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Across settings, it has been shown that the co-residential household is an insufficient measure of family structure and support. However, it continues to be the primary means of population data collection. To address this problem, we developed a new instrument, the Kinship Support Tree (KST), to collect kinship structure and support data on co-residential and non-residential kin and tested it on a sample of 462 single mothers and their children in a slum community in Nairobi, Kenya. This instrument is unique in four important ways: (1) it is not limited to the co-residential household; (2) it distinguishes potential from functional kin; (3) it incorporates multiple geospatial measures; and (4) it collects data on kin relationships specifically for children. In this paper, we describe the KST instrument, assess the data collected in comparison to data from household rosters, and consider the challenges and feasibility of administration of the KST.

Introduction

A large body of literature demonstrates the importance of family structure and family support on the well-being of children and adolescents in both high-income countries (Cavanagh and Huston 2006; Magnuson and Berger 2009; Steele et al. 2009; Kim 2011) and low- and middle-income countries (Chae 2011; Clark and Hamplová 2013; Thiombiano et al. 2013; Goldberg 2013; Marteleto et al. 2016). While much of this work has focused on parental co-residence, other research has considered the protective or beneficial role of grandparental survival (Cunningham et al. 2010) or presence (Townsend et al. 2002; Parker and Short 2009). Most of these studies equate 'family structure' with co-residence and co-residence with support. Yet, family demographers have long recognized that the co-residential household, for all its practical advantages in data collection, only provides a partial picture of the influence of family structure and family support on children's well-being. Families transcend time and space and defy easy categorization because of the complexities inherent in defining membership and roles, made

evident in research based in the United States (US) (Stack and Burton 1993; Roy et al. 2004) and in the African context (Madhavan and Gross 2013; Madhavan et al. 2014). More recent work in the US context has paid increased attention to 'family complexity', which has arisen mainly from increases in divorce, remarriage, cohabitation, and non-marital childbearing, combined with the emergence of new forms of family such as 'living apart together' (LAT) (Cancian et al. 2011; Manning et al. 2014). Such complex families often offer more limited and less consistent forms of family-based support (Harknett and Knab 2007).

In urban contexts in sub-Saharan Africa, similar shifts are underway, driven primarily by high levels of non-marital fertility and divorce. Migration and premature adult death add further complexity. These changes, coupled with acute financial pressures, have brought about family structures that are dispersed over households, regions, and even countries. Yet measures of family structure and family support continue to be centred on data drawn from household rosters. Moreover, kin relationships within the household that are captured

by these rosters are usually from the perspective of the household head. In complex family structures, establishing the relationship of co-residential kin to children becomes a 'best guess' effort, thereby limiting our ability to conduct robust analyses of the influence of family structure and support on child well-being. Methodological innovations in research on migration (Hosegood and Timaeus 2006; Collinson 2010) and social networks (Kohler 1997; White and Watkins 2000) have advanced our understanding of the importance of social relationships beyond household boundaries, but this work has not paid attention to kinship or children's well-being. Finally, spatial statistics are increasingly being used in disease and health surveillance (Rushton 2003; Cromley and McLafferty 2012), as well as in human geography (Kwan 2000), but have yet to be applied to assess kinship ties, despite the promises that they offer (Cope and Elwood 2009). While mixed methods research on family and child well-being has been growing (Roy et al. 2004; Weisner 2005), geospatial analysis has been notably absent.

To address these issues, we have developed a new survey instrument, the Kinship Support Tree (KST), to collect kinship structure and support data for single mothers and their children in one slum community in Nairobi, Kenya. We focused on this population because children born in the slums of Nairobi are significantly more likely to die by age five than children in the rest of Kenya (African Population and Health Research Center 2014). Therefore, it is critical that we better understand the factors that contribute to this problem in order to develop appropriate interventions. Moreover, children of single mothers may have particularly high rates of mortality (Clark and Hamplová 2013). While economic support and childcare assistance from their co-residential and non-residential extended kin could help protect the children of single mothers, kinship support for these mothers is potentially declining because of three processes underway in much of sub-Saharan Africa: (1) increased distance between adult children and extended kin owing to high rates of migration for men and women, particularly from rural areas to informal settlements in urban locations (Adepoju 2000; Posel 2006); (2) declining economic opportunities and pervasive poverty, which influence the ability and willingness of kin to provide support (Jakiela and Ozier 2015); and (3) transformation of views on marriage, women's roles, and family norms, with a greater reliance on conjugal bonds than kinship ties (Smith 2001; Clark et al. 2010). As a result, kinship support for poor, urban, single mothers and their children could be very limited

which, in turn, could put the health and well-being of these children at risk. This hypothesis, however, has not been examined carefully because of inadequate data collection instruments. In this paper, we: (1) review the current state of data collection on family structure and support; (2) describe the new KST instrument; (3) assess the data collected for single mothers and their children via the KST and, specifically, in comparison to data collected from standard household rosters; and (4) discuss challenges encountered in administering the KST in this setting.

Current state of data collection on family structure and support in sub-Saharan Africa

With a few notable exceptions, almost all data collection instruments currently in use treat the household as a proxy for family support. According to Randall et al. (2011), the very concept of the household is itself subject to different 'cultures of understanding' by the various actors involved in the production of data. While acknowledging these debates and even recognizing the implications for data quality, the use of residential boundaries to delineate family continues to be standard practice. Moreover, in line with an altruistic household model (Becker 1981), the presence of particular individuals is assumed to be a valid measure of support. While it may be true that, in general, co-resident members provide some type of support to one another, in the context of a slum community with very limited livelihood options, there is good reason to question this assumption. Furthermore, support is treated as a generic concept encompassing financial, material, practical, and emotional dimensions, and without any level of specificity about quantity, quality, or type.

The four primary sources of quantitative data on family structure and family support in sub-Saharan Africa are: (1) Demographic and Health Surveys (DHS); (2) Health and Demographic Surveillance Systems (HDSS); (3) censuses; and (4) specialized data sets focused on specific issues and populations. DHS data have long been used to examine issues related to family and child well-being (Gage 1997; Parker and Short 2009; Clark and Hamplová 2013; Smith-Greenaway and Madhavan 2015). Their main strengths are that they are nationally representative and use standardized questionnaires to facilitate comparison across countries and over time. Moreover, they are public and are, for the most part, easy to use for analysis. However, they are limited in a number of important ways. First, measures of

family structure and support are limited to co-residential household members, leaving out important non-residential family linkages. Second, co-residence is assumed to be an adequate proxy for family support, whereas some family members may offer little, if any, support in childrearing, despite residing with the child. To be fair, household rosters were primarily designed for identifying eligible respondents for individual interviews and not for collecting support data. However, in the absence of any alternatives, analysis using the data uses co-residence implicitly or explicitly as a proxy for support. Third, household rosters collect data on co-residential kin relationships as defined by household members' relationships to the head of the household, so relationships between children and other family members are not collected explicitly. Under some conditions, these relationships to the household heads can be easily transformed to reflect relationships with children. Quite often, however, we are left with 'best guess' classification, undermining our ability to examine family structure effects on children's well-being. For instance, although we may know that the father is married, we often cannot be sure that the father's wife is the child's biological mother. Another restriction of DHS data is that the primary respondents are women aged 15–49 and, by extension, children who live with them. This could lead to the exclusion of households in which children live with only older persons.

HDSS data are collected at 39 sites in Africa and 52 globally (see www.indepth-network.org/). There are two main features of the HDSS that contribute to their appeal. One is the longitudinal dimension, which enables deeper understanding of household-level change. The second is that HDSS sites make a greater effort to reflect the complexities of lived experience. For example, the Agincourt site includes temporary migrants as household members, even if they are not physically present, because of their social and financial link to the household (Collinson 2010). The Hlabisa site in KwaZulu-Natal, South Africa, goes one step further by allowing members to report more than one residence (Hosegood and Timaeus 2006). These benefits have enabled analysis of familial structure and support in innovative ways (Townsend et al. 2002; Schatz et al. 2014). Some sites collect data quarterly, which allows even more opportunity to capture household-level dynamics in shorter time intervals. This is particularly crucial in areas with high levels of mobility. However, the downside of such intensive follow-up is that it can only be done in localized communities, thereby making it difficult to generalize to larger populations.

Moreover, the resources needed to maintain an HDSS site are considerable. Lastly, similar to the DHS, kinship relationships are also defined by relationship to the household head, and co-residence is usually the only available proxy for family support.

National censuses offer some leverage in conducting household-level analyses, as long as it is understood that the household is essentially a unit of enumeration rather than an adequate representation of a social or economic unit (van de Walle 2006). In this sense, it should be seen less as a theoretically substantive measure of family structure or support and more so as a 'system for organizing the pattern of residence of a population accessible to interviewers … ' (van de Walle 2006, p. xxii). Within these limitations, censuses offer some advantages, as described in van de Walle's (2006) volume and by Garenne (2011). They are nationally representative, usually available at multiple time points, and offer geographical detail not available in standard surveys. More relevant for the present discussion is their ability to group individuals in such a way that we can study some attributes of co-residential family units, albeit with all their imperfections. Finally, because most censuses use a fairly standardized definition of household, centred on the pooling and sharing of resources, comparative analyses across countries are possible. However, one major drawback is that data access is often controlled by the political climate which may not be favourable to allowing access to outside researchers. A related issue is government control of the data collection, which can lead sometimes to substantial undercounts of certain areas or groups. The South African censuses conducted under apartheid, for example, suffer from substantial undercounting of the black population because of apartheid-era policies of counting 'Bantustans' (where the majority of the black population lived) as independent homelands outside the national boundaries (Khalfani et al. 2005).

In addition, there are a number of specialized projects that have attempted to collect data on family relationships that extend beyond household boundaries and also intergenerational transfers of financial support. The Cape Area Panel Study (CAPS) project in South Africa and the Malawi Diffusion and Ideational Change Project (MDICP) are two such efforts. These studies have provided insights on the critical role of non-residential kin and demonstrated that aunts and uncles are as likely, if not more likely, to make financial transfers as grandparents are (Weinreb 2002). However, the CAPS survey asks only about kin who provide support (Harper and

Seekings 2010), therefore telling us nothing about the availability of kin or the characteristics of kin who do not provide support. Furthermore, both surveys only include questions about financial or material transfers and provide no data on other forms of support. Finally, it should be noted that methodological advancement in GIS tools have made geospatial measures an increasingly popular addition to studies on family support (Matthews et al. 2005; Madhavan et al. 2014), but the full potential of GIS has yet to be exploited fully to understand family complexity.

Taken together, all these studies have broadened our conceptualization and measurement of family processes beyond the co-residential household. The survey instrument we present in this paper is an attempt to integrate and extend these innovations into a user-friendly standardized format that is unique in four important ways: (1) it is not limited to the co-residential household; (2) it distinguishes potential from functional kin; (3) it incorporates geospatial measures; and (4) it collects relationship data with reference to the focal child. In the remainder of the paper, we describe the instrument in detail and assess how well it captures co-residential and non-residential family members and support. We then examine how much respondents are able to report about their close kin, and determine the reliability of geospatial data. In addition, we discuss some of the practical challenges of implementing this type of data collection.

Description of Kinship Support Tree (KST)

Conceptual background

The design of our instrument was informed by kinship and life course theories, particularly the principle of 'linked lives', which emphasizes the interconnectedness of lives over the life course (Elder 1987). We also drew on Bourdieu's (1977) distinction between theoretical kinship, which is defined as the genealogically mapped universe of kin, and practical kinship, which refers to those kin who provide support. In the KST, we use the term 'potential kin' to identify those people who are capable of providing support. In this context, potential kin are defined as a child's relatives who are known by the child's mother to be alive and who are aged eight or above. The term 'functional kin' identifies those among the potential kin who provide one or more forms of support. Our use of the child as the reference category for enumerating relationships is a departure

from current practice that collects relationship data with reference to the household head. This is an important conceptual shift, because we privilege the child's social positioning rather than relying on the relationship to an adult to ascertain the child's position. However, it should be made clear that all data were collected from the child's mother. The emphases on functionality and interconnectedness are in line with recent calls to view families not as a fixed social institution but rather as a dynamic set of family activities (Morgan 1996; Finch and Mason 2000). Finch (2007) introduces the term 'display', which she defines as: '[the] process by which individuals, and groups of individuals, convey to each other and relevant audiences, that certain of their actions do constitute "doing family things" and thereby confirm that these relationships are "family relationships"' (p. 67).

Our three domains of the support provided by functional kin—economic support, childcare provision, and emotional closeness—are based on general theories of the importance of social capital (Coleman 1988) and were drawn specifically from Weisner's (1997) work on children's support networks in Kenya. We also drew extensively on ethnographic research on kinship connectivity conducted by some members of our research team in South Africa (Madhavan and Gross 2013; Madhavan et al. 2014). Moreover, we recognized that people may have several kinship support groups that are functionally distinct, change over time, and vary across space and other factors. By examining kinship structure and support at two time points and incorporating multiple geospatial measures, we will be able to observe in future how changes in circumstances and geographical proximity of particular kin affect their ability to provide particular types of support to single mothers and their children. We also distinguished between support provided to the household and that provided directly to the child, in order to identify specific support linkages with greater confidence.

Components of KST

Our instrument offers a quantitative option to the qualitative toolkit that Finch (2007) describes to capture 'display'. It has the following components:

(1) *Child's kinship tree*: Includes the names of all closest kin and their relationship to the child, starting with biological parents, then full siblings, maternal and paternal grandparents,

and maternal and paternal aunts and uncles. While close kin comprise only a subset of the universe of kin, these relationships are considered to be elemental ones that are universally recognized and, therefore, not subject to cultural differences in definitions as is the case of the household (Randall et al. 2011). Furthermore, we held extensive discussions with interviewers to ensure consistency in the use of Swahili terminology corresponding to each of these relationships. In addition, we recorded all step-parents (including mothers' co-wives), as well as half- and step-siblings. Inclusion of the complete set of full, half-, and step-siblings allows us to examine both the resource dilution effect (with younger siblings) and the care provision effect (by older female siblings).

(2) *Distant kin and non-biological sources of support*: Includes names and relationships of kin who are distantly related (e.g., third cousins) or not related to the child but who provide some form of support to them. The categorization of certain relationships as 'distant' was based on consultation with Kenyan colleagues.

(3) *Social, economic, and demographic data*: For each individual kin and non-kin member, we gathered data on survival status, age (or age at death for deceased kin), sex, ethnicity, educational attainment, and employment status. These data were collected regardless of whether the kin member provided support, so that we could examine the factors that increased the likelihood of being a functional kin member. We collected data on survival status in order to identify more carefully heterogeneity in kin structure. In other words, a kin group with three surviving brothers from a total of five may be quite different from one which has only ever consisted of three brothers.

(4) *Geospatial data*: Because of our interest in the role of geographical location and kin-based support in this project, we collected data on location of kin in four ways: (a) GPS coordinates to ascertain latitude and longitude; (b) the name of the specific location; (c) self-reported or vernacular reports of distance to kin, cost of travel to and from kin, and the difficulty of travel to the kin location; and (d) mode of transport to get to kin.

(5) *Type of support*: For each person named (excluding those aged under eight years), we asked about three types of support provided to the mother and child: financial, childcare, and emotional. We used this age cut-off because children as young as eight in this community often contribute childcare and sometimes emotional support.

In addition, we collected demographic data on the respondent (the biological mother), including complete union histories and self-reported measures of health. We also collected physical health and cognitive development data for the focal child. Finally, we conducted 'reliability interviews' using an abridged questionnaire with a small group of kin members to assess the extent of consistency between mothers' reports and those of their kin.

Study site, sample, and survey design

Site description

We tested the instrument in Korogocho, a slum community in Nairobi, Kenya. The choice of Kenya, and Nairobi in particular, was driven by three factors. First, Nairobi is a testament to the rapid urbanization occurring in many African countries, with its population having increased from 293,000 to about 3.4 million over the past 40 years. The last two decades alone saw a jump in the percentage urban in Kenya, from 18 per cent in 1990 to 25 per cent in 2014 (UN Habitat 2014). Second, the proliferation of slum communities that accompanies such rapid urbanization necessitates a better understanding of how people survive during formidable economic insecurity. Carr-Hill (2015) argues that conventional household surveys are inappropriate for slum communities because of the difficulty in identifying households and because of mobility. Third, the slum community of Korogocho is part of the Nairobi Urban Health and Demographic Surveillance System (NUHDSS), an ongoing longitudinal data collection system in place since 2002, which is administered by the African Population and Health Research Center (APHRC). The NUHDSS collects census data every four months on fertility, mortality, migration, marital status, educational attainment, ethnicity, household composition, selected child health indicators, and household socio-economic status from approximately 29,250 people living in 10,260 households. About 25 per cent of Korogocho residents aged twelve years and above were born in the area. The main ethnic groups include Kikuyu (30 per cent), Luo (29 per cent), Luhya (18 per

cent), and Kamba (7 per cent). Within Kenya, predominantly Kikuyu and Kamba areas are geographically closer to Nairobi compared with Luo and Luhya areas, which are located further away in western Kenya. Like other slum communities, the areas covered by the NUHDSS are characterized by a lack of sanitation, limited healthcare facilities, congested and low-quality housing, high levels of violence and crime, and widespread unemployment and poverty. Child health outcomes—nutritional status, vaccination coverage, and educational progress—are very poor (APHRC 2014). Testing the KST instrument in this site offered several distinct advantages because of the NUHDSS. First, it provided a current sampling frame, often not available in urban African settings. Second, the ongoing tracking of the population enabled follow-up of the study sample, at least within the study site. Third, our project had access to a highly experienced field team, fluent in both Swahili and English. Finally, APHRC's long history of community involvement greatly facilitated working in this community. While these site-specific benefits may raise concerns about the feasibility of administering the KST in a non-DSS site, the existence of so many DSS sites across Africa and elsewhere offers the potential to conduct cross-national research on kinship support.

Sample description

Our choice of single mothers as the target group was motivated by substantive and practical concerns. As mentioned earlier, the well-being of single mothers and their children continues to be an understudied topic because of inadequate data collection instruments. Moreover, single mothers may be especially dependent on the support from other family members to help them care for and financially support their young children. However, the continued use of standard household survey rosters does not advance our understanding of either the vulnerability or strengths of single mothers with respect to kinship support in such contexts. Practically, because this project is meant to be an experimental one to test validity and feasibility of the instrument and, therefore, has resource limitations, it made sense to identify a specific population of interest. Our target sample for Round 1 was 500 women in Korogocho who were single at the time of the most recent census update—April 2015—and had at least one child born between 2010 and 2015. Single is defined here as not currently married or cohabiting with a partner. We focused on one child per woman because different children may have different fathers and, therefore, different kin structures. To ensure that we could attain our target, we attempted to reach as many of the 840 women from the NUHDSS who fitted these criteria as possible. After excluding those who were deemed ineligible because they were in a union or did not have a child of eligible age ($n = 183$), those who had left the area ($n = 126$), those who either refused or did not schedule an interview ($n = 37$), and those who were not accessible for other reasons ($n = 32$), the research team successfully interviewed 462 women. The KST was administered a second time after a six-month interval to capture changes in kinship structure and support and to assess the feasibility of following individuals in a highly mobile community. However, this paper is limited to a description of the Round 1 data collection.

Design of survey

Figure 1 shows the survey design, describing the sample size and specific data collected at each stage.

Using the 462 women as our starting point, we asked each respondent to list her close kin—surviving and deceased—from the focal child's perspective. This included the child's siblings (full, half-, and step-), biological father, maternal and paternal grandparents, and maternal and paternal aunts and uncles. In addition, we asked the respondent to name any additional distant kin (i.e., those not enumerated as close kin) or non-kin (e.g., neighbours or friends) who provide her with support, which yielded only 27 names in total. Given there are so few and that our primary interest is close kin, we excluded them from the analysis presented in this paper, leaving 5,344 close kin. The group of enumerated kin was further classified by survival status and age, with targeted data collection designed for each of the subgroups. For example, we found 3,453 potential kin (those known to be alive and aged eight or above) and collected data on location, education, frequency of contact with child, and functional support provision from this group. This enabled us to identify the subset of functional kin (those who provide one or more of the three types of support).

Who and what does the KST capture?

Comparison with household roster

To gain a perspective on the utility of the KST, we compare it to the more conventional household
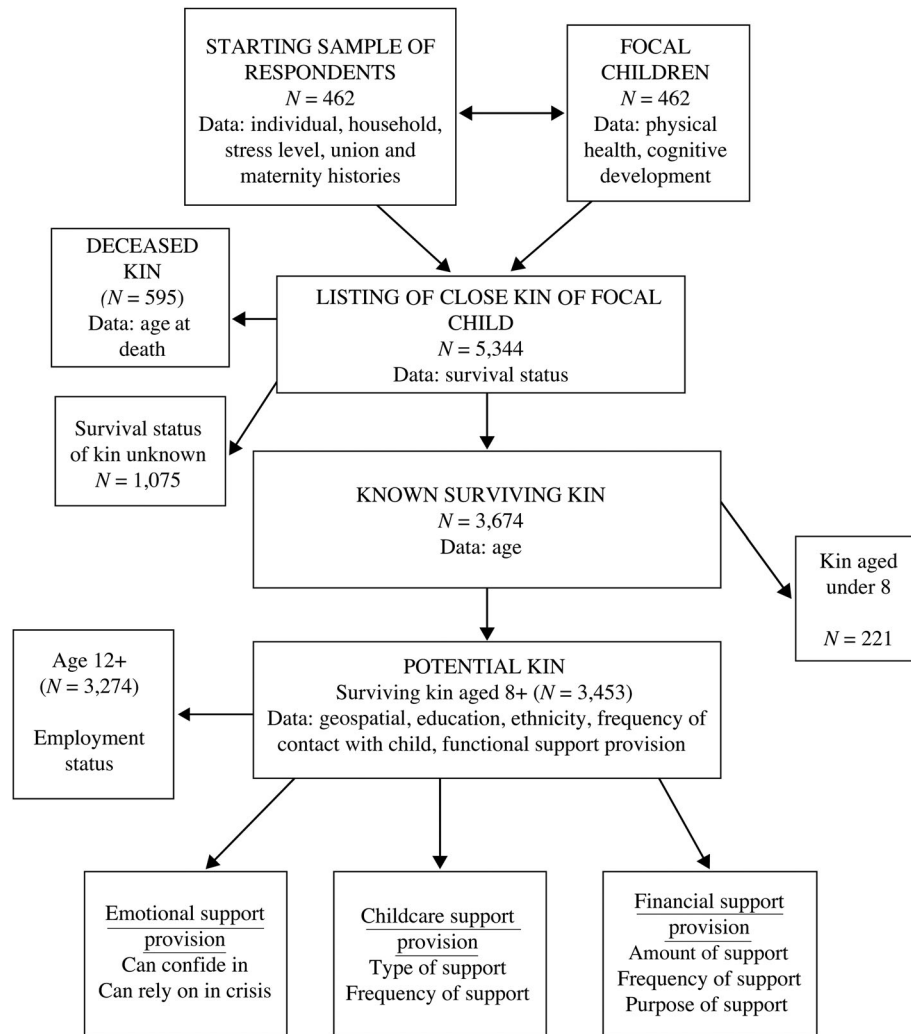
Figure 1 Flow chart of Kinship Support Tree survey questionnaire, showing sample sizes and data collected at each stage, Korogocho, Kenya, 2015

roster. Because the KST instrument was designed to distinguish potential from functional kin, it allows us to identify, with far greater precision and nuance, co-residents who actually provide support rather than assuming that all co-residents are support providers. Figure 2 compares the points of intersection between the KST and the household roster in terms of residence status, kin status, and functionality.

The areas of intersection show that both instruments capture co-residents who are close kin, regardless of their functional status, and co-resident distant/non-kin who provide support. However, the household roster cannot distinguish between functional and non-functional co-residents. Perhaps more importantly are the non-intersecting sectors. The KST captures all close kin who *are not* co-resident, regardless of functionality, as well as distant/non-kin who *are not* co-resident but provide support. The household roster, on the other hand, captures

non-functional distant/non-kin *who are* co-resident. It could be argued that knowing sources of support from non-residential members, as the KST does, is critical in understanding outcomes because it provides a more complete picture of vulnerability. This is a way to address Carr-Hill's (2015) criticism that household surveys are unable to capture true poverty in slum communities. However, not knowing that a distant cousin who provides no support lives in the household may undermine the KST's ability to measure the extent of burden commonly captured through indices like the dependency ratio. Indeed, when we compared average household size for respondents captured by the KST with that of the matched households in the NUHDSS, the figures were 4.3 and 4.8, respectively. To highlight these differences more clearly, Table 1 provides percentages for the categories delineated in Figure 2, showing who is being captured by the conventional
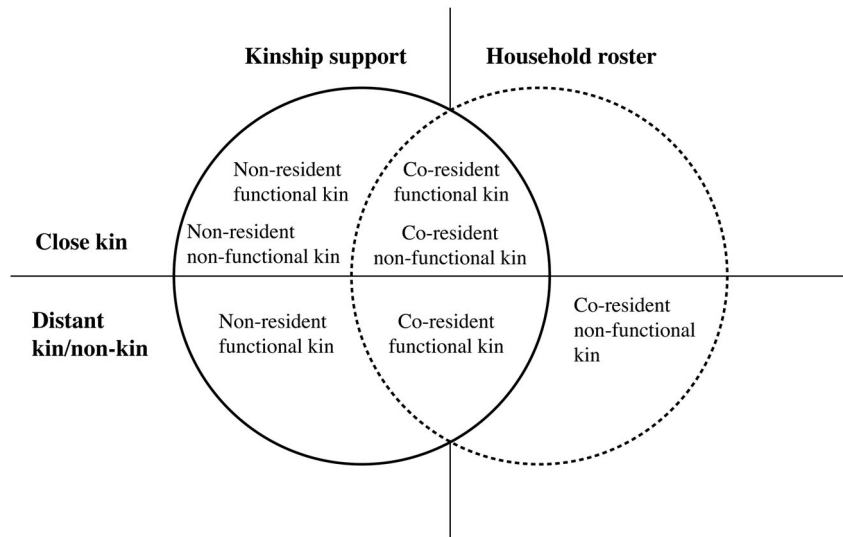
Figure 2   Coverage of Kinship Support Tree and conventional household roster

household roster and who by the KST. The denominator (100 per cent) is the total network of all co-residential and non-residential family members as captured by either the household roster, the KST, or both.

This table clearly shows the inadequacy of using the household roster to reflect family support. The household roster and KST both capture all co-resident close kin members (27.9 per cent of the total network). However, the KST is able to further distinguish between functional (16.0 per cent) and non-functional (11.9 per cent) co-resident close kin members. Functional status for this table is defined as kin who provide financial or childcare support. We did not include emotional support because almost everyone in our sample reported receiving it, resulting in minimal variation. The percentage of co-resident functional members is surprisingly low. In other words, on average, just 16 per cent of a network is made up of co-resident/functional members. The household roster, unlike the KST,

also captures co-residents who are distantly related kin and non-functional; this group makes up a surprisingly high proportion of these networks (24.3 per cent). Given that this is a slum setting, it may be fairly common to live with people who are distantly related (e.g., cousins or aunts once removed) or unrelated but who provide no support for women or their children. Beyond being able to distinguish functionality, the KST also captures non-resident close kin who are functional (6.4 per cent of the network) and non-resident close kin who are not functional, which comprise the largest proportion of the network at over 41 per cent. Not shown in the table but important to highlight is the fact that almost 63 per cent of all functional kin are co-resident and 37 per cent non-resident. When we break this down by type of support (not shown), we find that financial support is the least common type of support provided by kin, but that co-resident kin are more likely to provide this support where it is provided. Given the high rates of unemployment and fragile economic

Table 1   Percentage of single mothers' total network members captured by household roster and Kinship Support Tree (KST), Korogocho, Kenya, 2015

Per cent captured	Kinship Support Tree	Household roster
Co-resident/functional/close kin	16.0	27.9
Co-resident/non-functional/close kin	11.9	
Co-resident/non-functional/distant kin	–	24.3
Non-resident/functional/close kin	6.4	–
Non-resident/non-functional/close kin	41.4	–

Note: 100 per cent represents the total network of all co-residential and non-residential kin of the single mothers, as captured by either the KST, the household roster, or both. Distant kin who are functional, whether co-resident or non-resident, were excluded from the analysis because of small numbers and because close kin are the primary interest.
Source: Authors' calculations from KST data.

conditions, this is perhaps not a surprising finding. Moreover, only 18 per cent of all potential kin provide some form of childcare support and, even among household co-residents, it does not exceed 50 per cent (Clark et al. 2016). In short, the household roster overestimates the functional status of co-residents and misses all forms of non-residential support. Therefore, the KST greatly strengthens our ability to collect robust data on family support.

How much do people know about their kin?

While the idea of collecting detailed data on all close kin is alluring, researchers quickly encounter the problem that respondents do not know even basic information about particular kin. For example, even among married couples, Weinreb (2002) asked wives to only report support from their side of the family and husbands to report support from theirs, based on the assumption that respondents would know little about support given by their spouses' families. This issue is likely to have greater salience when interviewing single mothers, many of whom may know very little about the child's paternal kin. Unlike eliciting information about co-residential family members living in the same household, where the respondent would be expected to know their survival status, age, marital status, employment status, and education, some single mothers may never have met some of the child's paternal relatives or may have lost touch with them after their relationship with the child's father ended. As such, one of the goals of developing the KST was to ascertain how much single mothers knew about the child's close kin members on both sides of the family tree.

By design, the KST asks people to report the number of aunts, uncles, and grandparents on the child's maternal and paternal sides. While every child must have four grandparents, this is not the case for aunts and uncles. Therefore, it is possible for respondents to say that they do not know the number. On the maternal side, this was not an issue as only one woman could not give us a number for maternal uncles. The paternal side, however, presents greater challenges, with 169 women (36.6 per cent) not knowing the number of paternal aunts and 167 (36.1 per cent) not knowing the number of paternal uncles. Moreover, even among respondents who did estimate the number of paternal aunts and uncles, the average provided was far below that for maternal aunts and uncles, suggesting that single mothers severely under-report the number of paternal aunts and uncles because they may not know they exist. Substantively, this is an important finding, in that it shows the extent of disconnect between these single mothers and the paternal kin of their children. If we assume that children have on average the same number of paternal aunts and uncles as maternal aunts and uncles, we estimate that nearly three-quarters of paternal aunts and uncles are unknown to these single mothers.

For those who could be enumerated, Table 2 shows the distribution of *knowing* specific types of information about kin. In line with the survey design shown in Figure 1, each column shows the respective numbers (N) for kin for whom the questions were asked. Name and survival status were asked for all enumerated kin. If a kin member was reported as dead, the respondent was asked for age at death; if the member was alive, we collected data on current age. Of those who were alive and aged eight years or above, we asked about their location and educational attainment. Finally, for those aged twelve years and older, we also enquired about their employment status.

Overall, most respondents are able to provide basic demographic information on their kin. For example, respondents were able to report on educational and employment status for 72 and 81 per

Table 2   Specific information known about kin (percentage with knowledge), by single mothers in Korogocho, Kenya, 2015

	All kin	Dead kin	Living kin	Kin aged eight or above[1] (potential kin)	Kin aged twelve or above
Name	79.2				
Survival status	79.9				
Age at death		22.9			
Current age			65.7		
Current location[2]				92.7	
Education status				71.9	
Employment status					81.1
N	5,344	595	3,674	3,453	3,274

[1]Includes those whose ages are listed as unknown based on relationship status which established all these members as adults.
[2]Question only asked if kin member was non-resident ($N = 2,388$).
Source: As for Table 1.

cent of kin, respectively. The question that appears to present the greatest difficulty for respondents is age. Among dead kin, we were only able to ascertain age at death for about 23 per cent and, for those alive, current age was not available for about 34 per cent of the sample. The challenge of collecting data on age at death necessitates more consideration of the value of collecting data on survival status of kin. It is also interesting that name was not known for 21 per cent of enumerated kin. This may not be particularly surprising in contexts where the kin relationship is more critical to establishing one's identity than a given name. Indeed, there is a long tradition of anthropology that supports this observation (Riesman 1992; Fortes 1969 [2013]). Mothers may be aware that, for example, the child has a paternal uncle, but she may not know his name because she has never met him.

Consistency of geospatial data

While Table 2 shows that we were successful in obtaining data on location for the vast majority (93 per cent) of kin, it does not tell us how robust these data are. One of the innovative features of the KST is its attempt to capture multiple types of geospatial measure between the respondent and her kin. These include three self-reported or *vernacular* measures: travel time, cost of travel, and perception of distance; and two objective measures: distance based on geocodes of location and form of transport. Geocodes were collected using Google Maps, which allowed the interviewer and respondent to identify the location of the kin. We also collected assessments from the interviewer about the precision of the geocoded data. Table 3 shows the bivariate relationship between the vernacular and objective measures for all members who are alive, aged eight or above, and not co-resident in the respondent's household.

There appears to be a high level of consistency between vernacular and objective measures. Longer travel times are in line with longer distances. Similarly, the average distance is much greater for those reported as 'living too far away'. Finally, the cost of transport increases with actual distance. We would expect more variation in forms of transport, but the fact that longer distance, time, and cost are all associated with the use of inter-city buses is reassuring. We also tested the hypothesis that women are more likely to overestimate vernacular measures for paternal kin because they consider them to be socially more distant than maternal kin. When we compared consistency of vernacular and objective responses by type of kin, we found no evidence of

Table 3 Comparison of three vernacular responses with two objective geospatial measures for location of non-resident kin, Korogocho, Kenya, 2015

	Objective measures	
Vernacular measures	Average distance (kilometres)	Most common form of transport used for journey
Travel time (*N* = 1,347)		
<1 hour	2.20	Walk
1 < 3 hours	33.76	Matatu[1]
3 < 6 hours	95.65	Matatu
6 < 11 hours	277.95	Bus
11 < 24 hours	327.76	Bus
Do you regard trip as too far? (*N* = 1,343)		
No	17.71	Walk/matatu
Yes	250.35	Bus
Don't know	74.72	n/a
Cost to visit (*N* = 1,341)		
0–49 Kenyan shillings (KSH)	0.68	Walk
55–99 KSH	3.78	Matatu
100–249 KSH	10.36	Matatu
250–499 KSH	74.51	Matatu
500–999 KSH	116.70	Bus
≥1,000 KSH	279.79	Bus
Don't know	314.90	n/a

[1]A matatu is a van commonly used both within cities and for long distance trips that is often cheaper than other forms of transport.
Source: As for Table 1.

this type of bias. However, we did find that out of the 172 kin whose location is reported as 'don't know', almost all are paternal kin. Taken together, this exercise suggests that vernacular measures are quite robust and, therefore, could serve as the main means of data collection if resource constraints prevent the use of Google Maps. However, geocodes enable a level of precision not available with the more conventional vernacular measures. Moreover, they enable researchers to assess distances not only between the respondent and her relatives, but also between relatives. Finally, geocodes enable the creation of kinship maps, a highly effective means of conveying kinship structure and support. As one example of the type of in-depth analyses that can be done using these geocoded data, see Madhavan et al. (2014). In short, the decision to use Google Maps should be based on (1) level of precision needed to address research questions; and (2) practical considerations such as availability of money and equipment to collect the data.

Feasibility and challenges of administration

One possible criticism of the KST is its reliance on mothers' reports of support. We found that the overwhelming majority of support comes from maternal kin (Clark et al. 2016). It is possible that single mothers either exaggerate the role of maternal kin or under-report the role of paternal kin, or both. Their responses may be coloured by their views on the value of the relationship or perhaps by even more idiosyncratic issues that might influence her responses at the time of interview. This is likely to occur when discussing the biological father of the child and, by extension, paternal kin. If the dissolution occurred under particularly acrimonious circumstances, then the mother may be more likely to underestimate the father's support or that of his kin. Alternatively, if the mother is caught in conflict with her sisters or brothers, she might also downplay their contributions. In order to assess reliability, we administered an abridged version of the questionnaire by phone to selected kin, to examine the extent of consistency between responses of the mother and her corresponding kin. For example, does the mother's report of financial contribution from her brother match what the brother says he contributes? We successfully conducted reliability interviews with 101 kin linked to 47 mothers. More than half of these reliability respondents were residing in Korogocho when we interviewed them and all but eight were maternal kin. We found fairly high levels of reliability on responses to type of support provided. Kappa statistics show 70 per cent agreement on financial support provision; 85 per cent for childcare support and 61 per cent for responses to the question 'can you talk to [KST member] about a personal issue?' While this agreement is high for KST members who the mother reported as providing support, we had substantial difficulty accessing those kin who the mother reported as *not* providing support and who tended to be biological fathers and paternal kin. We had only seven biological fathers and only one paternal kin because mothers, not surprisingly, are more likely to know or to reveal contact information for those members with whom they have a good relationship and who tend to be maternal kin. Therefore, this exercise suggests a high level of concurrence among relatives in supportive relationships, which is an important finding. However, because of our limited number of interviews conducted with less engaged relatives, they tell us little about the reliability of a mother's reports of 'non-support'.

Another concern is the time needed to carry out the survey. On average, a questionnaire required two hours to complete, with some going beyond three hours. The time taken was directly correlated to the size of the kin network; the longer the list of enumerated kin, the longer the interview. While we limited data collection to only close kin, Kenya's very high fertility in the not-so-distant past means that there are likely to be at least three or four aunts and uncles on paternal and maternal sides. Moreover, if the woman is older, she is likely to have older children who would also be included on the list and if she was previously married to the father, she is likely to know more information about the paternal kin than if not. The monotony of asking a long list of questions for each member of a large kin group can be onerous. One way for the respondent to end a survey is to report the survival status of kin members as unknown. Therefore, we might expect to see a larger proportion of kin network with survival status unknown in larger kin networks. However, our analysis reveals no significant difference by size of kin group. If anything, there is a marginally negative relationship between size of kin group and proportion reported with unknown survival status. While this is somewhat reassuring, it is possible that data quality suffers (e.g., more 'don't know' answers) for those members who end up at the bottom of long lists. We examined this possibility by comparing the proportion of each type of grandparent whose survival status is reported as 'don't know' (Table 4) across

Table 4 'Don't know' responses to question on survival status of grandparents by mothers' kin group size (percentage responding 'don't know'), Korogocho, Kenya, 2015

Type of grandparent	Size of network (kin group)		
	Small (5–9)	Large (10+)[1]	Unknown size
Maternal grandmother	0	0	0
Maternal grandfather	23.2	12.5	16.2
Paternal grandmother	88.4	60.6	91.9
Paternal grandfather	91.2	66.2	93.2
Total *N*	72	315	75

[1]'Large' category includes those with unknown network size but who had a minimum of ten known kin; therefore, we know that their network size must be at least ten people.
Source: As for Table 1.

size of kin network. By focusing on one particular set of relationships—grandparents who always show up at the end of a roster—we are, in effect, controlling for type of kin relationship and, therefore, able to better isolate the effects of interview length. We separate out networks of indeterminate size smaller than ten people in order to see differences between small and large networks more clearly.

There is no evidence that length of survey increases the likelihood of reporting 'don't know' to the question on survival status in any of the grandparent categories. Although the differences between the maternal and paternal sides are striking, proportions are not higher for a large or unknown network size. If anything, the proportion is actually higher in smaller kin groups, suggesting that women with larger networks are more connected than those with small networks. We also asked respondents to convey any comments or suggestions about the survey at the end of the interview. Out of the 60 women who provided comments, ten complained about the length. However, 75 per cent reported that they found the questions easy to understand.

The KST was developed using Open Data Kit (ODK), an open-source survey development software and administered on Android-based tablet computers. The advantages of using ODK is that it is free, readily available, and routinely being updated and improved by a community of users. Perhaps one of its most attractive features is the relatively easy interface with Google Maps, which allows the interviewer to work with the respondent to identify the exact location of the named kin. Whereas this is not particularly challenging in the Kenyan context, owing in no small part to high levels of digital exposure, it should not be assumed that spatial orientation using a cartographic interface is meaningful in all contexts. Therefore, the effort taken to collect precise geocoded data, while highly appealing to

researchers who no longer need to conduct time-consuming post-survey manual coding, may not actually produce highly reliable data. Moreover, the use of Google Maps takes up time and bandwidth, which both come at a premium in the Kenyan context. Therefore, we would call for more testing on this aspect of the questionnaire to (1) determine the feasibility of using Google Maps; and (2) to identify the optimum geospatial measures for each context. Our own analysis, shown earlier, suggests that vernacular data (i.e., self-reports of distance, time, and cost) are consistent with objective measures based on geocodes. However, geocoded data offer a level of precision and flexibility that facilitates more in-depth analysis of geospatial factors and familial support. As a minimum, therefore, geocoded data should be collected as one form of geospatial data.

Tablet computers are increasingly becoming standard features in data collection (IRIS Center 2011; Paudel et al. 2013) because: (1) the questionnaire can be programmed to minimize data entry error; (2) they allow direct storing of data to a cloud-based server; and (3) they do away with the need to carry around large amounts of paper. For this project specifically, they enabled the use of an expandable number of loops for various parts of the survey including the collection of data on kin. This would have been impossible to do using paper surveys. However, our experience with tablets revealed other types of problem that should be addressed. Although programming can eliminate many sources of data entry error, the possibility of accidentally choosing the wrong answer when using touch screens exists and requires vigilance. Moreover, this project provided an opportunity to assess the feasibility of using such devices in high crime areas, an issue that has not garnered much attention. While the use of electronic devices for data collection has obvious advantages, it was important that we

considered the ethical dimensions of exposing interviewers to physical danger from attempted robbery. The interviewers on this project voiced such concerns during the training, even though all of them were extremely familiar with the community. Even with common-sense precautions, word spread quickly in these communities that interviewers were carrying tablets, which, in turn, made them targets for robbery. Fortunately, we only lost one tablet to a robbery in Round 1 and no one was hurt, but more thinking about this issue is needed.

Discussion

In this paper, we have presented an innovative data collection instrument that we believe will greatly advance our ability to understand the complexity of family structure and support. It has long been recognized that household-based measures are inadequate proxies for families, but few survey instruments have attempted to move beyond the household. Household rosters, while a convenient means of data collection, are unable to reflect the reality in many contexts (both high-income countries and low- and middle-income countries) brought on by changing norms around family obligations, union formation, and childrearing, as well as pervasive economic insecurity. If we want to understand these new forms of family complexity and the effects on children's well-being, we need better tools. The KST, we believe, is one promising way forward. Its key innovations include: (1) going beyond the residential household; (2) distinguishing functional from potential kin; (3) capturing multiple geospatial measures; and (4) switching the frame of reference to children. Through this project, we have uncovered a number of important findings. First, the instrument works well in distinguishing co-residential from non-residential kin and identifying functional from potential kin. Second, respondents can enumerate and provide demographic data about almost all a child's maternal kin but encounter more difficulty when asked about kin on the child's paternal side. Married mothers may be better informed than the single mothers in our study about the child's paternal relatives, but socio-demographic information about non-residential non-functional kin is likely to be limited. Third, vernacular responses to questions about location of non-residential kin are consistent with GPS measures. In addition, this first phase of development and testing has shown that it is possible to: (1) programme a complex survey instrument using open-source software; (2) gather precise GIS data on kin location, which seem to correspond reasonably well to perceptions of distance and time; (3) use tablet computers to collect the data in an efficient manner that minimizes errors; and (4) train interviewers to appreciate both the conceptual and practical value of the instrument. In addition, we are in the process of determining the feasibility of retaining the original sample over a six-month period through a second round of data collection. Findings from the follow-up survey (expected in the next few months) will offer important insights into the opportunities and challenges of following women and their children in highly mobile populations. Substantively, this is important because it will shed light on the extent of stability in women's support networks.

Even though this paper is restricted to a focus on the methodological aspects of the KST, it is nonetheless important to highlight some key findings that are emerging from analysis of the first round of data. Perhaps the most notable finding thus far is that a large number of potential kin do not provide any support to single mothers or their children. Among those who do, most are maternal kin and a substantial number live outside the household. These are crucial findings because they challenge the long-standing narrative that in the African context extended kin are available and able to provide support to women and children in need. While it is clearly premature to dismiss the role of extended kin, the time has probably come to interrogate the validity of this role, particularly in contexts undergoing rapid social and economic change.

While we recognize the need for further improvements to the KST instrument, such as extending the instrument to children of mothers in a union and capturing reciprocity in kin support, we are encouraged by our experience thus far. Our substantive findings provide further motivation to consider refinements to the instrument and identify other sites for testing. For example, it would be very useful to test the instrument in a rural context where one might expect kin support to be stronger. Given the fast progress of urbanization in many African countries, it is not only timely but essential that we use alternative and innovative data collection tools to understand the contours of family structure and the nuances of family support. It is also not unreasonable to consider sites outside Africa, including the US. Inspired, in part, by Carol Stack's (1974) seminal ethnography on the caregiving networks of low-income black residents of a Midwestern town, child development scholars and family sociologists have examined the role of kinship support in African-American families

(Jayakody et al. 1993; Taylor and Roberts 1995). However, these studies offer little insight into potential kin, thereby limiting our understanding of the quantity and quality of kin support. Moreover, in line with this scholarship, our instrument could incorporate the role of people often referred to as fictive kin—who are not biologically related, but treated as such—more systematically. Additionally, these studies have not incorporated geospatial measures, which limits our ability to discern the role of spatial location and dispersion on kinship support. Given mounting evidence linking child poverty, health, and educational outcomes to family support, and the growing recognition of the increasing complexity of families that extend beyond the household, particularly in low-income communities, the time may be ideal to conduct additional studies using a modified KST instrument.

Notes

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