313.
- Takahashi K, Saito K. ABO-incompatible kidney transplantation. *Transplantation Reviews*. 2013; 27:1–8. [PubMed: 22902167]
- Weng FL, Reese PP, Mulgaonkar S, Patel AM. Barriers to Living Donor Kidney Transplantation among Black or Older Transplant Candidates. *Clinical Journal of the American Society of Nephrology*. 2010; 5:2338–2347. [PubMed: 20876682]

Highlights

- Racial disparities in kidney transplantation are particularly stark among living donor transplants.
- It is thought that this is due to differences in potential donor characteristics, but this has not been well tested.
- This paper uses simulation analysis and finds that African Americans have greater access to ideal donors than whites.
- Simulations also find that white kin are more likely to be ideal donors individually.
- Excluding the HLA match requirement results in nearly universal donor access.

Figure 1. Illustration of Research Design

Table 1

Simulated Distribution of Suitable Donor Availability

Genetic Relationship	Race	Number of Donors (%)				
		(0)	(1)	(2)	(3)	(4) (5+)
All	White	41.8	30.4	15.4	6.8	3.0 2.7
	Black	37.5	30.4	16.8	8.0	3.7 3.7
Full Siblings	White	89.6	8.0	1.9	0.4	0.1 0.0
	Black	90.3	6.8	2.0	0.6	0.2 0.1
Half Siblings	White	98.3	1.5	0.2	0.0	0.0 0.0
	Black	94.4	4.6	0.8	0.1	0.0 0.0
Parents	White	91.7	7.6	0.7	0.0	0.0 0.0
	Black	91.6	7.9	0.5	0.0	0.0 0.0
Children	White	67.8	23.2	7.3	1.4	0.2 0.0
	Black	68.0	23.0	6.9	1.6	0.3 0.2
Grandparents	White	99.1	0.8	0.0	0.0	0.0 0.0
	Black	98.9	1.1	0.0	0.0	0.0 0.0
Grandchildren	White	93.3	5.6	0.9	0.2	0.0 0.0
	Black	91.4	7.2	1.1	0.2	0.1 0.0
Aunts/Uncles	White	98.7	1.1	0.2	0.0	0.0 0.0
	Black	98.7	1.0	0.2	0.1	0.0 0.0
Nieces/Nephews	White	94.8	3.8	1.0	0.3	0.1 0.1
	Black	94.1	4.1	1.2	0.4	0.1 0.1
1st Cousins	White	98.7	1.0	0.2	0.0	0.0 0.0
	Black	97.4	2.0	0.5	0.1	0.0 0.0
Non-Biological Kin	White	82.6	13.9	2.7	0.6	0.2 0.1
	Black	79.5	16.0	3.4	0.8	0.2 0.1

Table 2
Simulated Living Donor Evaluation Outcome, by Race and Genetic Relationship

Genetic Relationship	Race	Donor (%)	HLA	ABO	Exclusions (%)	
					Contraindication	Positive Cross-match
All	White	6.43	62.48	48.50	69.05	11.59
	Black	5.44	64.31	52.57	69.87	15.12
Full Siblings	White	21.00	21.91	31.38	58.72	7.10
	Black	18.18	21.92	33.27	62.77	9.06
Half Siblings	White	8.72	43.84	44.92	69.49	10.69
	Black	9.17	43.87	47.79	65.41	13.38
Parents	White	13.45	0.00	35.40	77.63	7.11
	Black	12.88	0.00	37.11	77.47	9.07
Children	White	22.30	0.00	35.17	63.20	6.85
	Black	18.87	0.00	37.07	66.98	9.14
Grandparents	White	6.21	43.88	44.90	78.38	10.55
	Black	6.19	43.90	47.90	76.76	12.80
Grandchildren	White	5.22	43.87	44.58	81.92	9.87
	Black	5.09	43.85	47.85	80.83	13.96
Aunts/ Uncles	White	11.84	43.77	44.99	58.88	10.32
	Black	9.30	43.86	47.98	65.38	12.45
Nieces/ Nephews	White	7.44	43.87	44.94	74.06	10.79
	Black	7.63	43.91	47.86	71.07	13.79
1st Cousins	White	5.37	65.82	49.78	66.08	12.23
	Black	4.87	65.84	53.28	66.13	14.78
Non-Biological Kin	White	1.67	87.74	54.26	67.02	13.60
	Black	1.40	87.73	58.54	68.63	17.61

Table 3
Estimated Percentage Race Gap Explained, by Simulation Counterfactual

ANY DONOR					
Counterfactual	Whites		Blacks		% Race Gap Explained
	Mean	90% Interval	Mean	90% Interval	
Baseline	0.58	(0.57,0.59)	0.63	(0.61,0.64)	--
Genetic	0.59	(0.58,0.60)	0.64	(0.63,0.65)	-14.48
Kinship	0.60	(0.59,0.61)	0.59	(0.58,0.60)	123.26
Health	0.58	(0.57,0.59)	0.62	(0.61,0.64)	-0.81
PRA	0.58	(0.57,0.59)	0.63	(0.62,0.64)	-18.72
All	0.61	(0.60,0.61)	0.61	(0.60,0.61)	95.84
NUMBER OF DONORS					
Counterfactual	Whites		Blacks		% Race Gap Explained
	Mean	90% Interval	Mean	90% Interval	
Baseline	1.10	(1.08,1.11)	1.25	(1.20,1.29)	--
Genetic	1.07	(1.06,1.09)	1.29	(1.25,1.33)	-40.59
Kinship	1.18	(1.16,1.20)	1.10	(1.07,1.13)	150.76
Health	1.09	(1.07,1.11)	1.25	(1.21,1.29)	-1.53
PRA	1.08	(1.06,1.11)	1.27	(1.24,1.30)	-20.39
All	1.15	(1.12,1.17)	1.15	(1.13,1.17)	97.23