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Original Investigation

Does Social Capital Explain Community-Level Differences in Organ Donor Designation?

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Policy Points:

- The growing shortage of life-saving organs has reached unprecedented levels, with more than 120,000 Americans waiting for them. Despite national attempts to increase organ donation and federal laws mandating the equitable allocation of organs, geographic disparities remain.
- A better understanding of the contextual determinants of organ donor designation, including social capital, may enhance efforts to increase organ donation by raising the probability of collective action and fostering norms of reciprocity and cooperation while increasing costs to defectors.
- Because community-level factors, including social capital, predict more than half the variation in donor designation, future interventions should tailor strategies to specific communities as the unit of intervention.

Context: The growing shortage of organs has reached unprecedented levels. Despite national attempts to increase donation and federal laws mandating the equitable allocation of organs, their availability and waiting times vary significantly nationwide. Organ donor designation is a collective action problem in public health, in which the regional organ supply and average waiting times are determined by the willingness of individuals to be listed as organ donors. Social capital increases the probability of collective action by fostering norms of reciprocity and cooperation while increasing costs to defectors. We examine

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whether social capital and other community-level factors explain geographic variation in organ donor designation rates in Massachusetts.

Methods: We obtained a sample of 3,281,532 registered drivers in 2010 from the Massachusetts Department of Transportation Registry of Motor Vehicles (MassDOT RMV). We then geocoded the registry data, matched them to 4,466 census blocks, and linked them to the 2010 US Census, the American Community Survey (ACS), and other sources to obtain community-level sociodemographic, social capital (residential segregation, voter registration and participation, residential mobility, violent-death rate), and religious characteristics. We used spatial modeling, including lagged variables to account for the effect of adjacent block groups, and multivariate regression analysis to examine the relationship of social capital and community-level characteristics with organ donor designation rates.

Findings: Block groups with higher levels of social capital, racial homogeneity, income, workforce participation, owner-occupied housing, native-born residents, and white residents had higher rates of organ donor designation ($p < 0.001$). These factors remained significant in the multivariate model, which explained more than half the geographic variance in organ donor designation ($R^2 = 0.52$).

Conclusions: The findings suggest that community-level factors, including social capital, predict more than half the variation in donor designation. Future interventions should target the community as the unit of intervention and should tailor messaging for areas with low social capital.

Keywords: organ donation, social capital, spatial statistics, geographic variation.

The growing scarcity of organs is one of the most pressing concerns facing the transplantation community.[1] Despite an increase in demand for organs and a heightened public awareness of the problem, the number of donors and organs available for transplantation has declined in recent years.[1-3] Currently, more than 120,000 Americans await transplantation, which is the optimal, and often the only, treatment for end-stage organ failure.[4] Waiting times, once measured in weeks and months, now exceed many years, resulting in an average of 18 people dying daily while awaiting a life-saving organ in the United States. Despite universal coverage and federal legislation mandating that "neither place of residence nor place of listing shall be a major determinant of access to a transplant," the chances of

receiving a life-saving organ transplant vary significantly by geographic region. This has resulted in significant differences in the waiting times for organs and the number of deaths of those on the waiting list. Stark geographic disparities can be found even among patients with comparable disease severity and need. For example, the 90-day transplant rates range from 18% to 86%, and death rates range from 14% to 82% across donation service areas.[5] Regional disparities in access to transplantation can be attributed to many factors, including the size and structure of the population, the number of transplant centers, the success of organ procurement organizations, and the availability of organs associated with varying rates of organ donor designation.[1-4]

Public policy initiatives have long aimed to increase organ donor designation by targeting individual-level factors, most recently through the use of educational initiatives and incentives.[6-8] Despite the limited success of running educational campaigns, publicizing organ donor designation,[6,9] and broadening the criteria for acceptable donors (especially the use of donors after cardiac death), geospatial determinants of organ donor designation remain poorly understood. Even though Morgan and colleagues[10] illustrated the importance of individual-level determinants—finding that approximately 15% of the variance in signing a donor card can be attributed to individual factors (particularly noncognitive beliefs such as fear, distaste, and medical mistrust)—our understanding of the effects of broader social forces remains minimal. Organ donor designation rates, especially among minorities and in low-income areas, are too low, for reasons that are poorly understood.[11-13]

Social Capital and Collective Action Problems

Implications for Organ Donation

Efforts to increase "altruistic" behaviors like voting, volunteering, and community participation rely heavily on social capital.[14,15] The social capital perspective offers a valuable and unique way of examining contextual factors affecting donor designation. Through this lens, organ donation can be viewed as a form of civic engagement and social altruism, revealing why communities with lower levels of social capital, trust, and cohesion may have fewer organ donor designators.

Organ donation is a collective action problem in public health, in which each individual benefits when everyone acts in a prosocial way and the reservoir of organ donors increases. The individual costs of registering as an organ donor (eg, discomfort with the decision, repugnance), however, may undermine participation. Social capital has been shown to mitigate collective action problems by encouraging prosocial behavior and reinforcing norms of reciprocity while increasing costs to defectors.[14] Other countries, such as Israel, have begun to reinforce norms of donation and reciprocity by giving priority to registered donors in organ allocation.[16] The United States has long granted living donors priority on the waiting list, which in a way supports reciprocity, although the motivation has largely been to reduce the risk the donors assume. Although organ donation has clear sociological underpinnings and depends on the public's willingness to donate, it is unclear how community-specific factors affect the likelihood of community members to donate.[17] Evidence from other literature suggests that community-level social capital is strongly related to the propensity of community members to engage in altruistic behaviors like organ donor designation.[18-20] Community preferences and values related to organ allocation vary widely and are closely tied to social valuations and perceptions of fairness, equity, and justice.[17] The features of communities that affect organ donor designation, however, remain unclear.

Social capital theory may help explain the geographic variation in organ donor designation rates and lower donation rates among racial or ethnic minorities.[21] In 2013, African Americans accounted for only 14.2% of all donors (16.6% of deceased donors and 10.9% of living donors), despite comprising 30.1% of the transplantation waiting list.[4] Recent evidence suggests that by 2050, Hispanic Americans will constitute a quarter of the country's population and that their presence on transplant waiting lists will grow by 260%.[22] Despite their growing need for transplantation, Hispanics are 60% less likely than non-Hispanic whites to donate organs.[22] Although many studies offer individual-level explanations, such as higher levels of medical distrust and differences in income, education, and religion, such factors do not completely explain the gap in donor designation rates.[11,12,22-30] Furthermore, few studies have connected individual determinants of donation with contextual factors, such as the built environment, residential segregation, crime rates, and residential stability. Given the high and increasing rates of residential segregation across the country, as well as the role of

such factors in influencing prosocial behaviors, contextual factors should be considered in explaining these groups' disproportionately low rates of donation.[15,18] It is worth noting that some racial and ethnic minorities' greater need for organ transplantation does not justify their donating their way to parity. Rather, a social capital framework better explains the social and environmental factors that may disproportionately hinder racial and ethnic minorities' willingness to donate organs, as they are more likely to reside in communities with lower social capital.[14]

Conceptualizing Social Capital

For the purposes of our study, we relied on Putnam's conceptualization of social capital, namely, "features of social organization, such as networks, norms, and trust, that facilitate coordination and cooperation for mutual benefit."[14(pp35-36)] So conceived, social capital captures our sense of solidarity, moral obligations, and social values, and it drives voluntary and altruistic behavior. Social capital increases the probability of collective action by "increasing the potential costs to defectors . . . , fostering robust norms of reciprocity . . . , facilitating flows of information . . . , including information on actors' reputations . . . , embodying the successes of past attempts of collaboration . . . , and acting as a template for future cooperation."[31(pp173-174)] Organ donor designation relies on many motivations, most central perhaps being altruism and generalized reciprocity, the belief that helping a stranger in need may result in the help being returned during a time of need.[32] A civic culture that promotes such norms aids both individuals and the collective. This may be the case for organ donation as well, as the organ pool relies on public trust and individual donations, and each individual's probability of receiving an organ should it be needed increases as the public's participation grows. Consequently, viewing organ donation through a social capital lens allows us to better understand low donation rates as fundamentally a collective action problem, in which efforts to enhance social capital may yield higher donation rates.

Using a social capital framework may be particularly helpful to understanding racial and ethnic disparities in organ donor designation. Although individual-level characteristics, such as low socioeconomic status and low self-efficacy, have been associated with a lower

propensity to donate,[25,26] these factors may also have a secondary effect by determining the type of community in which the individual resides. Community characteristics, in turn, have been shown to influence feelings of safety, belonging, and trust; access to social and health services; and information and attitudes toward organ donation.[12,17,18,25] In addition to contextual effects that affect individual characteristics, communities also form unique structures such as religious, neighborhood, business, and civic organizations whose impact exceeds the individual-level benefits to members. These groups establish and reinforce norms for reciprocity, trust, and participation. In the context of organ donation, these groups could establish norms for participating in the organ donation system and tailor messaging to address concerns unique to the community.[33-35] Finally, community social capital can help mitigate negative perceptions of societal inequalities, such as low social mobility and adversarial out-group dynamics.

Studies examining social capital and prosocial behavior demonstrate that people are more likely to engage in prosocial behavior if they live in areas with less crime, less residential segregation, greater social cohesion, and greater political participation, in which the norms of reciprocity and trustworthiness are strongly reinforced by the residents.[18,19,33,34] Social capital and residential segregation also predict levels of social engagement.[14] This includes donating to charity or volunteering, connectedness to friends and confidants, trust in local government and belief in one's own political influence, and work on community projects.[15,34,35] Individuals living in poor and residentially segregated communities may be less likely to engage in collective action—in this case, designating themselves as organ donors—owing to less trust in their community and public programs. This may partly explain racial and ethnic minorities' lower rates of organ donor designation, as they are more likely to reside in areas with low social capital.

Using Spatial Research Methods to Examine Organ Donor Designation Rates

Recent advances in spatial research methods allow us to examine more fully a set of unanswered questions about the relationship between community-level factors, like social capital, and altruistic behaviors, such as organ donor designation. This is important for two main

reasons. First, studies have long observed substantial geographic variation in donor designation rates that cannot be easily explained.[36,37] This variation impedes efforts to promote donor designation and leads to inefficient spending and ineffective targeting in community outreach. Second, although social capital and racial segregation are powerful predictors of altruistic behavior such as blood donation, charitable giving, and civic participation, previous studies explaining variation in organ donor designation have neglected community-level exposures.[34,35] Factors characterizing areas with high social capital that may also affect donation include trust in neighbors, age, race/ethnicity, socioeconomic status, and contextual factors such as homeownership, neighborhood poverty, crime rates, and residential segregation.[15]

Only 45% of licensed drivers and ID card holders have registered as organ donors through their state registry or motor vehicle department.[38] Areas with a particularly high demand sometimes have very low donation and donor designation rates, especially in communities with low social capital in which risk factors for kidney, liver, and lung failure are more prevalent.[25,26,39] This article examines the relationship between community variables, including social capital, and organ donor designation. Our analytic strategy takes into account both the contextual effects of living in an area with low social capital and the dose-response effect of living in an adjacent area. Using standard statistical models to estimate the influence of community factors and social capital on organ donor designation would violate a central assumption of independence because the effect of social capital spreads across communities. But spatial modeling adjusts for this by accounting for spatial autocorrelation between observations[40] arising from a lack of spatial independence in modeling donor designation.[41] To account for the multifaceted effects of social capital and residential segregation, we used a number of well-validated social capital measures, including residential mobility as measured by residents who moved in the last 5 years, residential segregation measured by isolation indices, civic participation measured by voter registration and voter turnout, political party affiliation measured by registered party, and community violence measured by violent-death rate. This is the first study, to our knowledge, to explain organ donor designation based on community-level factors, including social capital.

Methods

The Sample

The sample was obtained from the Massachusetts Department of Transportation Registry of Motor Vehicles (MassDOT RMV) database in 2010. It included 3,281,532 registered drivers residing in 4,466 census block groups (the smallest geographical unit for which the US Census Bureau publishes sample data). The sample reflected 73% of the population of eligible drivers in Massachusetts (individuals over age 16). The 4,466 census block groups in Massachusetts served as the most specific units of analysis in our study. This database contained individual-level records of organ donor designation, gender, age, and address. We obtained block group level demographic and socioeconomic measures from the 2010 US Census[42] and the American Community Survey (ACS);[43] social capital measures from the Public Mapping Project,[44] Dave Leip's Atlas of U.S. Presidential Elections,[45] and Social Explorer Religion 2010;[46] and death records from the Massachusetts Department of Public Health.[47]

Outcome Variable

The main outcome variable was the percentage of organ donor designation in each census block group in 2010, calculated by geocoding individual organ donor designations (using ArcGIS version 9) and aggregating them by census block group.

Independent Variables

Social Capital Measures. For this study, we used Putnam's conceptualization of social capital and operationalized social capital with such validated measures as residential mobility, residential segregation, voter participation, and violent-death rate.[15,33,48-54]

We measured residential mobility at the level of census block group using US Census data by dividing the number of residents in each census block group who moved during the last 5 years by the number of residents in each block group. We measured residential segregation at the census tract level using isolation indices,[51] which measured the likelihood of members of one racial group encountering another in a

census tract, and compared this with the larger metropolitan area. These indices were calculated from racial and ethnic compositions at the census block group level.[55]

For example, the isolation index for blacks within a census tract was calculated using the formula

$$SUM(b_i/B)\times(b_i/t_i),$$

where b_i = the black population of each census block group in the census tract for which this isolation index was being calculated;

t_i = the total population of the census tract for which this isolation index was being calculated; and

B = the total black population of the census tract for which the isolation index was being calculated.

We measured civic participation at the census tract and county levels using two indicators,[56-58] the percentage of registered voters in 2010 at the census tract level and the 2008 presidential voter turnout rate at the county level.[44] Finally, we measured community violence at the census tract level using the violent-death rate, as determined by the percentage of death records showing homicide as the cause of death in each census tract.[47]

Although sometimes included as a social capital measure, religiosity may function as both a social capital measure of community cohesiveness and a source of specific teachings regarding altruism and organ donation. Thus, although we did include religiosity in the social capital model as a control variable, we regarded it as separate from the rest of the social capital measures. We measured religiosity at the census block group level as the percentage of the total population in each census block group that self-designated as members of religious traditions. Although research on political ideology and social capital is still in its nascency, some studies have found an association among political ideology, social capital, and health.[59,60] We measured the political party affiliation at the census tract level using the percentage of residents registered as Democrats or Republicans in 2010.[44]

Neighborhood Demographics and Socioeconomic Status. In keeping with the existing literature,[24,61] we used a range of census-based measures to determine neighborhood demographics and socioeconomic status at the census block group level.[27,62] These measures were meant to capture the community's sociodemographic characteristics. At the census block

group level, to measure age structure we used the percentage of the population younger than 18 and the percentage of those 65 and older; to describe racial structure, the percentage of the nonwhite population; to describe poverty, the percentage of households below the poverty line and the employment rate of residents over 16; and to measure the distribution of the population and urbanity, educational attainment as determined by graduate degree holders among residents over 25 and population density (1,000s per square mile [SQMI]).

Data Analysis

We divided the block groups into deciles by organ donor designation and compared the top decile and bottom 90% on each of the independent measures. This univariate analysis estimated the relationships between organ donor designation and each of the variables and served as the basis for the multivariate analysis.

All the models used robust, clustered estimates of variance to account for intragroup correlation and nonidentical distributions when using a linear regression with a binary dependent variable. In the basic specification, using multivariable linear regression, we modeled the percentage of donor designation (Y) within block group i, with covariates

$$Y_i = \beta_o + \left[\textit{summation from } \mathrm{j} = 1 \textit{ to } p\right] \beta_j X_{ij}, \tag{1}$$

where X_{ij} is the value of covariate j in block group i. The parameter estimates should be interpreted as the estimated effect of a 1-unit increase in the predictor variable on the expected percentage of organ donor designation. All statistical models were calculated with robust standard errors (SEs) clustered at the most aggregated level (ie, if some variables included in a model are at the census tract level and others are at the block group level, the SEs were robust and clustered at the census tract level).

We fitted the Basic Model (Model 1) using community-level factors using census-based variables for demographics and socioeconomic status, including the percentage of the population younger than 18, the percentage 65 and older, the percentage of minorities, the percentage of households below the poverty line, the employment rate among residents over 16, the number of graduate degree holders over 25, and the population density (1,000s per SQMI).

We fitted the Social Capital Model (Model 2) using the Basic Model variables followed by the social capital measures: the percentage of residents who moved in the last 5 years; the isolation indices for blacks, Asians, and Hispanics; the percentage of registered voters in 2010; the percentage of residents registered as Democrats or Republicans in 2010; the 2008 presidential voter turnout; the violent-death rate; and the percentage of members of a religion. A significantly improved fit in the Social Capital Model would suggest the potential effects of neighborhood social capital, independent of the demographic and socioeconomic variables in the Basic Model.

To account for spatial dependence in our data, we defined a set of variables for adjacent block group characteristics (denoted by the prefix "Adj_"): linear combinations of the predictor values in neighboring block groups. We defined connectivity between block groups i and k, denoted by L_{ik}, as $L_{ik} = 1$ if block groups i and k are adjacent and $L_{ik} = 0$ otherwise. The spatial dependent predictor was then defined as

$$S_{ij} = \left[\textit{summation when k not equal i}\right] L_{ik} X_{kj} / \left[\textit{summation when k not equal i}\right] L_{ik}, \quad (2)$$

where S_{ij} is the mean of the values of the covariate j in the block groups adjacent to i. Because data were available only for census block groups in Massachusetts and for block groups on the border of Massachusetts and another state, k included only block groups in Massachusetts. We performed sensitivity analysis by restricting the sample to nonbordering census block groups. To assess whether there were spatial dependencies independent of the effects already included in the Social Capital Model, we fitted the following Spatial Dependence Model:

$$Y_i = \beta_o + \left[\textit{summation from } j = 1 \textit{ to } p\right] \beta 1_j X_{ij} + \left[\textit{summation from } j = 1 \textit{ to } p\right] \beta 2_j S_{ij}. \quad (3)$$

We included in the Spatial Dependence Model (Model 3) the spatially dependent predictors for all the variables in the first two models (Basic Model and Social Capital Model). For each model fitted, the measure of fit was reported as the adjusted R^2 value, defined as the squared correlation between the observed rates and the rates expected under the model.

Results

Figure 1 shows the organ donor designation rates in the Greater Boston area, and Figure 2 shows the organ donor designation rates across Massachusetts. First, we compared block groups in the highest decile of organ donor designation ($n = 446$) with all the other groups ($n = 4{,}020$) to examine the relationship between social capital and organ donor designation. Table 1 shows that the block groups in the highest decile for organ donor designation had significantly lower mean values for the percentages of the population under 18 and those 65 and older; the percentage of families below the poverty line; the percentage of minorities; the isolation indices for blacks and Hispanics (meaning areas where blacks and Hispanics are more segregated from whites); and religiosity. Conversely, organ donor designation was positively and significantly correlated with population density, percentage employed, percentage with a graduate degree, block groups with higher percentages of people who moved in the last 5 years, isolation index for Asians, percentage of registered voters, and percentage of registered Democrats. Violent-death rate, percentage of registered Republicans, and voter turnout were not significantly correlated with organ donor designation. Spatial dependence variables measuring the additional effect of exposure to a given characteristic of neighboring block groups demonstrated identical relationships, with the exception of a significant and negative correlation between violent-death rates in neighboring block groups and organ donor designation.

We used nested linear regression models (Table 2), in which we initially assessed the relationships between demographic and socioeconomic measures and organ donor designation (Model 1). We next added first-order social capital measures (Model 2) and then spatially dependent measures (Model 3) for all the variables in the first two models.

In Model 1, block groups with higher proportions of very young or older residents (under 18 or over 65) compared with those with higher proportions of working-age persons (aged 18 to 64) had lower percentages of organ donor designation, as well as block groups with a greater overall minority population, controlling for all other sociodemographic variables.

Model 2 examined the relationship between social capital variables and the percentage of organ donor designation, controlling for all the

Figure 1. Rate of Organ Donor Designations in the Greater Boston Area by Census Block Group

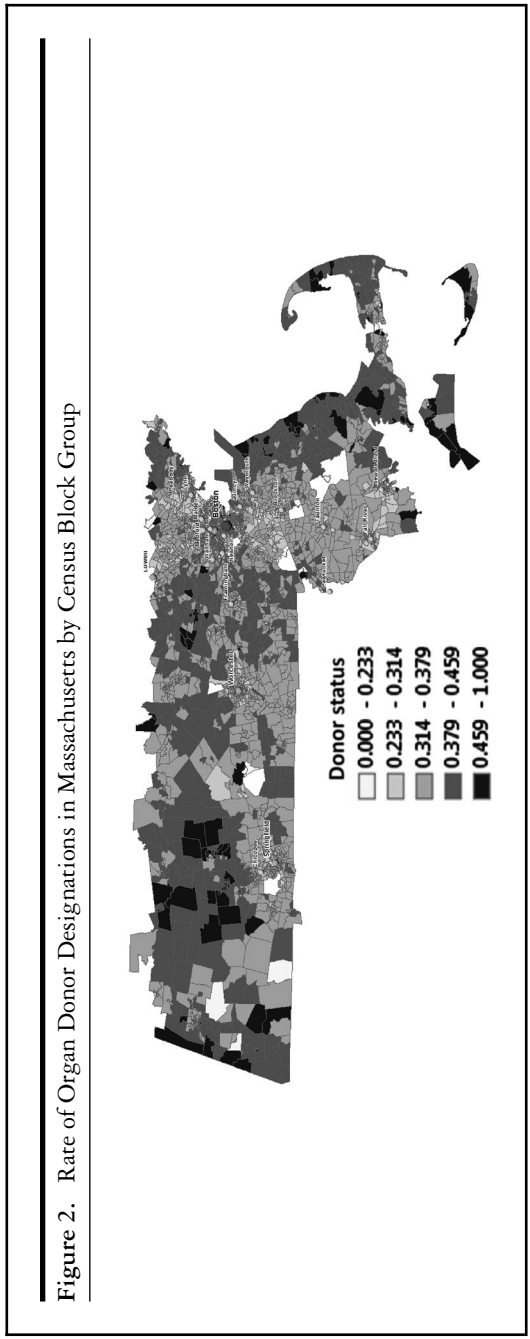

Figure 2. Rate of Organ Donor Designations in Massachusetts by Census Block Group

Table 1. Comparison of Block Groups in the Highest Decile Versus Other Deciles for Organ Donor Designation Rates in Massachusetts, 2010

	Top Decile ($n = 446$) Mean (SD)	**Remaining Deciles ($n = 4{,}020$) Mean (SD)**
Age < 18	0.159 (0.100)	0.218 (0.087)
Age > 64	0.131 (0.093)	0.144 (0.090)
Population density (1,000s/SQMI)	14.004 (17.950)	7.686 (12.182)
Families below poverty line	0.043 (0.080)	0.087 (0.132)
Employed	0.659 (0.132)	0.613 (0.119)
With graduate degree	0.316 (0.159)	0.151 (0.132)
Minority	0.130 (0.140)	0.195 (0.228)
Moved in last 5 years	0.373 (0.198)	0.303 (0.166)
Isolation index black	0.069 (0.092)	0.113 (0.160)
Isolation index Asian	0.102 (0.098)	0.088 (0.095)
Isolation index Hispanic	0.083 (0.096)	0.132 (0.152)
Violent-death rate[a]	0.002 (0.018)	0.004 (0.018)
Registered voters 2010	0.693 (0.116)	0.641 (0.108)
Registered Democrats 2010	0.294 (0.099)	0.244 (0.072)
Registered Republicans 2010[a]	0.071 (0.043)	0.070 (0.035)
Voter turnout 2008[a]	0.471 (0.072)	0.472 (0.054)
Members of religion	0.253 (0.052)	0.273 (0.039)
Adj _ age < 18	0.167 (0.073)	0.216 (0.055)
Adj _ age > 64	0.137 (0.062)	0.144 (0.052)
Adj _ population density (1,000s/SQMI)	12.839 (13.618)	7.200 (9.558)
Adj _ families below poverty line	0.058 (0.062)	0.084 (0.088)
Adj _ employed	0.646 (0.082)	0.614 (0.072)
Adj _ with graduate degree	0.288 (0.130)	0.154 (0.111)
Adj _ minority	0.164 (0.134)	0.190 (0.195)
Adj _ moved in last 5 years	0.364 (0.148)	0.303 (0.116)
Adj _ isolation index black	0.077 (0.078)	0.111 (0.146)
Adj _ isolation index Asian	0.107 (0.083)	0.087 (0.075)
Adj _ isolation index Hispanic	0.093 (0.085)	0.130 (0.132)

Continued

Table 1. *Continued*

	Top Decile ($n = 446$) Mean (SD)	Remaining Deciles ($n = 4{,}020$) Mean (SD)
Adj _ violent-death rate	0.002 (0.009)	0.004 (0.013)
Adj _ registered voters 2010	0.685 (0.093)	0.643 (0.094)
Adj _ registered Democrats 2010	0.291 (0.089)	0.245 (0.067)
Adj _ registered Republicans 2010[a]	0.070 (0.039)	0.071 (0.032)
Adj _ voter turnout 2008[a]	0.472 (0.070)	0.472 (0.053)
Adj _members of religion	0.252 (0.051)	0.273 (0.037)

Except as noted, all comparisons are significantly different at $p < 0.05$. Adj_ = linear combinations of the predictor values in adjacent block groups.
[a]Comparison not significant.

demographic and socioeconomic measures in Model 1. There was a strong positive relationship between organ donor designation and residential mobility (as measured by the proportion who moved in the last 5 years) (0.061, $p < 0.01$), higher education attainment (as measured by the proportion of graduate degree holders) (0.194, $p < 0.001$), and voter turnout (0.201, $p < 0.05$), controlling for all other variables in the model. The proportion of minority residents was negatively associated (−0.087, $p < 0.001$), meaning that a higher proportion of minority residents corresponded to lower organ donor designation. Even controlling for the proportion of minority residents, residential segregation (greater isolation of a particular minority group) was still significantly associated with the percentage of organ donor designation. The isolation index for blacks was negatively associated with organ donor designation (−0.056, $p < 0.01$), as was the isolation index for Asians (−0.086, $p < 0.005$), meaning that the greater residential segregation of blacks and Asians corresponded to the lower organ donor designation rate.

In Model 3, we found that the characteristics of neighboring block groups had significant and independent effects on the percentage of a

Table 2. Nested Linear Regression Models Predicting Organ Donor Designation Rates in Massachusetts, 2010

	Model 1: Basic Model		**Model 2: Social Capital Model**		**Model 3: Spatial Dependence Model**	
Variables	Estimate	*p*	Estimate	*p*	Estimate	*p*
Intercept	0.375	< 0.001	0.226	0.001	0.206	0.015
Age < 18	−0.108	< 0.001	−0.094	< 0.001	−0.059	< 0.001
Age > 64	−0.117	< 0.001	−0.142	< 0.001	−0.120	< 0.001
Population density (1,000s/SQMI)	0.000	0.267	0.001	0.047	0.000	0.392
Families below poverty line	−0.003	0.753	−0.012	0.373	−0.025	0.101
Employed	0.001	0.932	−0.023	0.154	−0.011	0.381
With graduate degree	0.229	< 0.001	0.194	< 0.001	0.125	< 0.001
Minority	−0.148	< 0.001	−0.087	< 0.001	−0.078	0.001
Moved in last 5 years			0.061	0.005	0.036	0.020
Isolation index black			−0.056	0.009	−0.049	0.045
Isolation index Asian			−0.086	0.003	−0.045	0.004
Isolation index Hispanic			0.008	0.717	−0.026	0.290
Violent-death rate			0.137	0.075	0.114	0.009
Registered voters 2010			0.126	0.062	0.074	0.443
Registered Democrats 2010			0.011	0.915	−0.069	0.701
Registered Republicans 2010			0.295	0.061	−0.021	0.934
Voter turnout 2008			0.201	0.012	−0.268	0.343
Members of religion			−0.200	0.128	0.000	0.931
Adj_age < 18					−0.155	0.013
Adj_age > 64					−0.235	0.004

Continued

Table 2. *Continued*

	Model 1: Basic Model	Model 2: Social Capital Model	Model 3: Spatial Dependence Model	
Adj_population density (1,000s/SQMI)			0.000	0.411
Adj_families below poverty line			0.090	0.017
Adj_employed			−0.027	0.550
Adj_with graduate degree			0.118	< 0.001
Adj_minority			−0.043	0.335
Adj_moved in last 5 years			0.085	0.007
Adj_isolation index black			0.029	0.337
Adj_isolation index Asian			−0.069	0.186
Adj_isolation index Hispanic			0.036	0.314
Adj_violent-death rate			0.086	0.534
Adj_registered voters 2010			0.133	0.292
Adj_registered Democrats 2010			0.057	0.780
Adj_registered Republicans 2010			0.448	0.126
Adj_voter turnout 2008			0.461	0.142
Adj_members of religion			−0.200	0.453
Adjusted R2	0.4010	0.4732	0.5202	

Adj_ = linear combinations of the predictor values in adjacent block groups.

proximal block group's organ donor designation. There were continued positive relationships for the percentages of those who moved in the past 5 years (0.036, $p < 0.020$) and those who had a graduate degree (0.125, $p < 0.001$) with organ donor designation. The proportion of residents who identified as minority continued to be negatively associated with organ donor designation (−0.078, $p < 0.005$). Residential segregation also continued to be significantly associated with donor designation, even controlling for all other variables, including the overall proportion of minorities, with negative relationships for the isolation index for blacks (−0.049, $p < 0.05$) and the isolation index for Asians (−0.045, $p < 0.005$). In addition, for spatial dependent variables, we found positive relationships for the adjacent block groups' proportion of families below the poverty line (0.090, $p < 0.02$), the adjacent block groups' number of graduate degree holders (0.118, $p < 0.001$), and the proportion of adjacent block groups who moved in the last 5 years (0.085, $p < 0.01$), controlling for all other variables in the model.

The variance explained by each model increased from the Basic Model, which included community-level sociodemographic characteristics, to the Social Capital Model, and further from the Social Capital Model to the Spatial Dependence Model. The set of social capital variables added in the Social Capital Model increased the adjusted R^2 from 0.40 (Basic Model) to 0.47, indicating that neighborhood social capital characteristics explained the differences in block groups' organ donor designation beyond the sociodemographic measures. The Spatial Dependence Model represented further improvement over the first-order Social Capital Model, with an increase in the adjusted R^2 from 0.47 to 0.52. This demonstrates that the community-level characteristics, social capital, and characteristics of adjacent areas all contributed to explaining the variation in donor designation. Characteristics of adjacent block groups were independently correlated with donor designation, beyond first-order sociodemographic and social capital measures. Sensitivity analysis demonstrated that all coefficients and confidence intervals remained consistent except for the rate of violent death, which became not statistically significant when the sample was restricted to nonbordering census block groups.

Discussion

Like voting or vaccination, organ donor designation is a collective action problem. Collective action problems involve activities that are vital to a

community and its residents but in which individual involvement often conflicts with self-interest. Organ donor designation is a collective action problem because even though the community benefits are significant, individual incentives to participate are low. Social capital and community activity can increase collective actions such as civic participation and vaccination.[63] Well-connected communities can more easily enforce norms of cooperative behavior and apply social pressure to overcome individual self-interest (in the cases of voting and vaccination).[64] Higher levels of social capital can improve information diffusion and help dispel myths surrounding organ donor designation. Importantly, social capital can also help show residents the rewards of organ donor designation by introducing them to people who may benefit from their action.

Our article examined whether community-level factors, including residential segregation, residential mobility, and political participation, explain geographic differences in organ donation designation. We found, for the first time, that community-level sociodemographic and social capital variables explain more than half of the variation in organ donor designation among block groups in Massachusetts. Furthermore, we found that the association with social capital extended even beyond the block group. Living near a neighborhood with low social capital was independently associated with lower levels of organ donor designation, even after controlling for the resident's own neighborhood characteristics. In particular, residential mobility, higher educational attainment, and higher levels of political participation were independently associated with higher rates of organ donor designation, even after adjusting for all other variables. This suggests that social capital effects are pervasive and may help explain the regional variation in organ donor designation. Residential mobility was somewhat surprising in that higher mobility was associated with higher rates of organ donor designation. Although this seemingly contradicts many studies finding that stable communities have higher rates of social capital,[65] our finding may be an artifact of the particular migration patterns of our sample. Both the Greater Boston area and Massachusetts as a whole draw many students, trainees, and high-skilled workers for temporary periods, many of whom develop strong ties to their local communities. Compared with the national average, fewer Suffolk County (which includes Boston) residents live in the same house for more than a year (78.2% versus 86.7% nationally).[66] In this context, highly mobile block groups may also have a higher socioeconomic status, which may play an important role, despite residential mobility's being independently associated with organ

donor designation. Future studies should examine whether residential mobility is associated with higher organ donor designation rates nationwide and how different types of migration (same county, adjacent county, same state, and out of state) affect organ donation.

Our findings may also help explain racial minorities' lower donation rates. Not only are minorities more likely to live in communities with high poverty and high crime rates, but higher levels of residential segregation among certain groups (blacks and Asians) also corresponded to even lower donor designation compared with more racially integrated communities with similarly low social capital. This finding demonstrates that when minority populations are less isolated and better integrated, they exhibit higher rates of altruistic behavior such as organ donor designation. This finding reinforces the importance of tailored messaging and strategic partnerships with community-based organizations in efforts to increase organ donor designation. Because Hispanics represent a growing proportion of the overall organ transplant waiting list, the effects of residential segregation on this population are worthy of investigation. Although our findings do not demonstrate that residential segregation affects organ donor designation among Hispanics, future research is needed to examine whether this is an artifact of the Massachusetts sample.

Ethical Implications: Local Mistrust and Geographic Sharing of Organs

Our findings have both empirical and ethical implications. Low social capital—which is often characterized by few positive interactions between members of different groups, fragile social ties, perceived or experienced discrimination, and strong kinship or group identity—may reduce social cooperation, which in this case results in lower organ donation rates.[14] Community-level characteristics like residential segregation, which is an indicator of weak between-group ties and mistrust, may partially explain the lower overall willingness to donate to a collective good.[67] In particular, the relationship between lower rates of organ donor designation and lower social capital strengthens the notion that mistrust is local, expanding on individual-level findings that have documented the importance of mistrust to organ donation decisions. For example, Terrell and colleagues examined the relationship between

blacks' willingness to donate organs and cultural distrust (a measure of how much blacks trust whites), motivation to volunteer, and gender.[68] The authors found that blacks with high levels of cultural distrust were less willing to consent to organ donation than were blacks with lower levels of cultural distrust. Similarly, Lam and McCullough found that greater "social distance" was associated with people "willing to donate organs to people similar to themselves before they will donate to strangers at large."[69(p455)] Beyond cultural and institutional distrust, minorities are often found to exhibit significantly higher rates of medical distrust. In examining the relationship between organ donor designation and knowledge, attitudes, social norms, medical mistrust, bodily integrity, and religiosity among African Americans, Morgan and colleagues found that African Americans with lower levels of medical mistrust were more likely to have signed an organ donor card.[25,26]

Myths discouraging organ donation are propagated in communities where the in- and out-group dynamics are tense, areas that often also exhibit low social capital.[70] These myths and misconceptions, propelled by medical distrust and distrust of government, differ but often follow a line of reasoning that suggests that medical professionals will not try as hard to save people who are registered as organ donors because of the high demand for their organs.[8,10,11] Another common belief is that the donor's family will be burdened with donation costs and that the body will be mistreated in a way that will not allow for an open casket burial. Finally, several studies suggest that concerns about fairness in organ allocation and access to transplantation, specifically that minority patients may not benefit from organs donated by minorities, has undermined efforts to increase organ transplantation among minorities.[71-73] Of all the misconceptions, this last one is likely the most damaging and most closely linked to social capital. The association between social capital and organ donor designation suggests that in conjunction with other efforts to promote organ donation and address mistrust, giving priority to the community where the donor resided may help reinforce norms of reciprocity and trust and may help promote organ donation in communities with low donor designation rates. Future research should examine how messages about fairness in organ procurement and allocation can be framed to address the concerns of local communities and institutions in a way that supports social capital and also whether such framing improves organ donor designation rates.

Currently, the transplant community is debating the merits of expanding geographic sharing of organs (eg, sharing organs across regions without abiding by the current practice of prioritizing the organ first to the donor's own region). The relationship between social capital and organ donor designation rates may also have implications for this policy and may lead us to question the common view that a broader geographic sharing of organs would improve both equity and efficiency, two of the main ethical criteria determining organ allocation policy.[74] Proponents argue that broader sharing is equitable in that it equalizes waiting times across regions and ensures that the organ goes to the patient most in need (as opposed to the patient highest on the list in a particular region, where the overall need may not be as high). Furthermore, critics of the current organ allocation system argue that it is subject to gaming, in that patients with means who are able to fulfill the residency requirements of more than one region can increase their odds of receiving a transplant, a practice referred to as "multiple listing." This practice, exemplified by notable cases such as Steve Jobs's speedy ascension on the waiting list to a liver transplant in Memphis, raises concerns about systemic fairness and transparency in organ transplantation.[75] Perhaps most compelling is the argument that there is no direct evidence that donors care whether their organ travels far or stays nearby, as long as it goes to a recipient who is in need and will be a good steward of the organ.[74] Our findings present a foundation for future studies to examine this.

Given that residents of the same community commonly share risks and benefits likely to affect both the need for and the availability of transplanted organs, such as social capital, access to health and social services, speed and helmet laws, rates of violent crime, and other social determinants, there may be ethical and practical imperatives for considering local prioritization. Under the current system, geographic prioritization is achieved largely by donation sharing areas (DSAs), zones with somewhat arbitrary borders that have developed organically over time. DSAs do not necessarily reflect meaningful boundaries and do not optimize equity or efficiency. Although our findings do not go so far as to indicate clearly how best to select boundaries, we have presented some initial evidence against expanded geographic sharing, illustrating that more research regarding local prioritization could promote both efficiency and equity by capitalizing on social capital.

Policy Implications

Several studies reinforce the notion that connectedness and social capital may play an important role in promoting organ donor designation. One recent study demonstrated that donor designation rates vary significantly across the country depending on the designation process, specifically on whether the Department of Motor Vehicles (DMV) employee was involved in registration. Hajhosseini and colleagues found that approaching DMV applicants verbally was associated with a higher designation rate, compared with other nonpersonal modes of donor designations.[76] Although numerous mechanisms may be involved, given that DMV employees often reside in the communities that they are serving, directly involving them in the registration process by encouraging them to ask registrants about their status may help increase cultural sensitivity and communication about organ donation. Earlier research examining people's rationales to register as blood donors has cited the importance of factors such as social responsibility and desire to contribute in explaining organ donation. Alessandrini found that most people reported donating blood because they felt they were socially responsible (24.6%), received personal satisfaction (28.3%), wanted to give back to the community (31.3%), and wanted to do good (13.8%).[77] These factors are closely related to social capital, civic engagement, and the common good. Future research should examine whether these motivations apply to organ donor designation as well.

Efforts to increase organ donor designation may benefit from an approach that integrates social capital when framing interventions. Although it is beyond the scope of our available data, future research should examine partnering with community organizations, religious organizations, unions, employers, and even social media websites to harness existing social capital and promote norms of reciprocity and trust.[67] Organizations deeply rooted in a community can help create and disseminate tailored messaging that may prove to be more cost-effective than the blanket marketing of an entire region. Successful efforts may include education and recruitment efforts in collaboration with well-respected and trusted philanthropies (eg, food banks, religious philanthropies). Alternatively, integrating tailored messages about organ donation into community-building and capacity-strengthening initiatives may provide another route to increasing trust, social capital, and organ donor designation in areas with low rates. These efforts could include local

infrastructure projects, environmental initiatives, and partnerships with local schools and parent-teacher associations.

Recent efforts using social media and online communities have shed light on the impact of social networks on influencing donation decisions. In May 2012, Facebook began allowing users to designate their organ donation status on their public profiles. The effects were striking, with 13,000 people registering to become organ donors on the first day, 21 times the average daily number of registrations. The "Facebook effect" suggests that both social capital and social networks can significantly increase prosocial behaviors, such as organ donation, by raising costs to defectors (being the only friend in a network not listed as an organ donor), increasing norms of trust and reciprocity surrounding giving, and enhancing the diffusion of information related to becoming an organ donor.[6] Although the dramatic social media effect was felt by state registries nationwide, it varied geographically, ranging from a 7-fold increase in Michigan to a 109-fold increase in Georgia. Particularly encouraging were states like Texas and New York, which have relatively low donation designation rates.[6] Although the half-life of the effect was short, the innovative use of social capital and social networks to mobilize support for a public health cause holds great promise for future interventions.

Another promising approach for increasing organ donation among minorities is harnessing social capital through partnering with local organizations, such as African American churches. In a recent randomized-control trial conducted in 22 African American churches in southeast Michigan, church members were trained as peer health leaders and conducted discussions about organ donation with church groups.[78] The study demonstrated that although attitudes toward organ donation did not change, organ donor designation increased in the intervention churches compared with that in the control churches. One interpretation is that although individual determinants, such as medical distrust, socioeconomic status, and perceptions of organ donation, may be static, social capital fostered by trust and participation in community organizations can increase prosocial behaviors such as organ donation, possibly by fostering norms of reciprocity and trust and increasing the perceived costs to defectors.

While higher rates of donation overall would increase the organ supply and thereby reduce the waiting times for everyone, higher rates of donation by minorities could disproportionately benefit the members of

minority groups. The reason is that although organs are not matched according to race or ethnicity, the chances are greater that criteria critical to donor-recipient matching, like blood type and some tissue markers, will be found more often among members of the same ethnicity.[79] A greater diversity and supply of donors could enhance equity and efficiency. Framing the local prioritization of organs using a social capital approach could help reinforce reciprocity and dispel myths associated with organ donor designation, thereby reducing the disparities associated with residential segregation. Furthermore, the greater diversity of organ donors could improve everyone's access to transplantation, increasing efficiency. Finally, a greater reservoir of organs from minority donors could improve both the likelihood and the quality of matches for minority patients wait-listed for transplantation, further enhancing equity. Reducing barriers to donation among racial and ethnic minorities in no way implies that the burden of the organ shortage rests on them. Instead, understanding the effect of contextual factors and intervening to improve social capital may help mitigate health disparities and ultimately improve voluntary participation in public programs such as organ donation.

Limitations

This retrospsective study is not without limitations inherent in the dataset. First, although the study contained individual-level data on age, gender, organ donation status, and address, the MassDOT RMV does not collect individual-level data on race, ethnicity, income, or occupation. Accordingly, as is true of most geospatial studies, we were unable to completely differentiate individual-level sociodemographic and social capital effects, even though our models adjusted for racial and ethnic composition at the block group level. Second, given the retrospective observational study design, the causal inference is limited. Our ability to measure social capital was also constrained by the data available at the state level. Although other surveys have used social capital measures, such as levels of trust in neighbors and community engagement, these data were not available by block group or census tract and were not available for the entire state, thus limiting their representativeness. Third, our models do not vary the heterogeneity within and around each census block group, and the analysis was restricted to the smallest unit of aggregation available for each variable. We were also limited

because we had information only from the MassDOT RMV. Although Massachusetts's donor designation rates are similar to the national average, care should be taken when generalizing these findings to other contexts. Although we used many of the commonly used social capital indicators, others might be able to broaden our understanding of the social capital mechanisms. This should be examined in future studies.

Conclusions

As our research demonstrates, people do not make decisions about organ donor designation in a vacuum. Interventions that focus on the community as the unit of analysis instead of the individual alone are more likely to increase participation in organ donation registries.

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