Kin Count(s): Educational and Racial Differences in Extended Kinship in the United States

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Abstract. Kinship networks are important but remain understudied in contemporary developed societies. Because hazards of vital events such as marriage, fertility, and mortality vary demographically, it is likely that average numbers of extended kin also vary meaningfully by education and race, but researchers have not addressed this topic. Existing research on kinship in developed societies focuses on group-level differences in multiplex kin networks such as those comprising household co-residence, instrumental and emotional support, and frequency of contact. By contrast, we provide the first population-based estimates of group-level differences in living kin in the contemporary United States. We estimate, by race, educational attainment, and age, average numbers of living parents, children, spouse/partner, full and half siblings, grandparents, grandchildren, aunt/uncles, nieces/nephews, and cousins, and test whether group differences in average kin counts are attributable to group differences in kin mortality and other processes.

INTRODUCTION

How many aunts, cousins, and nephews does the average U.S. resident have, how does this vary sociodemographically, and to what degree are group differences in vital rates responsible for these differences? These are demographically important questions because kinship ties play an important role in other key outcomes such as child survival and health, food provisioning, and financial and emotional support (Mare 2011, Sear and Coall 2011). Although a long line of studies has examined kinship systems in small, pre-literate societies, historical contexts, or rural areas (e.g., Bearman 1997, Morgan 1870, Padgett and Ansell 1993, Verdery et al. 2012), researchers have not undertaken broad, classificatory studies of kinship in large, contemporary societies like the United States. Talcott Parsons (1943) noted this fact in his 1943 functional analysis of the American kinship system, attributing it to a combination of inattention and infeasibility. On the attention front, neglect of kinship seems traceable to Marxist-Engelian ideas that kinship systems beyond the immediate family were antithetical to capitalist relations of production (Bloch 2013:12-13). Since then, there has been a general divergence between analyses of kinship in small societies, and studies of families or households in larger, economically advanced ones. Scholars of the United States have given much attention to various functional roles played by close family and socio-economic differences therein – for instance, three-generations living in the same household (Crosnoe and Elder 2002, Swartz 2009, Uhlenberg 1996), instrumental support (Mazelis and Mykyta 2011, Sarkisian and Gerstel 2004), and contact with mothers, siblings and other relatives (Raley 1995). However, these analyses have largely ignored questions of kin availability. How many living kin do Americans have, and how do these counts vary by social group? Until very recently, existing studies have also largely neglected the empirical study of more distant kin like grandparents and cousins despite strong theoretical arguments articulating the important roles such kin might play in an individual's life (Mare 2011). Even those wishing to ask such questions, however, have been hindered by barriers to the feasibility of conducting kinship research in large societies. In this paper, we redirect attention to American kinship by showing that it may be feasibly examined using existing survey data and social network methodology.

Compounding this general sociological inattention, demographic research on kinship in developed societies tends to ignore network theory. This is problematic because network theory offers a parsimonious framework to highlight the mechanisms through which kinship effects matter for demographic outcomes. A fundamental insight of the networks literature is that network ties can be dynamic and multiplex (Moody, McFarland and Bender-Moll 2005, Verbrugge 1979): ties can be created and dissolved, and different types of ties can overlap with one another. In addition, the networks literature characterizes kinship ties as role relations (White 1963), which means that they constitute a persistent latent structure (a role) that can achieve multiplex status by being "activated" as another tie type - for instance, as a channel of social support. As Parsons noted, however, the types of formal network analysis typically explored by anthropologists and others in the social network research tradition have not been applied to American kinship (Bearman 1997, Davis and Warner 1937, Weil 1949, White and Jorion 1992, White and Jorion 1996), partly because the American kinship system has features "not closely approached in any known non-literate society" (Parsons 1943:22).[1] Prior studies of American kinship, emanating primarily from the demographic and family literatures, have typically only examined dyadic kin ties that have been activated along some relational dimension – e.g., through co-residence or offering financial support – at a given point in time. This neglects kin ties which are not multiplex with respect to that dimension at that point in time, which underestimates the potential importance of extended kin, understates the potential pool of kin, and conflates group differences in kin functions with differences in kin availability. By contrast, we assert that it is important to chronicle the general set of living kin, what we refer to as kinship structures, in order to understand the distribution of kin availability for contemporary Americans.

In addition to population averages in kin counts, it is important to understand *variation* in kinship structures. Because age so strongly structures probabilities of vital events, a strong relationship between age

[1] The features of the American kinship system that make it unique from pre-literate systems and European and other systems are reviewed by Parsons in greater depth, but the most notable components are: a) a lack of extended kin groupings (e.g., patrilineal or matrilineal clans); b) a lack of kinship exogamy or marital preference except incest taboos; c) a high prevalence of independent and isolated conjugal units; d) presence of norms of intestancy (no gender or birth order favoring in inheritance); e) gender symmetricality. Put more succinctly, the American kinship system is open and dispersive, what Parsons refers to as an "open, multilineal, conjugal system" (Parsons 1943: 24). Parsons discusses class and racial deviations from some but not all of these distinctive features on page 29.

and certain kin counts is obvious (e.g., toddlers have no children, 90 year olds have no living grandparents), but the degree of age variation in each kin count between these extremes is unclear. Due to long-running racial and socio-economic differences in fertility, mortality, and marriage rates, it is likely that strong differences in counts of living kin exist between these groups. These differences are almost tautologically true for certain types of kin – group difference in childbearing or marriage rates will, by definition, translate to educational differences in numbers of born children or married spouses – but their ramifications for extended kin are understudied outside of mathematical and simulation-based research. For close relations, such as children or spouses, the number of living kin of these types will be affected by mortality in addition to fertility and marriage rates. For more contingent relations, such as cousins, an even larger set of conditional events play a role. The number of cousins one has depends on: 1) how likely is it that one's grandparents had multiple children who lived to their reproductive years, 2) and how likely it is that one's parents' siblings had children, and 3) how likely it is that they remain alive. These questions highlight the fascinating symmetry between historical demographic processes and current kinship networks, a symmetry that has rarely been explored empirically. Therefore, examining racial and educational differences in numbers of living kin of various types provides a mirror onto the consequences of several historical socio-demographic processes, including: fertility, mortality, marriage, and the intergenerational transfer of social and human capital as it affects demographic rates. As we show in this paper, kinship structures reveal heretofore unseen angles regarding the historical confluence of socio-demographic processes across generations.

There are two main objectives of this paper. First, we enumerate age, racial, and educational differences in counts of living spouses, parents, children, full siblings, half siblings, grandparents, grandchildren, aunts and uncles, nieces and nephews, and cousins. We remain agnostic about how these differences arise, for instance, we do not address whether having more siblings makes one less likely to attain higher levels of education or whether having higher levels of education leads one to have fewer children. Rather, we document group differences in kin counts. Second, we test two important potential explanations for group-level kinship differences: differential kin mortality, and the differential existence of ties that are necessary conditions for a kin tie to be observed (e.g., one must have children to have grandchildren).

To meet these objectives, we use a largely untapped resource for characterizing contemporary American kinship patterns, the Family Identification Mapping System (FIMS) of the Panel Study of Income Dynamics (PSID). The FIMS data track sibling and parent ties and the survey instrument contains marital identifiers. We use network methods to extend these elementary network ties to other kin types of interest (Batagelj and Mrvar 2006, Verdery et al. 2012, White 1963). Our analytic design corrects for key confounders and the complex study design to provide the first population-based, and most comprehensive study of kin availability in the contemporary United States. Because these data come from the PSID, our results are generalizable to contemporary white and black Americans who descend from individuals in the United States in 1968.[2]

We first review previous studies of American kinship and discuss how they have typically focused not kin functions rather than kin availability. Next, we describe the data and methods we use to construct and analyze the kinship networks and account for key confounders and data limitations. We then present our findings and conclude with a discussion of how data on kinship structures can improve our understanding of the role that kin play in contemporary American society.

BACKGROUND

Most previous investigations of racial, ethnic, and (less commonly) educational differentiation in family and kinship examine kinship functions among multiplex ties, not kin availability. For instance, much previous research has examined patterns of household co-residence (Angel and Tienda 1982, Hofferth 1984, Ruggles 1994), kin contact (Raley 1995), and kin support (Mazelis and Mykyta 2011, Sarkisian and Gerstel 2004). These kin functions capture the multiplex nature of kin ties, for example that the respondent *has* a grandmother and *also receives support* for *or co-resides* with that grandmother. Although research in this area has yielded many valuable insights, kinship functions and kin availability are not identical. This research typically finds that African Americans, in addition to higher fertility rates (Census 2011) and have larger households on

[2] Although the PSID includes respondents from Latino, Asian, Pacific Islander, Native American, and other racial/ethnic backgrounds, we focus on the kinship networks of white and black respondents for reasons discussed below.

average (Choi 1991, Kamo 2000, Peek et al. 2004). Although these findings could be produced by group differences in kinship structures, they may also be produced in part by differential tendencies for kin ties to operate in this way, suggesting the need for descriptive research on kinship structures to contextualize these findings.

Household Composition

Research on household composition illustrates the potential importance of studying patterns of kinship structures. For instance, much research has investigated three-generation households containing grandparents, parents, and children (Ruggles 2007, Swartz 2009). It is frequently argued that the emergence of this household form is a result of increases in human longevity since the industrial revolution. Since people are living longer, they are more likely to live until they have grandchildren (Crosnoe and Elder 2002, Uhlenberg 1996). Fertility decline has resulted in smaller generations at the bottom of the lineage, resulting in what is frequently called a 'beanpole' kinship structure (Bengtson 2001, Uhlenberg 1996). Although researchers of household composition have debated the extent to which population fertility and mortality patterns influence the likelihood of observing different household forms (Ruggles 1993), it has been impossible to directly test whether the rise of three-generation households is a function of the availability of three generations who are simultaneously alive. This is due to a lack of data on the number of available kin from each generation. Without measuring the full kinship structure, researchers cannot empirically test whether the odds of forming a three-generation household has increased over time conditional on the availability of three living generations – grandparents, parents, and children – in a lineage.

Kin Contact

Research on demographic patterns of contact with kin provides another example of the potential utility of studying kin availability. For the most part, Americans interact with their kin quite frequently, especially inter-generationally (Connidis 2001, Lawton, Silverstein and Bengtson 1994), but the frequency and type of kin contact is strongly associated with socioeconomic status and race, among other characteristics. McPherson, Smith-Lovin and Cook (2001) report that over half of the core discussion networks of Americans in 1985 and 2004 were composed of kin, and that not-kin only outnumber kin in these networks amongst the most highly educated individuals (those with more than 14 or 18 years of education in 1985 and 2004). More indirect measures paint a similar picture. For instance, both Blacks and working class persons are more likely to live near their kin and have more frequent contact with them than Whites and middle class persons respectively (Cherlin and Furstenberg 1986, Connidis 2001).

Historical demographic differences between groups are a likely mechanism that could contribute to these differences because Whites and the college-educated have long tended to have fewer children than other groups (Yang and Morgan 2003). Studying group patterns of kin availability could increase our understanding of these patterns by assessing whether group differences in total contact with kin owes to differences in the number of contacts, the intensity of those contacts, or some combination. However, there are also reasons to suspect that group differences are not only caused by historical demography. For instance, we would not expect meaningful gender differences in kin availability in the contemporary United States because son-preference, sex-selective abortion and gender differences in infant mortality are insufficiently large to generate such differences, but authors have noted that African American women are in more frequent contact with their kin than white women, whereas the reverse is true when comparing men by race (Raley 1995). Knowledge of group differences in kin structures will increase our understanding of these processes.

Kin Support

Research on kinship patterns of instrumental and affective support provides an additional example of the importance of studying kin availability. Beginning in the 1960s with the publication of the Moynihan Report (Moynihan 1965), which attributed racial gaps in poverty to differences in family structures, a large literature has developed which looks at the link between race, ethnicity, socioeconomic status, and kinship (Aschenbrenner 1975, Moynihan 1965, Stack 1974). Countering the Moynihan Report, many have argued that, although the 'traditional' nuclear family among African Americans appears to be characterized by greater instability, this is compensated for by the presence of stronger extended kinship ties (Aschenbrenner 1975, Martin and Martin 1985, Stack 1974). An assumption that emerged from this research was that African Americans exchange more assistance with their extended kin than Whites, but the empirical reality has turned out to be more complicated (Lee and Aytac 1998, Roschelle 1997, Sarkisian, Gerena and Gerstel 2007, Swartz 2009). As with research on household forms and kin contact, understanding differences in kinship structures may shed light on differences in the strength of extended kin ties and support.

Summary

This paper builds on existing demographic and family research which has tended to examine multiplex kinship functions rather than the underlying kinship structures. We bring a social networks approach to the study of contemporary American kinship and document the availability of kin ties. This approach answers the longstanding call from Parsons to unite the anthropological and sociological approaches to kinship and family, and it pays particular attention to a topic he only began to explore: how such patterns vary by race and class (see Parsons 1943:28-29). Our hope is that future work will build on this by examining the structure and functions of non-co-resident kin, the demographic processes which produce differential availability of kin at the group level, and adjusting between-group comparisons of kin functions for the availability and structure of kin.

METHODS

Data

We use data from the Panel Study of Income Dynamics Family Information Mapping System (PSID FIMS). The PSID began in 1968 by following a nationally representative, household-based sample of over 18,000 respondents. Data were collected annually from 1968 to 1997 and then biennially, with data available through 2011. The PSID follows the original, nationally representative sample of U.S. households using a genealogical design – as members of the original households left home, the study followed the new households they formed in addition to the original households. So, for instance, when children who lived in the originally sampled household grew up, moved out and formed new households, these household are studied in subsequent waves. Since most households consist of bio-legal kin, this study tracks the evolution of biological, adoptive, and marital lineages over a 43-year span. The FIMS data set provides linkage variables delineating parent-child (biological and adoptive) and sibling (distinguishing full-, half-, and step-siblings) ties among observations. The PSID has had high response rates and appears to provide "good representation of the corresponding national population with coverage of approximately 97% of the U.S. population of children in 2007 and reasonable balance for most groups" (Duffy and Sastry 2012:0). Because of this study's genealogical design, the PSID is the most comprehensive data on kinship networks in the U.S., but has never been used to describe the distribution of extended kin.

Over the course of the study period (1968-2011), 73,251 individuals have been interviewed as part of the PSID. However, we examine the kinship structure of a subset of those respondents. First, we exclude respondents that were never part of the bio-legal networks of the original households – for instance, someone renting a room or never lived with bio-legal kin. Second, we exclude supplementary samples that were added to the study over time because these families are observed over a much shorter timeline which severely limits the amount and quality of the kinship network data for these families. The largest of these supplements was the Latino household supplement added in 1990. Because these supplementary respondents cannot be studied using our methods, our sample consists of households descended from white and black households in 1968 (described in more detail later). Third, we do not examine kinship structures for persons interviewed in this dataset that died before 2011 or permanently left the sample. However, those who died before 2011 are utilized in the kinship network calculations for other respondents, provided they lived at some point with a PSID sample member. Last, we cannot examine kinship structures for persons married or partnered into the PSID lineage because we do not have full kinship data on their side of the family. However, these persons are counted as ties for their partners and other family members in the PSID lineages for which we have full kinship data. With these restrictions, we are left with an analytic sample of 7,186 people reporting on 41,545 living ties of interest.

Due to the PSID's data collection design, our analytic sample, weighted using the 2011 cross-sectional weights, is approximately representative of third generation or higher Whites and Blacks in the U.S. This represents a large proportion of the contemporary U.S. The Census Bureau estimates that 75.8% of Americans in 2013 self-identify as non-Hispanic White alone or black or African American alone,[3] and the

[3] http://quickfacts.census.gov/qfd/states/00000.html. Accessed 11/16/2015.

number is larger when considering the adult population only. Other ethnic groups such as Asians and Latinos, that have had high immigration rates since the PSID began in 1968, are not represented in our sample. Thus, our results are generalizable to bio-legal descendants of Black and White U.S. residents in 1968.

Measures

Dependent variables: Kinship Ties

Our analysis describes a broad range of different kinship ties: parent, child, spouse/partner, full sibling, half sibling, grandparent, grandchild, aunt and uncle, niece and nephew, and cousin ties. This is a much more comprehensive set than is typically explored. From the data, we identify union ties as either self-reported marital ties or non-marital ties between co-resident individuals who bore a child together while being co-resident in any survey year (we call these partner ties). The data do not allow us to measure non-marital, stable unions between heterosexual or homosexual couples without children. We use the household-based structure of the PSID study to identify kinship ties between persons connected by chains of co-residence. Not only can we identify the relationships between people who have ever lived with that kin, but we can also measure ties through other family members, such as between people who have either lived with other kin who have lived with that kin, and so on. Most kinship ties likely meet this definition since the elementary ties of bio-legal kinship (marriage/partnership, parent-child, and siblings) are typically co-resident at some point when measured every year or every other year. For each relationship type, we model the number of living ties of that type. For spouses/partners, this includes ex-spouses.[4]

To characterize kinship ties, we use matrix multiplication methods of kin identification (Batagelj and Mrvar 2006, Verdery et al. 2012, White 1963), incorporating information on biological, adoptive, and marital ties to characterize the full kinship structure. Stata code to run the specific algorithms we used are available as an electronic supplement to this article.[5] The key intuition is that all bio-legal kinship ties can be defined as a

[4] As a robustness check, we also modeled current partners only, and found substantively identical patterns (results not shown).
[5] Any future updates or expansions to this code will also be posted on the lead author's webpage (URL OMITTED).

function of three elementary matrices: parent matrices (**P**, a non-reciprocal matrix in which $\mathbf{P}_{i,j}$=1 if person *j* is person *i*'s parent and =0 otherwise), sibling matrices (**S**, a reciprocal matrix in which $\mathbf{S}_{i,j}$ =1 if *j* is *i*'s sibling and =0 otherwise), and spousal matrices (**E**, a reciprocal matrix in which $\mathbf{E}_{i,j}$=1 if *j* is *i*'s spouse and =0 otherwise). For instance, one's grandparent is one's parent's parent, and one's aunt is one's parent's sibling or the spouse of one's parent's sibling (algorithms available upon request). Using these matrices, we calculate the broad kinship structures of contemporary Americans.

Independent variables: Age, Race, and Education

We examine the kinship structure of respondents in the analytic sample by age, race, and educational attainment. *Age* is measured as either one's PSID-calculated age in 2011 or, if one is still alive but a non-respondent in 2011, the last valid reported age plus the differences in years since that report. We code age categorically as 25-34, 35-44, 45-54, and 55 and above.

Education is measured as the most recent valid 2011 response to the question, "What is the highest grade or year of school that (he/she) has completed?" and we recode this into four categories: less than high school, high school, some college, and a four-year degree or higher. If no valid education measure is available in 2011, the most recent valid measure is used. All analyses of educational differences are restricted to those 25 years old or older because many younger people are still completing their education. *Race* is measured at the household level based on head of household and "wife" reports.[6] Similar to our education measure, if no measure was available in 2011, we use the most recent valid measure.

Key confounders: Opportunities for ties

We are not able to observe certain types of ties for certain respondents. For example, we are unlikely to observe the grandparents or cousins of the heads of households in the first wave of the data, because those kin alters are unlikely to live in an observed chain of connected households. Our analysis addresses these

[6] How this was done depends on the relationship to the head of the person whose race is being assigned. If they are a child, their race is inferred from that of the head and wife (if available). So for children or grandchildren of the head, the same race is assigned if head and wife are the same race, and multiracial is assigned if the head and wife differ. If that person is the child of just one of the adults, that adult's race is assigned. If one is the head or wife's sibling or parent (or other older-generation relative), one is assigned the head or wife's race, respectively. Other relationships with indeterminate relationships with the head are assigned as though they their children.

aspects of the study design so that we do not underestimate many kin ties. We define a measure that indicates whether an individual's age and generation in the PSID data collection design makes it likely that a tie of a specific sort will be observed for that individual. We call this an individual's *opportunity for a tie* (OFT), and it depends on that individual's age and generation in the PSID. We define generation by the number of measured parent-child ties preceding someone in a lineage: first generation (G1) respondents are those who have no parents, grandparents, or great-grandparents in the PSID dataset; second generation (G2) respondents have a parent but no grandparent or higher; third generation (G3) respondents have a grandparent but not great-grandparent or higher; and so on. We cannot reliably observe the parents of a G1, but we likely can observe parents for respondents that are G2 or later. Similarly, G2 persons in this study cannot, by definition, have measured grandparental ties, and, because of this, it is unlikely that we would see their cousins unless, at some point during the PSID, their parents lived with their aunt or uncle.[7] Since the probability of this outcome may be related to education, we define all G1 and G2 persons as not having the opportunity for a cousin tie. In addition to generation, age also plays a role because of age-patterns of fecundity, fertility and marriage. The specific definitions of OFT we use for each tie type are as follows. For each of the OFT measures below, we set them equal to one if the condition is met and equal to zero if it is not:

OFT(Child): Any generation, age ≥20

OFT(Half-Sibling, Full-Sibling, Parent, Niece/Nephew): G2 or higher

OFT(Grandparent, Aunt/Uncle, Cousin): G3 or higher

OFT(Grandchild): Any generation, age ≥40

OFT(Spouse/Partner): Any generation, age ≥18.

In constructing these OFT measure, we make several age assumptions. We assume a minimum marriage/partnering age of 18 and minimum intergenerational interval of 20 years.[8]

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[7] It is worth noting that simulation evidence from villages in Thailand has shown that directly enumerating sibling ties can reduce biases in counts of extended kin by more than 75% (Entwisle et al. 2009).

[8] Of 15-19 year olds who are not in our analytical sample because of the 25 year old cut-off but who are in the PSID-FIMS data in 2009, only 16 cases (0.94%) had children. There was not a significant difference by education group in these rates, though there was an association (t=0.85); these facts support our decisions about intergenerational intervals.

Key Confounders: Missing Children in Founding Households

In the initially-sampled households of the PSID (but not subsequent ones), we do not observe children and ex-spouses of householder couples that have already left the household. For these households, we are missing some children and sibling ties, and extended kin ties that are linked through these G2 kin (G3 niece/nephews to G2 aunts/uncles, G3 cousins to one another, etc.). To adjust for this problem, we calculate a multiplier, M, that converts the observed kin count O to the true total kin count T, as T=O*M, so that M=T/O. Further decomposing T into unobserved ties O and unobserved ties U, we can express M as (O+U/O), meaning that we can calculate M if we can estimate U. To do so, we use an item from the original 1968 household survey of the PSID that asks for the number of children of the head of household under 25 who are not living with their parents. Calculating the analytical-sample-wide sum of this figure (our estimate of U) as 1,940 and the total observed sibling ties as 18,632, we estimate M=(18632+1940)/18,632≈1.104. We use this estimate of M to adjust all calculated means for affected kin counts upward by ten percent in our adjusted regression models. For child counts (which are presented as predicted probabilities and cannot be straightforwardly adjusted as mean counts can), we add an additional child to an observation's count with a randomly-generated probability of 0.104, then re-estimate the regression.

Key Confounder: The 'missing half' problem

Because the PSID sample follows only the direct descendants of originally-sampled households, we do not observe kin connected through persons who 'marry in' to the focal lineage. Figure 1 shows that the study follows the PSID branch of the respondent's family, but not the other side. This has two key implications for our analysis. First, we do not have full kin information for relatives who marry into the lineage, and therefore these respondents are excluded as focal observations in this analysis. Besides decreasing our sample size, this does not affect the analysis because it is essentially a coin-flip as to which person descended from a PSID household in a given marriage/partnership. Second, the missing half problem leads to underestimates of certain kin ties (cousins, aunts/uncles, and grandparents) by approximately half because

Thus, although these age assumptions are violated in a few cases, we drop such cases from our analysis to ensure maximum comparability between groups.

nearly all sample members will have one parent who is not a member of an original PSID household. Because there is no compelling reason to suspect systematic differences between the kinship structures of direct descendants of the PSID original households and those who marry into them, we assume these data are also missing at random conditional on an individual's generation in the study. Accordingly, we present counts of grandparents, aunts/uncles, and cousins by multiplying all observed values by two, conditional on the focal individual's generation in the data. It is important to note that the missing half problem does not apply to counts of parents, full- and half-siblings, children, nieces, nephews, spouses/partners, and grandchildren because this 'omitted half' problem is not encountered when looking at direct ties or down or sideways through the generation structure for those with the 'PSID gene'. Finally, it is unlikely that our estimates of racial or educational differences in counts of these ties are biased, because this would require that the kinship structures of persons who 'marry/partner in' to these lineages be systematically and unobservedly different by race or education. As described below, we offer sensitivity tests that suggest that such factors are not likely to bias our results.

-- FIGURE 1 HERE --

Analysis

We conduct our analysis in three stages. First, we describe the number of kinship ties by type over the life span (Figure 2). Second, we use two types of regression models to estimate counts of different kin types accounting for study design and to test whether these kin counts differ by age, education, and race. We use zero-inflated negative binomial (ZINB) (Long 1997) and ordered logistic (OL) regression models to estimate counts of different kin types. We used ZINB models for estimating kin types with a higher range of counts (full siblings, half siblings, grandchildren, aunts/uncles, cousins, and nieces/nephews) [9] as follows:

[9] In the ZINB models, inflated counts of zero ties were modeled as a function of age groups. In some instances, models converged using cubic age specifications but not when using categorical specifications. Accordingly, results of aunt/uncle counts by education are modeled by specifying age cubically. For full sibling counts by race, the model converged when we specified age effects cubically in the inflation model (but not in the count model), and we accordingly report those results. For models where both age operationalizations converged, supplemental analyses (not shown) indicate substantively identical contributions.

$$\log(\lambda_i) = \alpha + \beta_1 D + \beta_2 A + \beta_3 DA + \varepsilon \quad (1)$$

$$logit(p_i) = \alpha + \beta_1 D + \beta_2 A + \beta_3 DA + \varepsilon \quad (2)$$

where D indicates the demographic group (education or race), and A indicates age. Equation (1) is the negative binomial model, and equation (2) is the zero-inflation model.

For kin types with narrower count ranges, the ZINB models were not appropriate, so we modeled those tie types (parents, children, grandparents, and spouses) using OL models[10]:

$$P(Y = i) = P(\kappa_{i-1} < \beta_1 D + \beta_2 A + \beta_3 DA + \varepsilon < \kappa_i) \quad (3)$$

where Y is the dependent variable, i is a particular value of it, and κ_{i-1} and κ_i are cutpoints in the underlying function. Because the independent variables of interest are unordered categorical and modeled interactively, we conduct joint significance tests for the total effect of education and age using a Wald test of the hypothesis that the joint effect of all regression terms including education (the main and interactive effects) are significant, and an identical test for joint race and age effects. In all of our regression models, we separately estimate age patterns of each type of tie by education and race, specifying age categorically. We adjust the standard errors for the non-independence of observations within lineages using the sandwich estimator (Rogers 1993). We also subset the analysis to those who have the opportunity for that tie. The results of these regression models are presented first by education (Tables 1-2) and then by race (Tables 3-4). For tie counts modeled using ordinal logit models, we present the predicted probabilities of different kin count categories by age and education or race. For tie counts modeled using ZINB models, we present the predicted counts by age and education or race.

Third, we examine the degree to which group-level differences in kin counts can be explained by kin mortality and the presence of intervening ties. Kin mortality may be an important mechanism generating differences in kinship structures because race, educational attainment, and health are correlated within kinship networks (McPherson, Smith-Lovin and Cook 2001), and differences in kin counts by education or race could be partially produced by differences in kin mortality. We also examine the extent to which differences in kin

[10] As a sensitivity test, we also estimated multinomial logit models for the same dependent variables, and obtained consistent results (not shown).

counts owe to the behavior of the index individual vs. the behavior of their kin members through a test that we refer to as an intervening tie test. Intervening ties are important to examine as a potential mechanism in creating group differences in kin because of the way in which kinship networks are structured. In order to have a cousin, one must have an aunt or an uncle. Similarly, one must have a sibling to have a niece/nephew, or a child to have a grandchild. Educational or racial differences in connections to some types of kin (i.e. cousins, niece/nephew, or grandchildren) could be explained by differences in the behavior of the reference individual (e.g., one having a child) vs. the behavior of other kin (e.g., one's child having a child). Similar possibilities exist for several types of kin (aunts/uncles, siblings, or children), though the chains of relations are more complex.[11] For example, one could have no cousins, not because one has no aunts and uncles (a feature of one's grandparents behavior), but because one's aunts and uncles are childless. Thus, we test whether differences in the numbers of kin counts by race and education are due to kin fertility or mortality.

To assess the degree to which each of these factors explains educational and racial differences in kin counts, we proceed in two steps. First, we estimate identically-specified models, subset to those who either have no recorded deaths for that tie type (for the mortality test), or to those who do have the intervening tie (for the eponymous test). Second, we generate predicted kin counts or count probabilities from these subset models, then compare the predicted counts therein to those generated by the main models (with the difference expressed as the percentage difference in predicted counts/probability, calculated as $\frac{100(S-O)}{O}$, where S is the predicted count in the subset models and O is the predicted count in the primary models – see Appendix A). Third, we evaluate the statistical significance of these differences using Wald tests comparing the corresponding coefficients across the compared models. These results are presented in Table 5.

RESULTS

Age Patterns

[11] Although one must also have a parent to have a grandparent or aunt/uncle (or to exist), this is a deterministic relationship since no one is born without two biological parent, and almost no individuals in the data have no measured parental ties for G2 and higher.

We begin by charting the average number of kin of each type across the life span in Figure 2. Cousins, aunts/uncles, and grandparents are the most common relatives in childhood and early adulthood. Nieces/nephews and children, then grandchildren become the most common types of kin in mid- and later life. Counts for full and half siblings are fairly stable across the life span until ages 60-69, although people have on average more full siblings than half siblings. Parent counts decrease steadily with age, and grandparent counts do so even more rapidly, with few grandparents observed after the 30-39 age range. Obviously, relatively few spousal ties are observed among those in young ages, and the average count rises until age 40-49, then declines somewhat at older ages. These estimates are telling, yet they are unadjusted and cross-sectional, and likely reflect a combination of period and cohort effects.

-- FIGURE 2 HERE --

Educational Patterns in Kin Counts

Tables 1 and 2 present results from regression models predicting kinship counts as an interactive function of respondent educational attainment and age. These tables present both observed, lower bound estimates as well as upwardly-adjusted estimates as described above. Several patterns are immediately clear. First, there are strong age effects on kin ties across all education categories and kin types. The Wald tests for joint age effects are statistically significant for every kin relation measured in this analysis. These are especially clear for parent ties, where the most respondents have at least one living parent in all education groups when they are ages 25-34, but fewer than half have any living parents in the 55+ age range (Table 1). The opposite pattern is observed for children (for both observed and adjusted counts), as the probability of having 0-1 children decreases with age and the probability of having two or more children increases with age (Table 1). Especially stark age effects are observed for grandparent counts, where almost no respondents have living grandparents if they are ages 45 or older (Table 1). Patterns for those 55 and older are omitted due to the rarity of this tie in this age range. For full siblings, nearly all educational attainment groups show a curvilinear relationship between age and observed or adjusted[12] counts of full or half siblings and nieces/nephews, with average counts peaking in the 45-54 age range and declining in either direction from there (Table 2). The lone exception to this rule is the some college group counts of half siblings. Predictably, counts of grandchildren increase steadily with age; and counts of aunts and uncles decrease, as do cousins (Table 2). Whether due to age, period, or cohort effects, there are clear and interesting patterns of kin counts by age.

Tables 1 and 2 also show evidence of statistically significant and substantive educational differences in kin counts for most kin relations. Table 1 shows that the probability in each age group of having 1 or 2 living parents typically increases with increasing educational attainment, and the probability of having no living parents decreases with increasing educational attainment. The same pattern holds for grandparents and spouses. However, most educational effects run in the opposite direction. Within age groups, the probability of having two or more living children decreases slightly with increasing education. Similar patterns are found for half siblings, grandchildren, and cousins. Patterns of kin counts by education are more complex for full siblings, aunts/uncles, cousins, and nieces/nephews. Full sibling counts show divergent patterns by age: counts increase with education for those younger than 45, but decrease with education for older groups. There is no consistent education pattern in aunts/uncles counts, as average counts decrease monotonically for those age 25-34, increase monotonically for those 35-44, and are typically too low for older groups to make for meaningful comparisons. The joint effect of education on aunt/uncle counts is not statistically significant which indicates that we cannot distinguish whether group differences in these counts owe to sampling variability or whether there are meaningful group differences. There are significant education effects within age groups for nieces/nephews, but these run in different directions by age group: niece/nephew counts decrease monotonically with education for those 25-35 and 45 and older, but show a curvilinear relationship for 35-44 year olds such that expected counts are highest among those with some college and are lower for the less and more education.

-- TABLES 1 AND 2 HERE --

[12] Since the adjustment procedure is a multiplier, the same patterns hold for adjusted and unadjusted calculations. Accordingly these differences will not be referenced further.

Racial Patterns in Kin Counts

Tables 3 and 4 provide estimates of kin counts by race comparable to those provided for education in Tables 1 and 2. Race is significantly associated with kin counts for all types except aunts/uncles and nieces/nephews. As with educational attainment, differences in parent counts are especially stark: White respondents are more likely to have two living parents at all ages, and less likely to have no parents, compared to Blacks. Blacks are more likely than Whites to have exactly one living parent between ages 25 and 44, but are less likely to have one parent at older ages. Patterns of living child counts by race are complex: at high (2-4) parities, Blacks are more likely than Whites to have the indicated count between ages 25 and 54, but less likely than Whites to have the count in question among those age 55 and older. The probability of having one living child is higher for Blacks than Whites in the 25-34 age group, but lower at older ages. Finally, Whites are more likely than Blacks to have no living children between the ages of 25 and 54, but less likely than Blacks to do so in the age 55+ range.

Sibling patterns by race show a consistent pattern: Whites have higher average counts of full siblings than Blacks in all age groups, whereas Blacks have higher counts of half siblings than Whites in all age groups. Whites are more likely to have one or more spouses/partners in all age groups than Blacks in all age groups. Whites are also more likely than Blacks to have non-zero counts of grandparents in all age groups examined, whereas Blacks are more likely to have none. In contrast, Blacks have higher average counts of grandchildren and cousins compared to Whites in all age groups.

-- TABLES 3 AND 4 HERE --

Deceased and Intervening Ties Tests

Table 5 presents results from tests examining whether kin mortality and intervening ties significantly mediate the relationship between education, race, and kin counts. Supplemental tables A1-A4 show how model coefficients change when adjusting for these processes. In other words, it examines what aspects of demographic history explain the differences that we presented in Tables 1-4. The left side of Table 5 examines whether these factors explain educational differences in kin counts and the right side examines the results for racial differences. We test for mortality effects for all types of kin, but for the effects of intervening ties, we only test for the three types of kin for which intervening ties are relevant – grandchildren, nieces/nephews, and cousins. These are kin types that it is impossible to have without another intervening kin relation: one must have children to have grandchildren, siblings to have nieces/nephews, and aunts/uncles in order to have cousins.

We do not find evidence of statistically significant mediations of intervening ties for grandchildren, cousins, or nieces/nephews in explaining educational differences in these types of kin, suggesting that these differentials are largely attributable to kin fertility. However, kin mortality does play a statistically significant role in explaining educational differences in some types of kin. Mortality matters for counts of grandparents and spouses, and has marginal effects for aunts/uncles. For grandparents, examining only those with no recorded grandparent deaths decreases the probability of observing no grandparents at ages younger than 45. This effect is approximately equal (64-72% reduction, see supplemental tables A1-A4) across educational groups for 25-34 year olds. Educational differences in these changes in predicted probabilities are especially pronounced for the probability of observing two living grandparents for those aged 25-34: the probabilities in the no-mortality subset model increase by greater amounts for those with lower educational attainment compared to those with a college degree, suggesting that grandparent mortality early in life is more common for those who have low educational attainment.

Educational differences in spousal mortality effects, on the other hand, are most pronounced at more advanced ages. Eliminating those observations who have experienced spousal mortality from the model decreases the probability of observing no spousal tie among those age 55+, but changes are more pronounced for low-educated persons (-47% for those with less than high school, -45% for those with a high school degree) than highly-educated persons (-25% for those with some college, -32% for those with a college degree). By contrast, we see concomitant positive increases in predicted probabilities for observing one (54% for those with less than high school, 29% for those with a high school degree, 17% for those with some college, and 13% for those with a college degree) or two (112% for those with less than high school, 87% for those with a high school degree, 33% for those with some college, and 32% for those with a college degree) living spousal/partner ties. This indicates that spousal mortality contributes to educational patterns of spousal ties in a way that decreases the probability of observing a living spouse for less educated older persons compared to more educated ones.

The right-hand side of Table 5 assesses the degree to which kin mortality and intervening ties explain racial differences in living kin counts. We find that intervening ties are insignificant for explaining race differences in grandchildren and nieces/nephews, and only marginally significant for race differences in cousin counts. On the other hand, we find that kin mortality significantly mediates the association of race with counts of parents, children, grandparents, and spouses. Eliminating those with parental mortality from the model increases the proportion with two parents for all groups, but increases this probability more for Black respondents 54 and younger than for comparable Whites (9%, 74%, and 134% with increasing age categories for Blacks, whereas the comparable numbers for Whites are 10%, 30%, and 128%), but increases it more for White respondents 55 and over than for comparable Blacks (363% and 216% respectively). This also increases the probability of having exactly one parent for Whites and Blacks age 55 and older, but more so for the latter (51% and 116% respectively). For younger respondents, this procedure reduced the probability of having one living parent for Whites but increased it for Blacks. It decreased the probability of having no living parents for all groups.

The effects of subsetting the analysis to only those without measured mortality are very clearly seen in the case of grandparent counts. Comparing these probabilities to those in the baseline model, the probability of having two or more grandparents increases substantially for all groups, but the racial differences are differentiated by age: significantly more for Whites in the 25-34 range (377% increase for Whites vs. 258% increase for Blacks), but significantly more for Blacks in older age ranges (290% and 551% for the 35-44 and 45-54 ranges for Blacks; the same numbers are 104% and 231% for Whites). Similarly, the probability of having one grandparent in the 45-54 age range increases by 115% for Whites and 291% for Blacks. Together, this suggests that Blacks' grandparent counts are significantly depressed by grandparental mortality compared to Whites. Comparable differences for child and spousal counts were statistically significant under the Wald test, but were substantively small.

-- TABLE 5 HERE --

Sensitivity Tests

Since our method relies on counting kin by connected chains of residence among family members, we tested to what extent higher rates of non-coresident fatherhood suppress the number of kin we estimate for Blacks and those with low education. The types of kin most affected by this are children and grandchildren and their reciprocals (parents, grandparents) as well as spouses/partners. We assess the robustness of some of our findings indirectly in three ways. First, we calculate the percentage of children in single-parent households whose parents are female as a first step to assess the likely degree of bias in group differences in kin counts. We find no significant difference by parental education. Although we do find a statistically significant difference by race, it is substantively small (89% female for Blacks, 87% female for Whites). Second, we estimate models testing for educational and racial differences in child ties among women only, because when parents are not co-resident, children most commonly reside with their mothers. Third, we estimate grandchild counts, but only among women and limit the counts to grandchildren that are descended through daughters (matrilineal descent). This is a conservative test because non-coresident fatherhood biases would be expected to compound over the two generations observed. If these results differ from the previously estimated models, then we can conclude that non-coresident fatherhood is biasing our results. If we do not, we can assert quite confidently that the directionality if not precise magnitude of our findings are robust to potential biases owing to non-coresidence. The results of this sensitivity test did not alter the conclusions of our study, as this analysis confirmed that Black women have statistically significantly more children and matrilineal grandchildren, and that more highly educated women have statistically significantly fewer children and matrilineal grandchildren (all results available on request). Thus these results suggest that differential parental co-residence rates do not seriously bias our estimates of racial and educational patterns of kin counts, though it is likely that we underestimate the population means of affected counts. As such we conclude that our results are robust to issues stemming from differential co-residence between racial and educational groups.

DISCUSSION

Compared to friendship and co-affiliation networks, kinship networks in contemporary, developed societies have received comparatively little attention in networks research. This paper addresses this limitation by using innovative methods with an underutilized source of network data, the PSID, and describing the typical distribution of kinship ties and racial and educational differences therein. It also assesses the role that kin mortality and intervening, contingent events might have played in producing these differences. Doing so holds a mirror to historical demographic patterns, and illuminates new angles by which we might understand the emergence of inherited inequality.

Our steps toward understanding group differences in kinship structures rather than the multiplex ties of co-residence, kin contact, and kin support produce a number of findings, and it is worth considering them in their own right before we speculate on what they imply for studies of kin function. First, the distribution of kinship ties is tightly linked to stage of life through a combination of age, period, and cohort effects. Cousins and aunts/uncles are especially common below age 40, and grandparents especially common below age 30, and all three kin ties are much less common in middle age and older groups. Parent, full sibling, and half sibling tie counts follow a similar pattern, but these taper off less rapidly. Niece/nephew counts peak between ages 30 and 69, with comparatively few such ties observed in younger and older age ranges. Spousal tie counts increase from nearly zero in the 10-19 age range to high levels between 30 and 69, and taper off above age 70. Average counts of children are moderate in the 20-29 range, and peak between the ages of 30 and 70, with a slight uptick in the highest age range. Age differences in all types of ties are statistically significant.

Educational differences in these network ties are less pronounced, but important. Statistically significant differences in kin counts by education are observed for parents, children, spouses, full siblings, half siblings, grandchildren, cousins, and nieces/nephews. These differences are partially explained by patterns of kin mortality in the case of grandparents, spouses, and (marginally) aunts/uncles. Given that intervening tie counts only marginally mediate educational differences amongst grandchildren, and not at all for cousins and nieces/nephews, it is likely that these differences (along with differences in children and siblings) are primarily explained by educational patterns of own and kin fertility.

To understand these patterns, it is important to remember that some kin ties are constrained in number, but others are not, and that different kin counts are differentially influenced by vital processes. For instance, one can have no more than two biological/adoptive parents and four grandparents. Having more or fewer parents and grandparents than this can result only from re-marriage and mortality, respectively. In contrast, one is far less limited in the number of cousins, nieces/nephews, aunts/uncles, siblings, and children one can have, and fertility, mortality, and marriage are all important mechanisms producing such ties. Finally, these relationships are structured by age: siblings and cousins are likely to be of similar age, aunts/uncles are likely to be older, nieces/nephews are likely to be younger, and children and grandchildren are certain to be younger, and parents and grandparents are certain to be older. Given the shape of the age-mortality curve, one's similar-age (full and half siblings, cousins, spouses) and younger-age kin (nieces/nephews, children, grandchildren) are less likely to have died while one is alive than one's older kin (parents, grandparents, aunts/uncles).

These observations help us to infer the demographic origins of group differentials in kinship. On average, those with lower educational attainment have more full and half siblings, children, grandchildren, cousins, nieces and nephews, and aunts and uncles than do those with higher educational attainment. However, those with higher educational attainment have, on average, more living parents, grandparents, and spouses than those with lower educational attainment. Together, these results suggest that those with lower educational attainment have on average lower counts of tie types that are constrained in number and most strongly influenced by mortality rates (parents, grandparents) and more of other types of relationships that are less constrained in number and more strongly influenced by fertility. This is especially pronounced for relationships that are less likely to be strongly influenced by mortality (children, nieces/nephews, grandchildren). These patterns suggest that the kinship networks of those with less than a high school education are strongly influenced by their family's higher fertility rates compared to the general population. These mechanisms should be more directly tested in future research.

Similar dynamics appear to contribute to racial differences in kin counts. White respondents have higher average counts of parents, grandparents, spouses, full siblings, and aunts/uncles, whereas Blacks typically have higher counts of children, half siblings, grandchildren, cousins, and nieces/nephews. This suggests that Whites' higher counts of kin are typically among older kin and spouses, suggesting a potentially stronger role for mortality mediation in explaining these differentials. Indeed, the mortality mediation tests find that differential kin mortality strongly moderates race differences in parent, grandparent, and spouse mortality. In contrast, kin types for which Blacks typically have higher counts are those which are typically more influenced by fertility regimes – children (though differential mortality also appears to play a role), grandchildren, cousins, and nieces/nephews. As for siblings, Blacks have more total siblings on average than do Whites, but theirs are more likely to have only one measured parent in common than Whites', suggesting a mediating role for marital rates as well as fertility. Our sensitivity analyses lead us to conclude that these patterns are not principally driven by differences in co-resident fatherhood.

Limitations

These conclusions are subject to a number of data limitations. First, our estimates apply to Whites and Blacks descended from households in the U.S. in 1968, but not newer immigrant groups. Second, our estimates make the assumption that the unmeasured kin ties of those who 'marry in' to the PSID lineages are equal on average to those of the PSID lineage, which affects our estimates of cousin, aunt/uncle, and grandparent ties. Although this assumption is surely untrue in the case of individual lineages, it is likely to be true in aggregate, although we cannot evaluate this possibility. That said, we have checked many of our undifferentiated estimates of kin counts against those published from mathematical models of the U.S. population (Keyfitz and Caswell 2005) and found general agreement (calculations available upon request). Third, the data limit our ability to measure non-marital partnerships who did not co-reside. Fourth, our network measurement strategy relies on chains of co-residence between kin. It is possible that racial or educational differences in patterns of co-residence could bias these estimates, but we find this to be unlikely. We used two sensitivity tests to examine this possibility and their results provide no indication that co-residence differences are producing differences in observed kinship structures after accounting for the statistical adjustments we employ in our analyses.

Implications for Research on Kinship Networks

To conclude, we speculate on the potential of network-based approaches to kinship to influence our understanding of family and its effects, and call for a comprehensive research agenda on this topic by proposing specific research programs in several areas. To facilitate this objective, we are providing Stata code to reconstruct these kinship networks using publicly-available data from the PSID as a supplemental file on the PDR website. Any future updates to the code will also be posted to the lead author's personal website at [URL omitted].

Studying Kinship Ties Beyond Household Walls

Most sociological research on kinship has focused on a small number of tie types, such as parent/child, sibling, and marital/partner ties. Other types of kinship ties are understudied but potentially also highly consequential (Mare 2011). One reason they may be understudied is that few large-scale surveys include questions about living kin of different types (e.g. the General Social Survey and National Health Interview Survey). However, these surveys do not allow researchers to distinguish *which* kin of a given type had a given influence on the respondent, and the asking individuals to recall counts of living kin may suffer from measurement error. In this study, we show that such data limitations need not limit the estimation of kin counts, and this knowledge can extend sociological research on the family. Kin are connected to each other via chains of elementary familial relations. Kinship ties can be constructed through persons who are connected through chains of these ties: different combinations of these ties define all other bio-legal kin relations, such as aunts, grandchildren, son- or daughters-in-law, and great-aunt/uncles-by-marriage. Importantly, many of these pair types rarely co-reside, meaning that they are missed by typical household-based survey strategies.

Second, we wish to extend the methods by which kinship functions are studied. Quantitatively, kin functions may be measured in three different ways. In the most typical research strategy, individuals are asked what types of assistance they have received from any kin in a recent period of time – a measure of multiplex kinship *functions*, not structure. A second and more comprehensive strategy is to measure the kinship network structure and then calculate the *rate* at which kin alters provide this type of help, overall and conditional on alter and pair characteristics. This research strategy is seldom pursued, but would offer beneficial insights.

Third, we encourage future researchers to pioneer sampling strategies that would permit the measurement of full kinship networks. We believe that the most promising strategy for doing so would take advantage of the fact that all extended kin pairs are connected through a chain of primary kinship ties. Such a project could begin by sampling a set of unconnected individuals, then asking them for contact information on their primary ties (spouses, children, parents, and siblings). Those alters could then be contacted, and their networks sampled as well. Over a long enough chain, this strategy would permit the elaboration of full family networks. However, such an approach would be highly sensitive to missing data either due to omission or due to deceased relatives who connected kin; thus, an alternative strategy may be to ask respondents to list more distant relations as well. Regardless, although this approach would pose considerable logistical challenges, we believe that this is the most promising strategy to fully measure extended kinship ties and attendant rates of kin contact and exchange.

Historical Demographic Processes Shape Kinship Networks

Kinship tie patterns arise through a combination of fertility, marriage, and mortality, but they represent a complex interaction of micro-level social processes that can translate to large differences in macro level social structures. Mortality patterns are relatively simple: kin counts for younger-generation ties are less likely to be influenced by mortality than those of older generations. The effects of mortality on same-generation ties (siblings, cousins, spouses) are likely to depend on one's own age and implied mortality risks, which relate to several social processes. Our findings that educational differences in grandparents, aunts/uncles, and spouses are partially mediated by mortality, and that the same is true for race differences parents, children, grandparents, and spouses, are consistent with this view, but further research is needed.

Otherwise, kin counts are primarily a function of the fertility patterns of oneself and one's kin. Child counts are obviously proportionate to one's own fertility, but this can also be related to one's spouse's fertility in the case of step-children. Grandchild counts will also, on average, be proportionate to one's own fertility. Otherwise, kin counts in other ties will be shaped by prevailing fertility rates, their fertility-relevant characteristics, and perhaps causal associations in completed fertility within kinship networks. The degree to which these network characteristics are shaped by each of these processes should be investigated in future research.

Unknown denominators may bias research on kinship functions

Sociologists have documented socioeconomic differences in three-generation households, kin contact, and kin support (Connidis 2001, Lee and Aytac 1998, Raley 1995, Roschelle 1997, Ruggles 2007, Sarkisian, Gerena and Gerstel 2007, Swartz 2009). For example, previous research has found that three-generation households are more common among those with the least resources (Ruggles 2007, Swartz 2009). However, the probability of living in a three-generation household depends on whether people of all three generations are alive and if they are, whether they live together. Data have not been available to test whether the odds of forming a three-generation household varies by education conditional on the availability of three living generations – grandparents, parents, and children – in a lineage. In light of socioeconomic mortality and fertility differentials, the rate at which these kin are simultaneously alive is unlikely to be approximately equal. Kin contact and kin support also vary strongly by socioeconomic status (Lee and Aytac 1998, Roschelle 1997, Sarkisian, Gerena and Gerstel 2007, Swartz 2009). However, this may be explained by the fact that those with less education are more likely to live near their kin and have more frequent contact with them than those with more education (Cherlin and Furstenberg 1986, Connidis 2001), so spatial distance to kin is an important area for further study. Without measuring the full set of living kin of a given type whose ties are not multiplex, the mechanisms at work are difficult to establish. Thus, understanding group differences in kin availability increases our understanding of these patterns by assessing whether group differences in total contact with kin owes to differences in the number of contacts, the intensity of those contacts, or some combination thereof.

However, few nationally representative datasets measure how many non-co-resident kin respondents have, and those that do are likely to be subject to substantial measurement error for more distant kin. Although most Americans likely know how many living parents, siblings, children, grandparents, and grandchildren they have, more distant kin ties such as cousins and great aunts likely will not have consistently accurate counts. It is possible that these more distant ties may provide important kin functions, as well, but we cannot know with current measurement strategies. Furthermore, few datasets identify which kin of a given type serve the indicated kinship function, meaning that we can frequently learn little about which kin provide assistance when kin are not co-resident.

In contrast, adopting a social network approach that links kin through chains of connected households overcomes many of these limitations. In this approach, important measures are captured for each member of a kinship network, and in principle one could easily ask respondents which specific kin provided specific assistance in specific ways (though no presently available data allow us to do so). Additionally, this network information permits researchers to calculate the rate at which kin of different types provide assistance of different kinds, because the ties that do not provide assistance are measured along with the ties that do. Accurately constructing a paired rate is critical to understanding kinship functions, since high rates of received assistance from, for instance, cousins could be produced by the fact that most people have more cousins than they have siblings, even if individual siblings in fact provide assistance at a higher rate than cousins. Therefore, if we wish to know what kin count, we need to count all kin.

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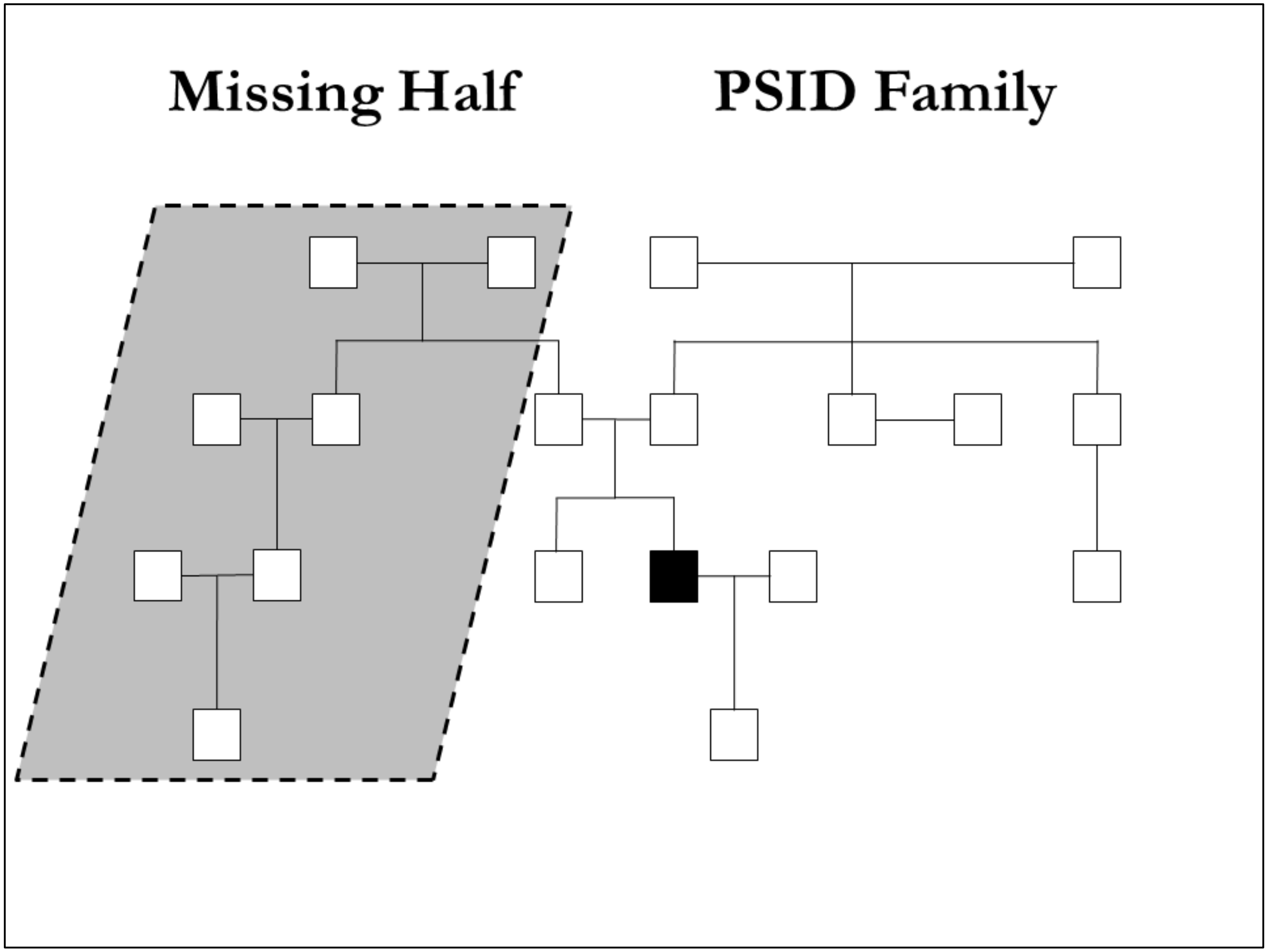
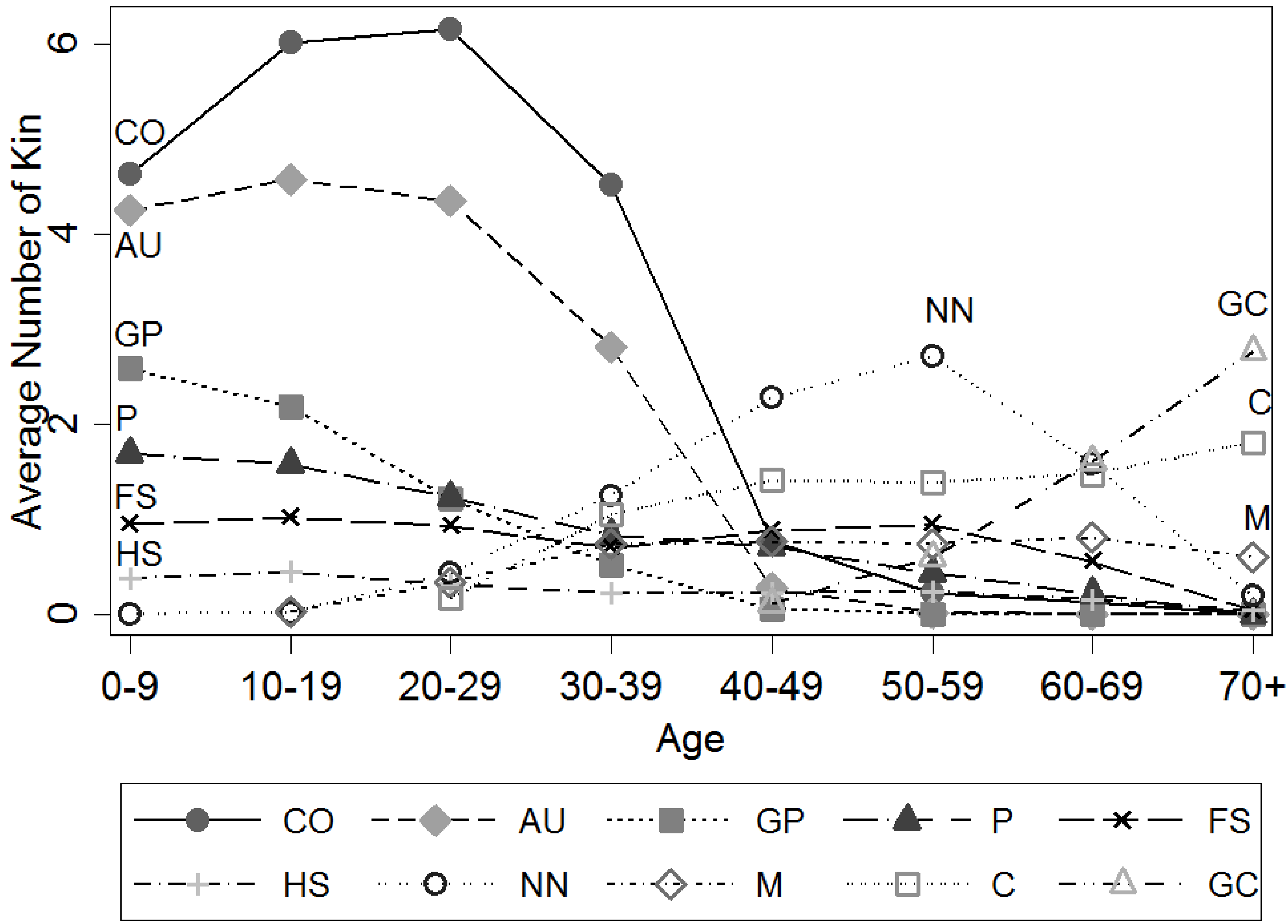
TABLES AND FIGURES

Figure 1: The Missing Half Problem



Notes: The black square represents the focal respondent.

Figure 2: Average Kin Counts (Lower Bound) by Age and Type



Notes: CO, AU, and GP counts are multiplied by two (see text). CO=cousin, AU=aunt/uncle, GP=grandparent, P=parent, FS=full sibling, HS=half sibling, NN=niece/nephew, M=spouse, C=child, GC=grandchild.

Table 1: Predicted Probability of Different Kin Count Categories by Education, Age, and Type, Estimated from Ordinal Logit Models.

		Parents			Children (Observed)					Children (Adjusted)					Grandparent			Spouse		
Education	**Age**	**0**	**1**	**2**	**0**	**1**	**2**	**3**	**4+**	**0**	**1**	**2**	**3**	**4+**	**0**	**1**	**2+**	**0**	**1**	**2+**
Less than High School	**25-34**	0.19	0.46	0.35	0.54	0.22	0.16	0.05	0.02	0.50	0.25	0.16	0.06	0.02	0.69	0.25	0.06	0.70	0.29	0.01
	35-44	0.26	0.47	0.27	0.25	0.23	0.31	0.14	0.07	0.23	0.24	0.29	0.15	0.07	0.85	0.13	0.02	0.59	0.40	0.01
	45-54	0.56	0.34	0.09	0.21	0.21	0.32	0.16	0.09	0.20	0.23	0.30	0.17	0.08	1.00	0.00	0.00	0.47	0.52	0.02
	55+	0.84	0.14	0.02	0.21	0.21	0.33	0.17	0.09	0.17	0.21	0.31	0.19	0.10	--	--	--	0.54	0.45	0.01
High School Degree	**25-34**	0.17	0.44	0.39	0.59	0.21	0.14	0.04	0.02	0.50	0.25	0.16	0.06	0.02	0.47	0.39	0.13	0.56	0.43	0.01
	35-44	0.16	0.44	0.40	0.31	0.24	0.28	0.11	0.05	0.26	0.25	0.28	0.13	0.06	0.81	0.16	0.03	0.41	0.57	0.02
	45-54	0.32	0.46	0.21	0.29	0.24	0.29	0.12	0.06	0.26	0.25	0.28	0.13	0.06	0.99	0.01	0.00	0.44	0.54	0.02
	55+	0.65	0.28	0.06	0.21	0.21	0.32	0.17	0.09	0.18	0.22	0.31	0.18	0.09	--	--	--	0.40	0.58	0.02
Some College	**25-34**	0.14	0.41	0.45	0.62	0.20	0.13	0.04	0.02	0.57	0.23	0.14	0.04	0.02	0.52	0.37	0.11	0.54	0.45	0.01
	35-44	0.20	0.46	0.35	0.32	0.25	0.28	0.11	0.05	0.28	0.26	0.27	0.13	0.06	0.73	0.22	0.05	0.38	0.60	0.02
	45-54	0.35	0.45	0.19	0.31	0.24	0.28	0.11	0.05	0.27	0.26	0.28	0.13	0.06	1.00	0.00	0.00	0.48	0.51	0.02
	55+	0.62	0.31	0.07	0.24	0.22	0.31	0.15	0.08	0.21	0.23	0.30	0.17	0.08	--	--	--	0.40	0.58	0.02
College Degree or Higher	**25-34**	0.06	0.28	0.65	0.85	0.09	0.05	0.01	0.00	0.76	0.15	0.07	0.02	0.01	0.51	0.38	0.12	0.58	0.41	0.01
	35-44	0.08	0.33	0.59	0.37	0.25	0.25	0.09	0.04	0.32	0.27	0.25	0.11	0.05	0.75	0.21	0.04	0.31	0.66	0.03
	45-54	0.18	0.45	0.38	0.31	0.24	0.28	0.11	0.05	0.28	0.26	0.27	0.12	0.06	1.00	0.00	0.00	0.32	0.65	0.03
	55+	0.58	0.34	0.09	0.23	0.22	0.32	0.15	0.08	0.21	0.23	0.30	0.17	0.08	--	--	--	0.31	0.66	0.03
N		6,135			7,183					7,183					3,030			7,183		
Wald Test, Educ	**χ^2**	136.80			102.35					--					268.80			56.55		
	p	0.00			0.00					--					0.00			0.00		
Wald Test, Age	**χ^2**	556.68			638.44					--					5525.99			140.15		
	p	0.00			0.00					--					0.00			0.00		

Notes: "--" is shown when too few observations were available to estimate. ‘Observed’ counts are those measured in the PSID data; ‘adjusted’ counts account for inferred patterns of missing kin in the first wave of the dataset (see text for details).

Table 2: Observed and Adjusted Predicted Kin Counts by Education, Age, and Type, Estimated from Zero-Inflated Negative Binomial Models.

Education	Age	Full Siblings	Half Siblings	Grand-Children	Aunts/ Uncles	Cousins	Nieces/ Nephews
Less than High School (Obs.)	25-34	0.81	0.76	--	2.96	5.90	0.96
	35-44	0.89	0.72	0.07	0.69	5.24	1.66
	45-54	1.83	0.86	0.81	0.00	0.94	3.85
	55+	1.74	0.49	3.00	0.00	--	3.56
High School Degree (Obs.)	25-34	1.09	0.47	--	2.67	4.11	0.77
	35-44	1.12	0.41	0.04	1.14	2.77	1.68
	45-54	1.66	0.52	0.48	0.02	0.89	2.80
	55+	1.01	0.38	2.21	0.00	--	2.02
Some College (Obs.)	25-34	1.14	0.33	--	2.8	3.95	0.77
	35-44	1.16	0.32	0.10	1.41	2.74	1.93
	45-54	1.52	0.29	0.31	0.02	0.85	2.58
	55+	1.14	0.31	2.01	0.00	--	1.93
College Degree or Higher (Obs.)	25-34	1.33	0.12	--	2.57	3.58	0.57
	35-44	1.38	0.23	0.01	1.23	2.32	1.70
	45-54	1.56	0.25	0.06	0.02	0.39	2.54
	55+	1.01	0.21	1.75	0.00	--	1.72
Less than High School (Adj.)	25-34	0.89	0.84	--	3.27	6.51	1.06
	35-44	0.98	0.79	0.08	0.76	5.78	1.83
	45-54	2.02	0.95	0.89	0.00	1.04	4.25
	55+	1.92	0.54	3.31	0.00	--	3.93
High School Degree (Adj.)	25-34	1.20	0.52	--	2.95	4.54	0.85
	35-44	1.24	0.45	0.04	1.26	3.06	1.85
	45-54	1.83	0.57	0.53	0.02	0.98	3.09
	55+	1.12	0.42	2.44	0.00	--	2.23
Some College (Adj.)	25-34	1.26	0.36	--	3.09	4.36	0.85
	35-44	1.28	0.35	0.11	1.56	3.02	2.13
	45-54	1.68	0.32	0.34	0.02	0.94	2.85
	55+	1.26	0.34	2.22	0.00	--	2.13
College Degree or Higher (Adj.)	25-34	1.47	0.13	--	2.84	3.95	0.63
	35-44	1.52	0.25	0.01	1.36	2.56	1.88
	45-54	1.72	0.28	0.07	0.02	0.43	2.80
	55+	1.12	0.23	1.93	0.00	--	1.90
N		6,135	6,135	4,297	3,030	3,030	6,135
Wald Test, Educ	χ^2	27.75	89.95	83.12	14.53	29.68	32.85
	p	0.01	0.00	0.00	0.27	0.00	0.00
Wald Test, Age	χ^2	9729.48	27.27	617.75	139.21	100.42	186.26
	p	0.00	0.03	0.00	0.00	0.00	0.00

Notes: Aunts/Uncles count results calculated from continuous model, as categorical model never converged. Margins calculated at midpoint of indicated age category. "--" is shown when too few observations were available to estimate.

Table 3: Predicted Probability of Different Kin Count Categories by Race, Age, and Type, Estimated from Ordinal Logit Models.

		Parents			Children (Observed)					Children (Adjusted)					Grandparent			Spouse		
Race	**Age**	**0**	**1**	**2**	**0**	**1**	**2**	**3**	**4+**	**0**	**1**	**2**	**3**	**4+**	**0**	**1**	**2+**	**0**	**1**	**2+**
White	**25-34**	0.09	0.35	0.56	0.72	0.16	0.09	0.02	0.01	0.64	0.20	0.11	0.03	0.01	0.48	0.39	0.13	0.54	0.45	0.01
	35-44	0.12	0.39	0.49	0.34	0.25	0.26	0.10	0.05	0.29	0.27	0.27	0.12	0.06	0.76	0.20	0.04	0.33	0.64	0.03
	45-54	0.25	0.47	0.28	0.31	0.24	0.28	0.11	0.05	0.27	0.26	0.27	0.13	0.06	1.00	0.00	0.00	0.36	0.61	0.02
	55+	0.61	0.31	0.08	0.22	0.21	0.32	0.16	0.09	0.18	0.22	0.31	0.18	0.10	--	--	--	0.36	0.61	0.02
Black	**25-34**	0.23	0.47	0.30	0.59	0.21	0.14	0.04	0.02	0.53	0.25	0.15	0.05	0.02	0.64	0.29	0.07	0.75	0.25	0.00
	35-44	0.35	0.46	0.19	0.27	0.23	0.30	0.13	0.07	0.23	0.25	0.29	0.15	0.07	0.79	0.17	0.03	0.60	0.39	0.01
	45-54	0.52	0.38	0.11	0.25	0.23	0.31	0.14	0.07	0.22	0.24	0.30	0.16	0.08	0.98	0.02	0.00	0.64	0.35	0.01
	55+	0.77	0.20	0.04	0.29	0.24	0.29	0.12	0.06	0.26	0.26	0.28	0.13	0.07	--	--	--	0.60	0.39	0.01
N		6,138			7,186					7,186					3,033			7,186		
Wald Test, Race	χ^2	157.43			22.90					--					297.83			112.98		
	p	0.00			0.00					--					0.00			0.00		
Wald Test, Age	χ^2	586.39			590.35					--					10577.82			101.63		
	p	0.00			0.00					--					0.00			0.00		

Notes: "--" is shown when too few observations were available to estimate.

Table 4: Observed and Adjusted Predicted Kin Counts by Race, Age, and Type, Estimated from Zero-Inflated Negative Binomial Models.

Race	Age	Full Siblings	Half Siblings	Grand-Children	Aunts/ Uncles	Cousins	Nieces/ Nephews
White (Obs.)	25-34	1.13	0.17	--	2.67	3.64	0.74
	35-44	1.10	0.23	0.03	1.61	2.43	1.65
	45-54	1.60	0.25	0.31	0.03	0.30	2.68
	55+	1.43	0.24	2.12	--	--	1.93
Black (Obs.)	25-34	0.65	0.98	--	2.43	5.48	0.51
	35-44	1.04	0.93	0.10	1.27	3.96	2.60
	45-54	1.28	1.13	0.46	0.12	1.77	2.89
	55+	1.50	0.73	2.20	--	--	2.29
White (Adj.)	25-34	1.25	0.19	--	2.95	4.02	0.82
	35-44	1.21	0.25	0.03	1.78	2.68	1.82
	45-54	1.77	0.28	0.34	0.03	0.33	2.96
	55+	1.58	0.26	2.34	--	--	2.13
Black (Adj.)	25-34	0.72	1.08	--	2.68	6.05	0.56
	35-44	1.15	1.03	0.11	1.40	4.37	2.87
	45-54	1.41	1.25	0.51	0.13	1.95	3.19
	55+	1.66	0.81	2.43	--	--	2.53
N		6,138	6,138	4,297	3,033	3,033	6,138
Wald Test, Race	χ^2	10.02	78.93	8.53	2.24	36.18	7.40
	p	0.04	0.00	0.04	0.52	0.00	0.12
Wald Test, Age	χ^2	43.01	20.09	551.2	107.57	115.83	227.1
	p	0.00	0.02	0.00	0.00	0.00	0.00

Notes: "--" is shown when too few observations were available to estimate.

Table 5: Results of Deceased Tie and Intervening Tie Tests

	By Education				By Race			
	Mortality Test		Intervening Tie Test		Mortality Test		Intervening Tie Test	
	χ^2	$p > \chi^2$	χ^2	$p > \chi^2$	χ^2	$p > \chi^2$	χ^2	$p > \chi^2$
Parents	14.99	0.24	--	--	19.97	0.00	--	--
Children	7.30	0.84	--	--	11.09	0.03	--	--
Grandparents	207.72	0.00	--	--	26.37	0.00	--	--
Grandchildren	12.62	0.18	16.45	0.06	6.86	0.08	5.53	0.14
Spouse	56.72	0.00	--	--	73.47	0.00	--	--
Full Sibling	15.68	0.21	--	--	7.15	0.13	--	--
Half Sibling	7.64	0.81	--	--	0.84	0.93	--	--
Aunt/Uncle	19.20	0.08	--	--	4.32	0.23	--	--
Niece/Nephew	13.54	0.33	14.50	0.27	4.25	0.24	2.90	0.41
Cousin	17.13	0.05	8.15	0.52	6.73	0.15	9.40	0.05

Notes: "—" indicates that intervening ties do not play a potential role in explaining educational or racial differences in those types of kin.

SUPPLEMENTAL TABLES

Table A1: Percent Change in Predicted Kin Counts in Mortality Test Comparisons for Ordinal Logit Models by Educational Attainment

		Parents			Children					Grandparent			Spouse		
Education	**Age**	**0**	**1**	**2+**	**0**	**1**	**2**	**3**	**4+**	**0**	**1**	**2+**	**0**	**1**	**2+**
Less than High School	**25-34**	-24	-3	16	1	-3	2	3	-4	-64	38	585	0	1	-22
	35-44	-57	-15	83	1	-3	1	3	-4	-15	55	225	0	1	-22
	45-54	-77	24	387	-7	-7	3	10	6	0	-59	-27	5	-3	-28
	55+	-74	247	1131	-3	-5	2	6	0	--	--	--	-47	54	127
High School Degree	**25-34**	-19	-2	11	0	-3	2	3	-4	-66	-23	305	-1	1	-20
	35-44	-42	-15	34	1	-3	1	2	-5	-24	64	286	0	1	-22
	45-54	-77	-30	180	2	-3	1	2	-5	-5	307	660	0	1	-21
	55+	-55	71	246	0	-3	1	3	-3	--	--	--	-45	29	81
Some College	**25-34**	-22	-5	11	1	-3	2	2	-5	-72	-21	405	-1	1	-21
	35-44	-51	-18	52	1	-3	1	3	-4	-17	21	159	-2	2	-19
	45-54	-71	-16	167	0	-3	2	4	-3	0	-100	-100	-3	4	-16
	55+	-70	53	370	3	-2	1	1	-6	--	--	--	-25	17	22
BA or Higher	**25-34**	-29	-15	9	0	-3	2	3	-4	-65	-15	326	0	1	-21
	35-44	-45	-27	22	1	-3	1	3	-4	-3	-6	72	-2	2	-19
	45-54	-63	-32	67	1	-3	1	3	-4	0	-59	-27	0	1	-21
	55+	-75	31	375	0	-3	1	4	-3	--	--	--	-32	13	30
	N	4004			7418					890			7110		
Wald Test, Mortality Mediation	**χ^2**	16.93			13.37					185.54			28.23		
	p> χ^2	0.15			0.34					0.00			0.01		

Table A2: Percent Change in Predicted Kin Counts in Mortality and Intervening Tie Test Comparisons for Zero-Inflated Negative Binomial Models by Educational Attainment

		Mortality						Intervening		
Education	**Age**	**FS**	**HS**	**GC**	**AU**	**CO**	**NN**	**GC**	**CO**	**NN**
Less than High School	**25-34**	5	-2	--	-28	-3	0	--	4	6
	35-44	-16	-9	-1	102	-1	0	-43	97	-8
	45-54	-31	-15	-2	-100	-84	-7	21	-100	-22
	55+	-36	-17	-7	--	--	-10	14	--	81
High School Degree	**25-34**	-7	-7	--	-26	-8	0	--	-6	-15
	35-44	-4	-9	-6	4	-14	-1	-69	72	-16
	45-54	-5	-23	-1	-66	-4	-3	3	445	-8
	55+	-16	-25	-2	--	--	-20	3	--	40
Some College	**25-34**	-2	-3	--	-19	-13	0	--	9	-17
	35-44	-3	-6	-1	-5	-14	-1	188	75	-3
	45-54	-7	-23	0	168	-17	-7	-16	553	-6
	55+	-10	-15	-4	--	--	-6	5	--	39
BA or Higher	**25-34**	1	-4	--	-5	-5	0	--	16	-21
	35-44	-1	-8	0	-15	-16	-1	-34	54	-1
	45-54	-1	-19	0	197	-13	-3	-33	133	4
	55+	-2	-11	0	--	--	-3	1	--	45
	N	5937	6007	4530	2539	2692	6221	3939	1661	5848
Wald Test, Mortality Mediation	**χ^2**	14.73	6.98	12.23	32.80	9.95	14.80	7.25	14.13	15.60
	$p > \chi^2$	0.26	0.86	0.20	0.00	0.35	0.25	0.61	0.12	0.21

Table A3: Percent Change in Predicted Kin Counts in Mortality Test Comparisons for Ordinal Logit Models by Race

		Parents			Children					Grandparent			Spouse		
Race	**Age**	**0**	**1**	**2+**	**0**	**1**	**2**	**3**	**4+**	**0**	**1**	**2+**	**0**	**1**	**2+**
White	**25-34**	-27	-8	10	0	-2	2	3	-4	-77	-28	377	-1	1	-23
	35-44	-49	-24	30	1	-3	1	3	-4	-10	19	104	-1	2	-22
	45-54	-76	-38	128	1	-3	1	3	-4	0	115	231	-1	2	-22
	55+	-72	51	363	0	-3	1	3	-3	--	--	--	-41	22	56
Black	**25-34**	-18	3	9	1	-3	1	2	-5	-43	32	258	0	1	-24
	35-44	-48	5	74	2	-3	1	2	-5	-29	78	290	0	1	-24
	45-54	-51	32	134	2	-3	1	2	-5	-7	291	551	-1	2	-22
	55+	-41	116	216	4	-2	0	0	-8	--	--	--	-19	28	19
	N	4004			7418					890			7110		
Wald Test, Mortality Mediation	χ^2	16.93			13.37					185.54			28.23		
	p> χ^2	0.15			0.34					0.00			0.01		

Table A4: Percent Change in Predicted Kin Counts in Mortality and Intervening Tie Test Comparisons for Zero-Inflated Negative Binomial Models by Race

		Mortality						Intervening		
Race	**Age**	**FS**	**HS**	**GC**	**AU**	**CO**	**NN**	**GC**	**CO**	**NN**
White	**25-34**	-1	-6	--	-14	-7	0	--	10	5
	35-44	-3	-7	0	-25	-14	0	43	49	9
	45-54	-3	-23	0	-6	-9	-2	34	237	3
	55+	-5	-15	-2	--	--	-9	12	--	28
Black	**25-34**	-26	-2	--	-16	-9	-1	--	12	8
	35-44	-11	-7	-3	-18	-9	-3	36	38	7
	45-54	-16	-14	-2	-71	-3	-18	34	127	2
	55+	-12	-18	-8	--	--	-20	14	--	20
	N	5937	6007	4530	2539	2692	6221	3939	1661	5848
Wald Test, Mortality Mediation	χ^2	14.73	6.98	12.23	32.80	9.95	14.80	7.25	14.13	15.60
	$p > \chi^2$	0.26	0.86	0.20	0.00	0.35	0.25	0.61	0.12	0.21