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Title: Interviewer-driven variability in social network reporting: results from Health and Aging in Africa: a Longitudinal Study of an INDEPTH community (HAALSI) in South Africa

Running Head: Interviewer effects on social network reporting patterns

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ABSTRACT

Social network analysis depends on how social ties to others are elicited during interviews, a process easily affected by respondent and interviewer behaviors. We investigate how the number of self-reported important social contacts varied within a single data collection round. Our data come from HAALSI, a comprehensive population-based survey of individuals aged 40 years and older conducted over thirteen months at the Agincourt health and demographic surveillance site in rural South Africa. As part of HAALSI, interviewers elicited detailed egocentric network data. The average number of contacts reported by the 5059 respondents both varied significantly across interviewers and fell over time as the data collection progressed, even after adjusting for respondent, interviewer and respondent-interviewer dyad characteristics. Contact numbers rose substantially after a targeted interviewer intervention. We conclude that checking (and adjusting) for interviewer effects, even within one data collection round, is critical to valid and reliable social network analysis.

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INTRODUCTION

Measurements of social networks depend on the number and type of social ties to others (Berkman et al. 2000; Smith and Christakis 2008). These ties are typically elicited through interviews, a process easily affected by respondent or interviewer characteristics and behaviors. Understanding social network structure and composition requires substantial amounts of information from respondents ("egos") about the people ("alters") they have relationships with (Marsden 1990). Notably, the survey burden associated with network data collection depends heavily on the number of alters elicited through "name generator" questions: each alter named leads to the repetition of all follow-up questions characterizing the ego-alter relationship ("name interpreters") (Burt 1984).

Interviewers have been identified as a key source of variation in survey responses, particularly for questions which are attitudinal, ambiguous or have complex skip patterns (West and Blom 2016). Several studies have previously identified interviewer effects on network size (Brüderl, Huyer-May and Schmiedeberg 2013; Josten and Trappmann 2016; Marsden 2003; Paik and Sanchagrin 2013; van Tilburg 1998). These interviewer effects may arise from arise from differential understanding of survey questions, and therefore how questions are presented to respondents. Interviewers can also affect which alters are elicited due to their own characteristics (e.g. sex, race, age or experience), or the nature of the interviewer-respondent dyad (e.g. gender, race or age homophily), leading to different lines of enquiry, levels of probing, or expectations of social acceptability (Collins 1980; Hox 1994; Marsden 2003; Phung et al. 2015).

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Furthermore, if respondents or interviewers are aware that naming more alters substantially increases survey length, then either group may consciously or unconsciously seek to minimize the number of alters named (Eagle and Proeschold-Bell 2015; Van der Zouwen and Van Tilburg 2001). In cross-sectional surveys, the opportunities for respondents to learn are limited, but those for interviewers will increase as the survey period progresses. Interviewers may try to reduce survey burden, either for themselves or for respondents, by favoring language or probes that decrease the number of alters elicited. Indeed, past studies in Europe have found evidence of interviewers intentionally filtering out questions by entering fewer responses that would trigger more questions. Such filtering behavior has been seen in Europe for interviewers who are being compensated by the interview rather than by the hour (Josten and Trappmann 2016; Kosyakova, Skopek and Eckman 2014), for interviewers with prior experience using the relevant screening tool (Matschinger, Bernert and Angermeyer 2005) and where interviewers are under substantial pressure to complete more interviews (Schnell and Kreuter 2000).

We aim to extend this literature by assessing how the number of alters elicited systematically changed over the course of a cross-sectional social network survey of older adults in rural South Africa. We show a substantial drop in alter numbers over time, and a swift reversal following retraining, providing substantial evidence for interviewer effects.

METHODS

Survey design

The social network module was one component of the baseline wave of the "Health and Aging in Africa: a Longitudinal Study of an INDEPTH community" (HAALSI) questionnaire conducted in 27 of the 31 villages that comprise the MRC/Wits Rural Public Health and Health Transitions Research Unit in Mpumalanga Province, South Africa (hereafter, "Agincourt") (Kahn et al. 2012). The HAALSI study is a population-based longitudinal cohort of men and women aged 40 years and over in rural South Africa, and was selected as a random sample of approximately 40% of all age-eligible individuals in the Agincourt demographic surveillance area; 85.9% of elibile indivduals approached consented to participate. Interviews progressed from village to village throughout the study period with interviewers randomly assigned to potential participants within each village.

Data were collected using computer-assisted personal interviews (CAPI). The baseline survey was modeled closely on sister health and aging studies including the US Health and Retirement Studies (HRS), LASI in India and CHARLS in China (Arokiasamy et al. 2012; Sonnega et al. 2014; Zhao et al. 2014). It comprised an approximately three-hour household visit including structured quantitative interviews, anthropometric and physiological measurements and blood draws. Inclusion of a social network module, however, was unique to HAALSI amongst the HRS sister studies. The structure of the HAALSI social network module was modeled on the network module in the US-based National Social Life, Health, and Aging Project (NSHAP) (Cornwell, Laumann and Schumm 2008). The HAALSI module, which was started around 30 minutes into the household visit,

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included one name generator question: "Please tell me the names of 6 adults with whom you have been in communication either in person or by phone or by internet in the past 6 months, starting with the person who is most important to you for any reason". This question aimed to capture the respondents' most meaningful recent relationships – those most likely to impact their health and wellbeing. If the respondent was married and the spouse was not named by the respondent, then the spouse's name was added as a seventh response. Neither the interviewers, nor the CAPI program, forced respondents to name six alters, despite the name generator wording.

Respondents were then asked a series of "name interpreter" questions about each named alter, including: (i) the alter's socio-demographics (age, sex, residential location, relationship to respondent); (ii) frequency of contact (in-person, by phone/text/email); and (iii) frequency of receiving four types of social support (emotional, informational, physical and financial) from the alter.

HAALSI was granted ethics approval by the University of the Witwatersrand Human Research Ethics Committee, the Harvard T.H. Chan School of Public Health Office of Human Research Administration and the Mpumalanga Provincial Research and Ethics Committee.

Interviewer recruitment and training

HAALSI interviewers were recruited from within the local resident community, amongst those with high school graduation ("matric pass") and fluent in both English and xiTsonga (the local language). Twenty of the 29 applicants selected for training were retained for the survey. Four supervisors with previous experience supervising the Agincourt demographic census oversaw the work of the fieldworkers. Both interviewers and supervisors received

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training specific to the social network module. Interviews began in November 2014. Three interviewers did not continue after January 2015 as performance requirements were not met. In May 2015 an additional seven interviewers were employed to accelerate survey completion. In September 2015, after the bulk of interviews were completed, the three best-performing fieldworkers (based on quantitative data and supervisor reports) were retained to revisit previously unavailable respondents, with other fieldworkers providing occasional assistance. Survey enrollment closed in December 2015. All but four of the 27 interviewers who worked on HAALSI had previous interviewer experience in Agincourt.

Data monitoring

Beginning in January 2015, HAALSI researchers produced monthly data quality monitoring reports until the end of the survey. Key results were shared with on-site and off site project managers, who then informed field supervisors at the weekly study management meetings and periodic re-training conducted with field staff (supervisors and interviewers). Social network module re-training in February focused on questions relating to alter ages (which had been missing in 25% of cases) and conflict (5-10% don't know/refused). Although declining rates of alter elicitation were noted early on, the extent of decline was not clear until later in the year. As a result, the issue was not presented to the field team until June. Despite subsequent discussions with field staff, alter numbers continued to decline to a nadir in September 2015. In October and November 2015, supervisors and project managers held intensive weekly meetings with the remaining interviewers during which they discussed the issue of low alter numbers.

Statistical analyses

We first described how the number of alters reported varied by: (i) respondent characteristics, using Kruskall-Wallis χ^2 tests; (ii) interviewer and their characteristics; and (iii) date of interview, including what types of alters were named differentially over time. We then conducted multilevel Poisson regression (having tested for and rejected overdispersion), in which respondents were nested within interviewers with random intercepts. Poisson models allowed us to model the count of alters elicited; multilevel models allowed us to decompose the variation in number of alters elicited into parts within and between interviewers. These regression models began with a null model with no covariates, then added in turn: month of interview; village of respondent; other respondent characteristics; interviewer characteristics and respondent-interviewer dyad characteristics.

Finally, we examined the extent of variation in the rate of decline across interviewers by running a multilevel model on only the first 11 months of data, i.e. the period prior to intensive interviewer supervision, including both random intercepts and slopes for each interviewer. The final model was of the form:

$$log(\mu_{ij}) = \beta X_{ij} + \gamma Z_j + \delta T_{ij} + v_j M_{ij} + u_j + e_{ij}$$

Where μ_{ij} is the count of alters named by respondent i with interviewer j. The model contained three sets of fixed effects: X_{ij} is a vector of respondent-level covariates, including M_{ij} an indicator for month of interview; Z_j a vector of interviewer-level covariates; and T_{ij} a vector of respondent-interviewer dyadic covariates. The model contained three random

effects: e_{ij} at the individual level, u_{ij} a random intercept for each interviewer, and $v_j M_{ij}$ a random slope for interviewers across months. This last term further decomposed the variation in alter numbers seen between interviewers by allowing for the rate at which interviewers decrease the average number of alters they elicit to vary, so we can determine whether rates declined over time for all, or only some, interviewers.

RESULTS

A total of 5,059 individuals responded to the social network module of HAALSI, describing 15,549 alters in the social network module (Supplementary Table 1). Respondents named a median of three alters, with 252 (5.0%) individuals reporting no alters and 532 (10.5%) reporting six alters (227 of whom also had an unnamed spouse who was added as a seventh alter). Over three-quarters (77.8%) of named alters were relatives, mainly living in the same household (34.1%) or village (35.1%) as the respondent. Most non-relative alters (76%) also lived in the same village as the respondent.

The 27 interviewers conducted between 25 and 351 interviews each, with a median of 211 (Table 1). The mean number of alters elicited per interview varied widely across interviewers – ranging from 1.4 to 6.1. Interviewers who were female, younger and who conducted more interviews elicited more alters, on average. There was also considerable variation across time, with the mean number of alters elicited in each study month falling from 4.8 in November 2014 to a low of 1.7 in September 2015, before rebounding to 3.1 in the last two months of data collection following re-training (Supplementary Figure 1). This downward trend and rebound occurred within interviewers (Figure 2), and appears to

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correspond to a fall in alters who lived outside the respondents' household, particularly within the Agincourt study area (Supplementary Figure 2).

The multilevel regression models show that approximately half of the variance seen at the interviewer level in the null model can be explained by the month of interview (Table 2). In addition to month of interview, respondents' age, gender, education level, marital status and household wealth are significant predictors of numbers of alters named. No other factors, however, are able to explain the remaining 50% of interviewer-level variance. Neither interviewer gender and age, nor dyadic homophily on these characteristics, predicted number of alters. Finally, when considering only the period up to September 2015, there was significant variability in how rapidly alter elicitation rates fell over time, although all 27 interviewers had a significantly negative slope coefficient (Supplementary Figure 3). This rate of decline was positively associated with level of alter elicitation, such that interviewers with higher elicitation rates saw slower fall-off in these rates. The predicted incidence rate ratio of elicited alters from model 7 continues to show a clear decline until September 2015, followed by a sharp rise (Supplementary Figure 4).

DISCUSSION

In this study of an egocentric social network data collection process within a large, cross-sectional in rural South Africa, we show that alters elicitation rates fell systematically as the survey progressed, even after adjusting for respondent, interviewer and respondent-interviewer dyad characteristics. Even more compellingly, we show that after fieldworkers

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and supervisors began meeting weekly to discuss fieldwork progress (including reviewing alter elicitation numbers), alter numbers rose sharply for the remainder of the study.

There are several possible explanations for the fall in alter numbers over time. First, later respondents may have learned from friends and family that the interview process was lengthy and could be shortened by reporting fewer alters. Given that the social network module was only one of several within the questionnaire, this seems unlikely. Second, later respondents may have true had fewer alters. Since this study was rolled out across consecutive villages in an overlapping fashion, the decline over time could represent a geographic pattern. Furthermore, later respondents included those who could not easily be found by the field team; such hard-to-find individuals might have had fewer alters. However, neither of these explanations explains the sharp uptick observed in the last two months of data collection. Third, increased experience may have improved interviewers' ability to elicit the truly important people in respondents' lives. Much of the drop in alter nominations was of kin not living in the same household, who might have been less vital to respondents. Yet, there was also a drop in the number of alters in daily contact with respondents (Supplementary Figure 5), which suggests that at least some truly pertinent alters were lost.

Finally, interviewers may have learnt to reduce survey length by eliciting fewer alters. Although interviewers were salaried, rather than paid per interview, there were substantial pressures on fieldworkers to complete interviews more rapidly – since the completion target of two interviews per day was regularly missed throughout the survey period. If interviewers learned that certain modules could be shortened, they may have

guided respondents to report fewer alter to speed up the process. This explanation is supported by the sharp increase in alter numbers seen once interviewers were made aware that their elicitation rates were being observed, and that higher numbers of alters were to be expected (i.e. a Hawthorne effect).

Variation in alter elicitation rates across interviewers – even with randomized assignment to respondents – is not surprising and has been seen previously for consent rates, reporting on sensitive topics, and indeed naming of alters (Brüderl, Huyer-May and Schmiedeberg 2013; Josten and Trappmann 2016; Marsden 2003; Paik and Sanchagrin 2013; van Tilburg 1998). In contrast, variation over time in elicitation rates within interviewers across a survey period has been reported less often. This study is the first to empirically examine possible interviewer learning effects outside of Germany and the second to examine social network data specifically. Our results corroborate findings that interviewers may lead respondents away from longer interviews after learning about the interview process and when under time pressures (Matschinger, Bernert and Angermeyer 2005; Schnell and Kreuter 2000), and suggest that such behavior occurs even when interviewers are salaried (Josten and Trappmann 2016; Kosyakova, Skopek and Eckman 2014) and may be placing future employment opportunities at risk – even when stable jobs are very scarce. Interestingly, our findings suggest that not just a sub-group (Matschinger, Bernert and Angermeyer 2005), but all interviewers elicited fewer alters over time, possibly because they worked as a single cohesive field team.

Future social network studies should develop ways to minimize interviewer-associated variation over time in labor-intensive surveys. Possible approaches include: (1) improved

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training to increase standardization of name generator question delivery and probing; (2) more feedback of alter elicitation rates, and more careful education about the importance of comprehensive alter elicitation to the fieldwork team; (3) computer programing strongly encouraging collection of a fixed or minimum number of alters from all respondents (although this requires careful training and allowing interviewers to relax the constraint in the case of truly isolated individuals); and (4) use of self-interview methods, so interviewers are not involved in alter elicitation.

We also note that while roster-style modules, with multiple questions asked about every alter named, may be particularly susceptible to interviewer effects given the impact of roster length on interview burden, other parts of an interview with loops and skip patterns may also open to control by interviewers (Brüderl, Huyer-May and Schmiedeberg 2013). Future work could usefully examine such potential effects.

Strengths and limitations

A major strength of this study is its use of standard social network data collection methods, modelled on the NSHAP study. In addition, this study was based on an existing longitudinal surveillance platform, ensuring well-trained fieldworkers and a strong fieldwork infrastructure. Given these standardized data collection approaches, the effects we report on are likely to generalize to many other settings. Our key weakness is the inability to entirely rule-out non-interviewer led explanations for the observed temporal trends. However, the striking pattern of rebound following intensive interviewer re-training strongly suggests interviewers' importance in generating the patterns of alter numbers seen. Furthermore, in settings where social networks can be collected via respondent-

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driven methods (e.g. self- or online-interviews) or via analysis of email or social media patterns, the concerns raised here may be less pfressing. Nevertheless, interviewers can help increase the validity and reliability of alter elicitation, if carefully trained and supervised, and thus interviewers are likely to be used – and interviewer effects remain a concern – even in more literate and computer-connected populations.

Conclusions

The time and effort required from both interviewers and respondents to measure networks is considerable, and is thus social network data is vulnerable to measurement error, as our findings suggest. We therefore recommend that researchers design network data collection processes to minimize opportunities for interviewer effects, continuously monitor data collection processes, and consider adjustment for both interview date and interviewer identity in any analyses they conduct – even for cross-sectional data.

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Table 1: Descriptive statistics for HAALSI interviewers

Interviewers	N	%	Respondents interviewed N	%	Mean number of alters named N	95% CI	χ² test
Sex							
Male	7	25.9%	1519	30.0%	3.18	[3.09 - 3.27]	
Female	20	74.1%	3540	70.0%	3.03	[2.97 - 3.08]	17.9 (p<0.001)
Age							
20-29	17	63.0%	3672	72.6%	3.15	[3.10 - 3.21]	
30-39	7	25.9%	1056	20.9%	3.15	[3.04 - 3.25]	
40-49	3	11.1%	331	6.5%	1.95	[1.80 - 2.11]	159.6 (p<0.001)
Interviews, total							
< 200 interviews	13	48.1%	1284	25.4%	2.32	[2.22 - 2.41]	
≥ 200 interviews	14	51.9%	3775	74.6%	3.29	[3.23 - 3.34]	323.2 (p<0.001)
Interviews per month							
< 17 interviews	13	48.1%	1452	28.7%	3.00	[2.90 - 3.09]	
≥ 17 interviews	14	51.9%	3720	73.5%	3.10	[3.05 - 3.15]	9.30 (p=0.002)
Total	29		5059				

χ^2 test is a Kruskal-Wallis test of equality of ranks with one degree of freedom comparing mean number of alters reported by respondents interviewed by interviewers from each category.

Table 2: Summary of mixed-effect Poisson regressions for number of alters elicited by HAALSI interviewers

	13 months of interviews (n=5059)							11 months of interviews (n=4856)	
	Model 1: Null model	Model 2: add Months	Model 3: add Villages	Model4 : add Respondent characteristics	Model 5: add Interviewer characteristics	Model 6: add Dyad characteristics	Model 7: Final model	Model 8: Random intercepts	Model 9: Random slopes
Month of interview †		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Respondent									
Village of residence			0.39						
Sex and Age decade				0.03	0.005	0.35	0.02	0.03	0.04
Education				0.04	0.01	0.01	0.01	0.02	0.01
Country of origin				0.78					
Marital status				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Household size				0.61					
Household wealth				<0.001	<0.001	<0.001	<0.001	<0.001	0.005
Interviewer									
Age					0.31				
Gender					0.63				
Total number of interviews					0.71				
Respondent-interviewer dyad									
Gender homophily						0.54			
Age difference						0.81			
Akaike Information Criterion	18,346.5	17,805.4	17,830.3	17,191.8	17,197.1	17,200.2	17,192.1	16,582.8	16,495.0
Interviewer variance (intercept)	0.12 [0.05 - 0.18]	0.06 [0.03 - 0.10]	0.06 [0.03 - 0.10]	0.05 [0.02 - 0.08]	0.05 [0.02 - 0.08]	0.05 [0.02 - 0.08]	0.05 [0.02 - 0.09]	0.05 [0.02 - 0.08]	0.05 [0.02 - 0.08]
Interviewer variance (per month)									0.01 [0.00 - 0.02]

All statistics for covariates are p-values from Wald tests for a linear hypothesis that all k categories of each variable (as shown in Supplementary Table 1) are jointly equal to zero, with an associated $k - 1$ degrees of freedom.

† Month of interview is categorical for models 1-7, to allow for non-linearities over time, and continuous for models 8 and 9 to allow for meaningful random slope coefficients. Point estimates and confidence intervals for all regressions are provided as Supplementary Table 2.

Figure 1: Mean number of alters reported to each interviewer in each month by HAALSI respondents
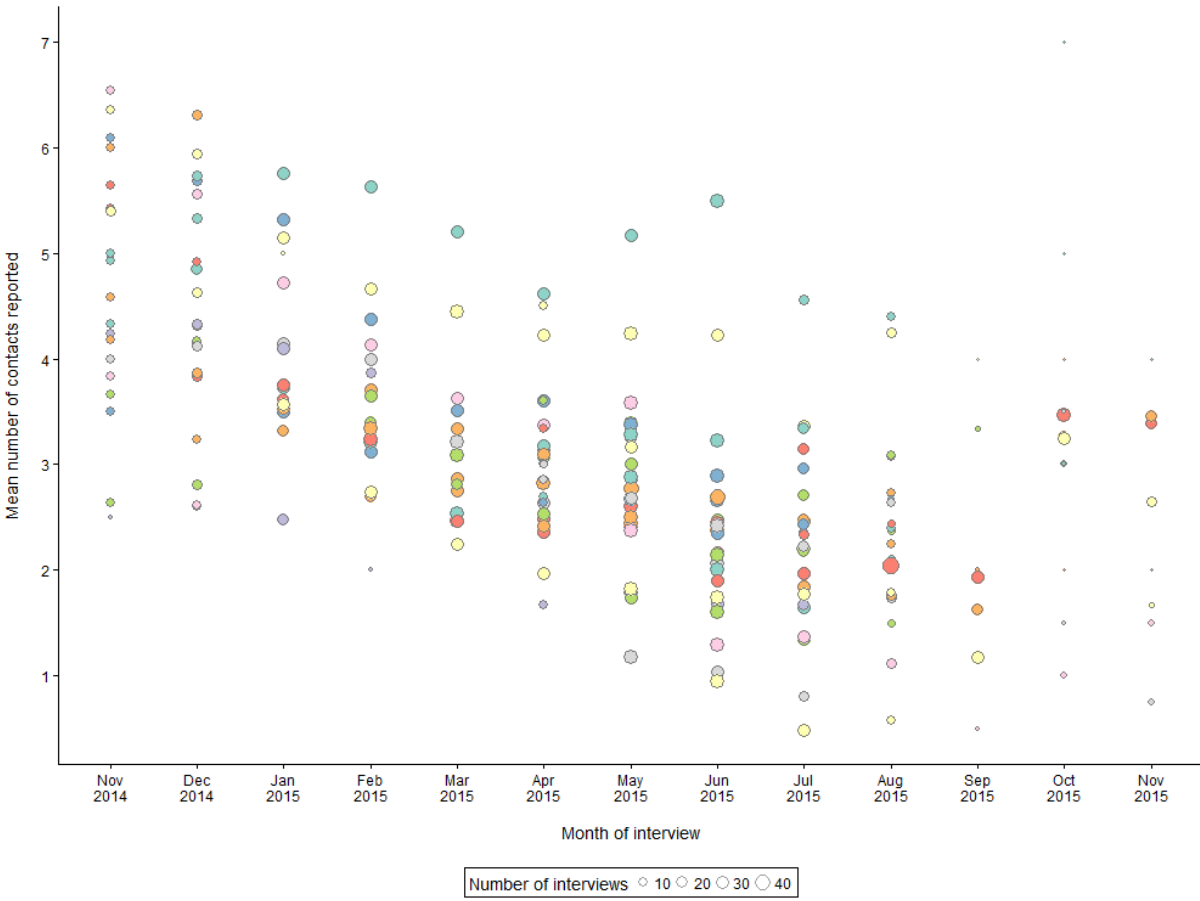
Each circle represents the number of interviews conducted by one of the 27 interviewers in one month; the volume of each circle is proportional to the number of interviews conducted. Each interviewer is represented by the same colour over time.

Supplementary Material

Title: Interviewer-driven variability in social network reporting: results from Health and Aging in Africa: a Longitudinal Study of an INDEPTH community (HAALSI) in South Africa

Supplementary Table 1: Descriptive statistics for HAALSI respondents

	Respondents		Number of alters	
	N	%	Mean	95% CI
Sex				
Male	2345	46.4%	3.13	[3.06 - 3.20]
Female	2714	53.6%	3.02	[2.96 - 3.09]
Age, years				
40-49	918	18.1%	3.04	[2.94 - 3.15]
50-59	1410	27.9%	3.14	[3.05 - 3.23]
60-69	1304	25.8%	3.24	[3.14 - 3.33]
70-79	878	17.4%	2.99	[2.88 - 3.10]
80+	549	10.9%	2.70	[2.56 - 2.85]
Education level				
No formal education	2306	45.6%	2.93	[2.86 - 3.00]
Some primary (1-7 years)	1614	31.9%	3.21	[3.13 - 3.29]
Some secondary (8-11 years)	537	10.6%	3.18	[3.05 - 3.32]
Secondary or more (12+ years)	585	11.6%	3.18	[3.05 - 3.31]
Country of origin				
South Africa	3528	69.7%	3.10	[3.05 - 3.16]
Mozambique/other	1526	30.2%	3.01	[2.92 - 3.09]
Marital status				
Never married	290	5.7%	2.10	[1.92 - 2.28]
Separated/divorced	650	12.8%	2.62	[2.50 - 2.73]
Widowed	1540	30.4%	2.60	[2.52 - 2.68]
Currently married/cohabiting	2575	50.9%	3.58	[3.52 - 3.64]
Household composition				
Living alone	534	10.6%	2.40	[2.26 - 2.54]
Living with 1 other person	538	10.6%	2.97	[2.83 - 3.11]
Living in 3-6 person household	1549	30.6%	3.30	[3.21 - 3.38]
Living in 7+ person household	2438	48.2%	3.10	[3.03 - 3.17]
Employment status				
Employed (part or full time)	805	15.9%	3.15	[3.04 - 3.26]
Not working	3719	73.5%	2.91	[2.86 - 2.96]
Homemaker	521	10.3%	4.15	[3.99 - 4.30]
Household consumption per capita				
Quintile 1 (lowest)	989	19.5%	3.16	[3.05 - 3.27]
Quintile 2	1009	19.9%	3.15	[3.05 - 3.26]
Quintile 3	973	19.2%	3.11	[3.00 - 3.22]
Quintile 4	975	19.3%	3.10	[2.99 - 3.20]
Quintile 5 (highest)	903	17.8%	2.91	[2.80 - 3.01]
Wealth index				
Quintile 1 (lowest)	985	19.5%	2.67	[2.56 - 2.77]
Quintile 2	995	19.7%	2.98	[2.88 - 3.08]
Quintile 3	1024	20.2%	3.09	[2.99 - 3.19]
Quintile 4	1002	19.8%	3.27	[3.16 - 3.38]
Quintile 5 (highest)	1053	20.8%	3.34	[3.23 - 3.44]

Based on Kruskall-Wallis tests, differences in the mean number of respondents reported were significant at $p<0.01$ for all variables except for sex ($\chi^2=3.3$, $p=0.07$). Missing values not shown in table: education level, n=17; country of origin, n=5; household composition, n=4; employment status, n=14; household consumption, n=210.

# Supplementary Table 2: Full results of mixed effect Poisson regressions for number of alters elicited

	Model 1: Null model	Model 2: add Months		Model 3: add Villages		Model 4: add Respondent characteristics		Model 5: add Interviewer characteristics		Model 6: add Dyad characteristics		Model 7: Final model		Model 8: Random Intercepts		Model 9: Random slopes	
						13 months of interviews (n=5059)								**11 months of interviews (n=4856)**			
Months																	
November 2014		1.00		1.00		1.00		1.00		1.00		1.00					
December 2014		0.94	[0.87 - 1.02]	1.00	[0.89 - 1.13]	0.96	[0.88 - 1.04]	0.96	[0.89 - 1.04]	0.96	[0.89 - 1.04]	0.96	[0.89 - 1.04]				
January 2015		0.84	[0.78 - 0.91]	0.91	[0.80 - 1.03]	0.83	[0.76 - 0.89]	0.83	[0.76 - 0.89]	0.83	[0.76 - 0.89]	0.83	[0.77 - 0.90]				
February 2015		0.77	[0.71 - 0.83]	0.82	[0.71 - 0.94]	0.75	[0.69 - 0.81]	0.75	[0.69 - 0.81]	0.75	[0.69 - 0.81]	0.75	[0.69 - 0.81]				
March 2015		0.66	[0.61 - 0.72]	0.69	[0.61 - 0.80]	0.65	[0.60 - 0.71]	0.65	[0.60 - 0.71]	0.65	[0.60 - 0.71]	0.65	[0.60 - 0.71]				
April 2015		0.66	[0.61 - 0.71]	0.68	[0.59 - 0.78]	0.66	[0.61 - 0.71]	0.65	[0.60 - 0.71]	0.65	[0.60 - 0.71]	0.65	[0.60 - 0.71]				
May 2015		0.64	[0.60 - 0.69]	0.68	[0.59 - 0.78]	0.64	[0.59 - 0.69]	0.64	[0.59 - 0.69]	0.64	[0.59 - 0.69]	0.64	[0.59 - 0.69]				
June 2015		0.55	[0.51 - 0.59]	0.58	[0.50 - 0.66]	0.54	[0.50 - 0.58]	0.54	[0.50 - 0.58]	0.54	[0.50 - 0.58]	0.54	[0.50 - 0.58]				
July 2015		0.52	[0.48 - 0.56]	0.54	[0.48 - 0.62]	0.50	[0.45 - 0.54]	0.50	[0.45 - 0.54]	0.50	[0.45 - 0.54]	0.50	[0.45 - 0.54]				
August 2015		0.53	[0.48 - 0.58]	0.56	[0.48 - 0.65]	0.49	[0.44 - 0.54]	0.49	[0.44 - 0.54]	0.49	[0.44 - 0.54]	0.49	[0.44 - 0.54]				
September 2015		0.41	[0.34 - 0.49]	0.44	[0.36 - 0.54]	0.39	[0.32 - 0.46]	0.39	[0.32 - 0.46]	0.39	[0.32 - 0.46]	0.39	[0.32 - 0.46]				
October 2015		0.78	[0.69 - 0.89]	0.87	[0.73 - 1.03]	0.71	[0.62 - 0.81]	0.71	[0.62 - 0.80]	0.71	[0.62 - 0.81]	0.71	[0.62 - 0.81]				
November 2015		0.69	[0.59 - 0.80]	0.74	[0.62 - 0.89]	0.65	[0.55 - 0.75]	0.65	[0.55 - 0.75]	0.65	[0.55 - 0.76]	0.65	[0.55 - 0.76]				
Months, continuous														0.92	[0.91 - 0.92]	0.89	[0.86 - 0.93]
Village 1				1.00													
Village 2				0.84	[0.73 - 0.98]												
Village 3				0.86	[0.75 - 0.98]												
Village 4				0.90	[0.81 - 1.00]												
Village 5				1.21	[0.78 - 1.88]												
Village 6				0.87	[0.72 - 1.04]												
Village 7				0.91	[0.77 - 1.08]												
Village 8				0.93	[0.75 - 1.14]												
Village 9				0.82	[0.67 - 1.01]												
Village 10				0.91	[0.79 - 1.06]												
Village 11				1.00	[0.82 - 1.22]												
Village 12				0.97	[0.83 - 1.14]												
Village 13				0.83	[0.70 - 0.99]												
Village 14				0.88	[0.78 - 0.98]												
Village 15				0.90	[0.77 - 1.04]												
Village 16				0.87	[0.76 - 1.00]												
Village 17				0.87	[0.71 - 1.08]												
Village 18				0.87	[0.73 - 1.04]												
Village 19				0.91	[0.81 - 1.04]												
Village 20				1.03	[0.69 - 1.54]												
Village 21				0.89	[0.76 - 1.05]												
Village 22				0.87	[0.75 - 1.00]												
Village 23				0.88	[0.70 - 1.11]												
Village 24				0.78	[0.68 - 0.91]												
Village 25				0.88	[0.73 - 1.07]												
Village 26				0.87	[0.72 - 1.05]												
Village 27				0.94	[0.80 - 1.10]												
Respondent																	
Male 40-49						1.00		1.00		1.00		1.00		1.00		1.00	
Male 50-59						0.95	[0.88 - 1.03]	0.95	[0.88 - 1.03]	0.93	[0.85 - 1.02]	0.95	[0.89 - 1.03]	0.95	[0.88 - 1.03]	0.96	[0.89 - 1.04]
Male 60-69						0.97	[0.89 - 1.04]	0.97	[0.90 - 1.05]	0.93	[0.84 - 1.04]	0.97	[0.90 - 1.05]	0.98	[0.90 - 1.06]	0.98	[0.90 - 1.06]
Male 70-79						0.90	[0.82 - 0.98]	0.90	[0.83 - 0.98]	0.87	[0.76 - 1.01]	0.90	[0.83 - 0.98]	0.90	[0.83 - 0.98]	0.90	[0.83 - 0.98]
Male ≥ 80						0.86	[0.78 - 0.95]	0.86	[0.78 - 0.95]	0.84	[0.71 - 1.00]	0.86	[0.78 - 0.95]	0.87	[0.78 - 0.96]	0.87	[0.79 - 0.97]
Female 40-49						0.95	[0.88 - 1.03]	0.96	[0.89 - 1.03]	0.95	[0.88 - 1.03]	0.96	[0.89 - 1.03]	0.97	[0.89 - 1.04]	0.96	[0.89 - 1.04]
Female 50-59						0.98	[0.91 - 1.06]	0.99	[0.92 - 1.06]	0.96	[0.89 - 1.05]	0.99	[0.92 - 1.06]	1.00	[0.92 - 1.07]	0.99	[0.92 - 1.07]

|	Model 1: Null model	Model 2: add Months	Model 3: add Villages	13 months of interviews (n=5059) Model 4: add Respondent characteristics		Model 5: add Interviewer characteristics		Model 6: add Dyad characteristics		Model 7: Final model		11 months of interviews (n=4856) Model 8: Random Intercepts		Model 9: Random slopes	
Female 60-69				0.98	[0.90 - 1.06]	0.99	[0.91 - 1.07]	0.94	[0.84 - 1.06]	0.99	[0.91 - 1.07]	0.99	[0.91 - 1.07]	0.99	[0.91 - 1.07]
Female 70-79				0.94	[0.86 - 1.03]	0.94	[0.86 - 1.03]	0.91	[0.79 - 1.05]	0.94	[0.86 - 1.03]	0.95	[0.87 - 1.04]	0.95	[0.87 - 1.04]
Female ≥ 80				0.86	[0.78 - 0.95]	0.87	[0.78 - 0.96]	0.84	[0.71 - 1.00]	0.87	[0.78 - 0.96]	0.87	[0.79 - 0.97]	0.88	[0.79 - 0.97]
Education															
None				1.00		1.00		1.00		1.00		1.00		1.00	
Some primary				1.04	[0.99 - 1.08]	1.04	[1.00 - 1.08]	1.04	[1.00 - 1.08]	1.04	[1.00 - 1.08]	1.04	[1.00 - 1.08]	1.05	[1.01 - 1.09]
Some secondary				1.08	[1.02 - 1.15]	1.09	[1.03 - 1.15]	1.09	[1.03 - 1.16]	1.09	[1.03 - 1.16]	1.08	[1.02 - 1.15]	1.09	[1.03 - 1.16]
Secondary or more				1.07	[1.01 - 1.14]	1.08	[1.02 - 1.15]	1.09	[1.02 - 1.15]	1.08	[1.02 - 1.15]	1.08	[1.02 - 1.15]	1.08	[1.02 - 1.15]
Foreign national vs South African				1.01	[0.97 - 1.05]										
Marital status															
Never married				1.00		1.00		1.00		1.00		1.00		1.00	
Separated/divorced				1.20	[1.09 - 1.32]	1.19	[1.09 - 1.31]	1.19	[1.08 - 1.31]	1.19	[1.08 - 1.31]	1.19	[1.08 - 1.31]	1.18	[1.07 - 1.30]
Widowed				1.19	[1.08 - 1.30]	1.19	[1.09 - 1.31]	1.19	[1.09 - 1.30]	1.19	[1.09 - 1.30]	1.19	[1.09 - 1.31]	1.19	[1.09 - 1.31]
Currently married				1.61	[1.48 - 1.75]	1.63	[1.50 - 1.78]	1.63	[1.49 - 1.77]	1.63	[1.50 - 1.77]	1.63	[1.49 - 1.78]	1.61	[1.48 - 1.76]
Household size															
Living alone				1.00											
Living with one other person				1.04	[0.96 - 1.12]										
Living in 3-6 person household				1.03	[0.97 - 1.10]										
Living in 7+ person household				1.05	[0.98 - 1.12]										
Employment status															
Employed				1.00		1.00		1.00		1.00		1.00		1.00	
Not working				0.96	[0.91 - 1.00]	0.95	[0.91 - 1.00]	0.95	[0.91 - 1.00]	0.95	[0.91 - 1.00]	0.95	[0.91 - 1.01]	0.96	[0.91 - 1.01]
Homemaker				1.09	[1.02 - 1.18]	1.09	[1.02 - 1.18]	1.10	[1.02 - 1.18]	1.10	[1.02 - 1.18]	1.09	[1.01 - 1.17]	1.08	[1.00 - 1.16]
Wealth index															
Quintile 1 (lowest)				1.00											
Quintile 2				1.05	[0.99 - 1.11]										
Quintile 3				1.03	[0.97 - 1.08]										
Quintile 4				1.05	[1.00 - 1.11]										
Quintile 5 (highest)				1.05	[0.99 - 1.12]										
Interviewer															
20-29						1.00									
30-39						0.96	[0.78 - 1.19]								
40-49						0.79	[0.58 - 1.07]								
Male						1.00									
Female						1.05	[0.86 - 1.29]								
Number of interviews						1.02	[0.92 - 1.13]								
Respondent-interviewer dyad															
Same-sex interviewer								0.99	[0.96 - 1.02]						
Age difference quintile 1 (smallest)								1.00							
Age difference quintile 2								1.03	[0.96 - 1.10]						
Age difference quintile 3								1.04	[0.96 - 1.14]						
Age difference quintile 4								1.06	[0.94 - 1.18]						
Age difference quintile 5 (largest)								1.03	[0.89 - 1.20]						
Akaike Information Criterion	18,346.5	17,805.4	17,830.3	17,191.8		17,197.1		17,200.2		17,192.1		16,582.8		16,495.0	
Interviewer variance (intercept)	0.12 [0.05 - 0.18]	0.06 [0.03 - 0.10]	0.06 [0.03 - 0.10]	0.05 [0.02 - 0.08]		0.05 [0.02 - 0.08]		0.05 [0.02 - 0.08]		0.05 [0.02 - 0.09]		0.05 [0.02 - 0.08]		0.05 [0.02 - 0.08]	
Interviewer variance (per month)														0.01 [0.00 - 0.02]	

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Regressions 1-7 are two-level hierarchical Poisson models, containing random intercepts at the interviewer level (n=27); model 9 additionally contains random slopes for interviewers.

Supplementary Figure 1: Mean number of alters reported in each month by HAALSI respondents
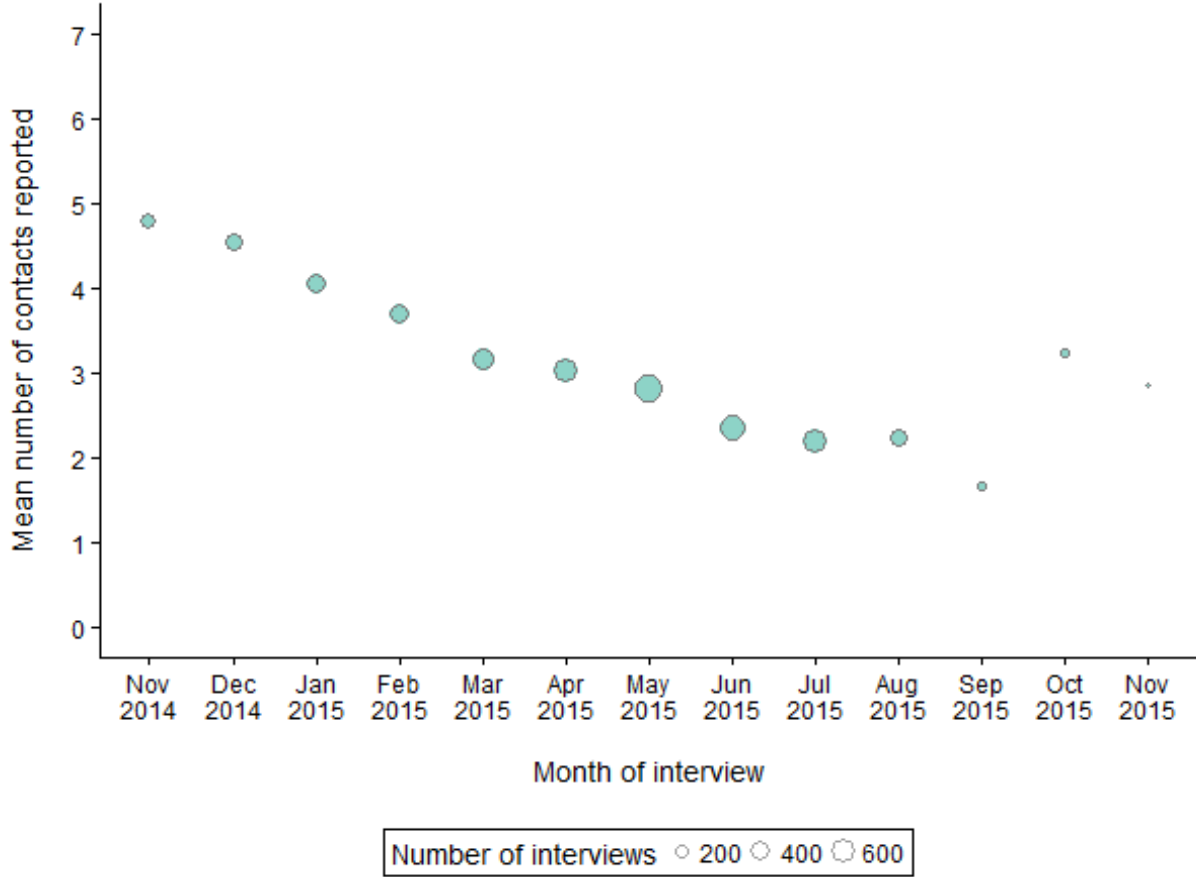

Each circle represents the number of interviews conducted by all interviewers in one month; the volume of each circle is proportional to the number of interviews conducted.

Supplementary Figure 2: Location and relationship-type of alters reported in each month by HAALSI respondents
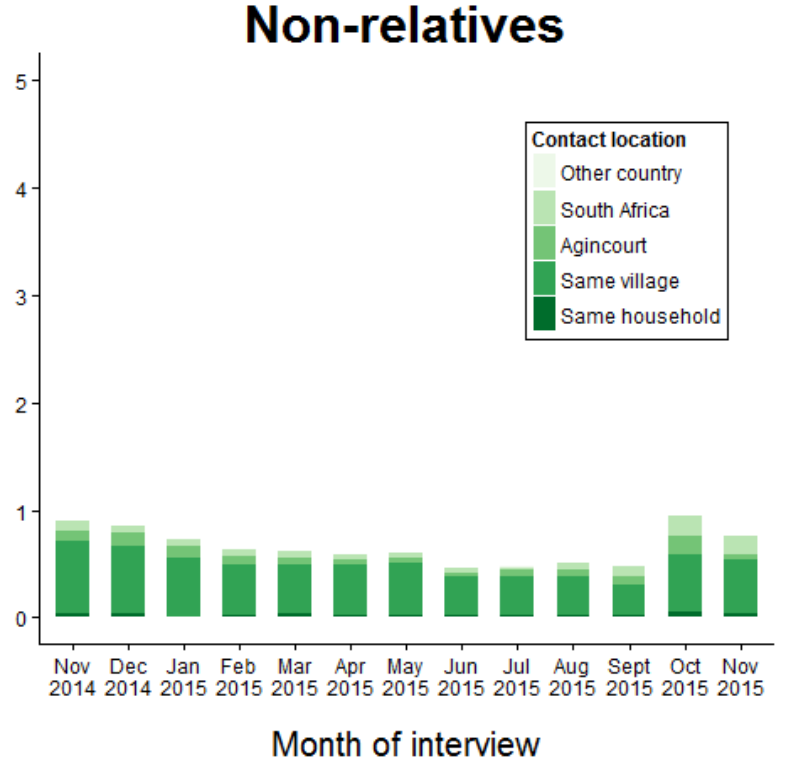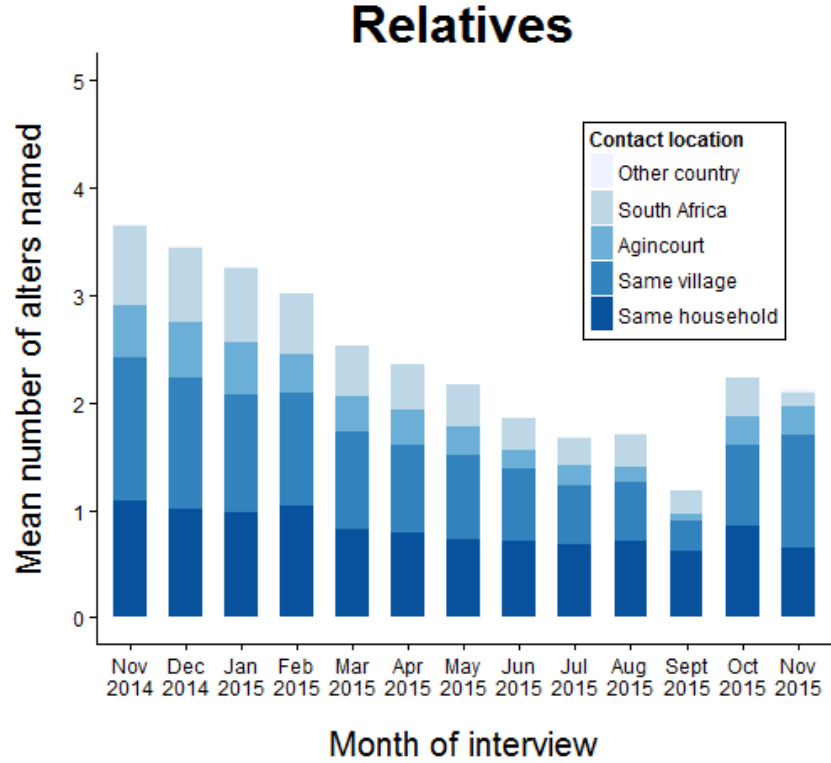
Supplementary Figure 3: Slope coefficients and intercepts for mean number of alters elicited over time by HAALSI interviewers between November 2014 and September 2015
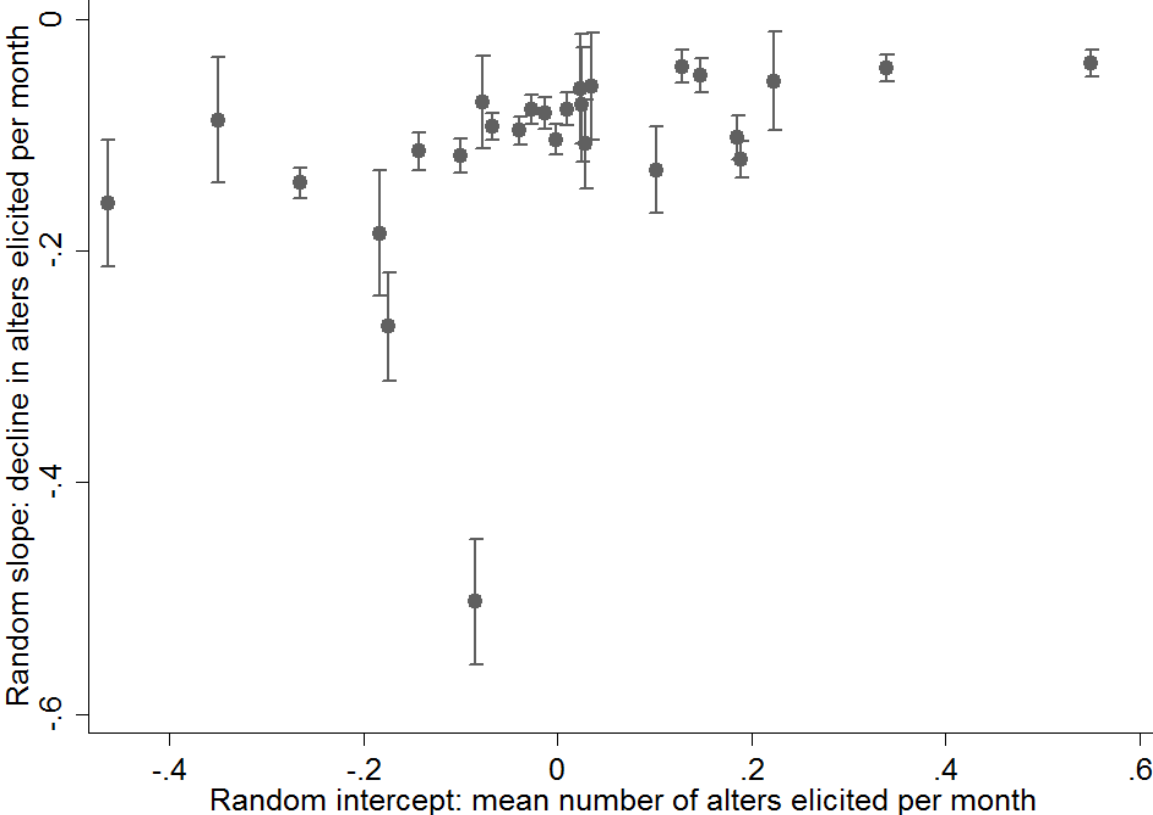

Coefficients taken from Model 9 in Table 2/Supplementary Table 2.

Supplementary Figure 4: Fitted incidence rate ratios for number of alters reported by HAALSI respondents in each survey month
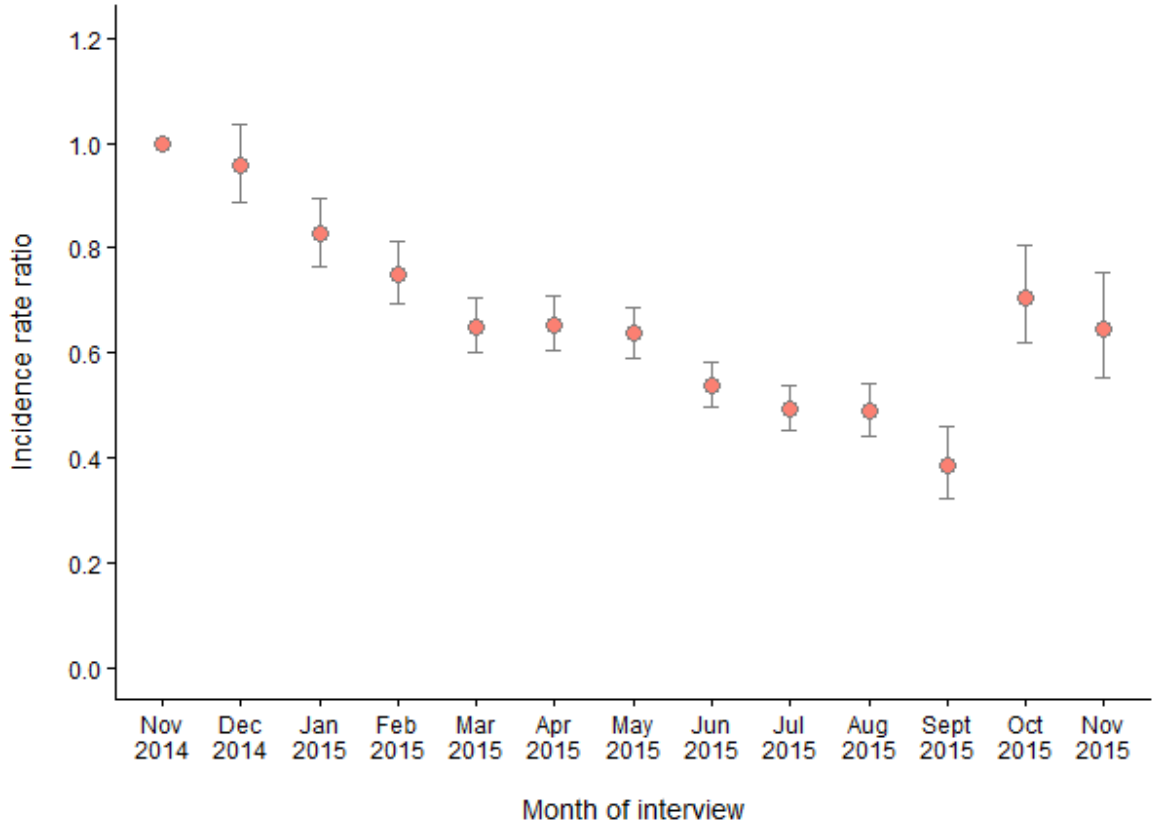
Coefficients (and 95% confidence intervals) are predicted values based on the Poisson two-level hierarchical Model 9 in Table 2 which includes all 13 months of data. All values are ratios relative to the number of alters reported in interviews in November 2014.

Supplementary Figure 5: Communication frequency of alters reported in each month by HAALSI respondents
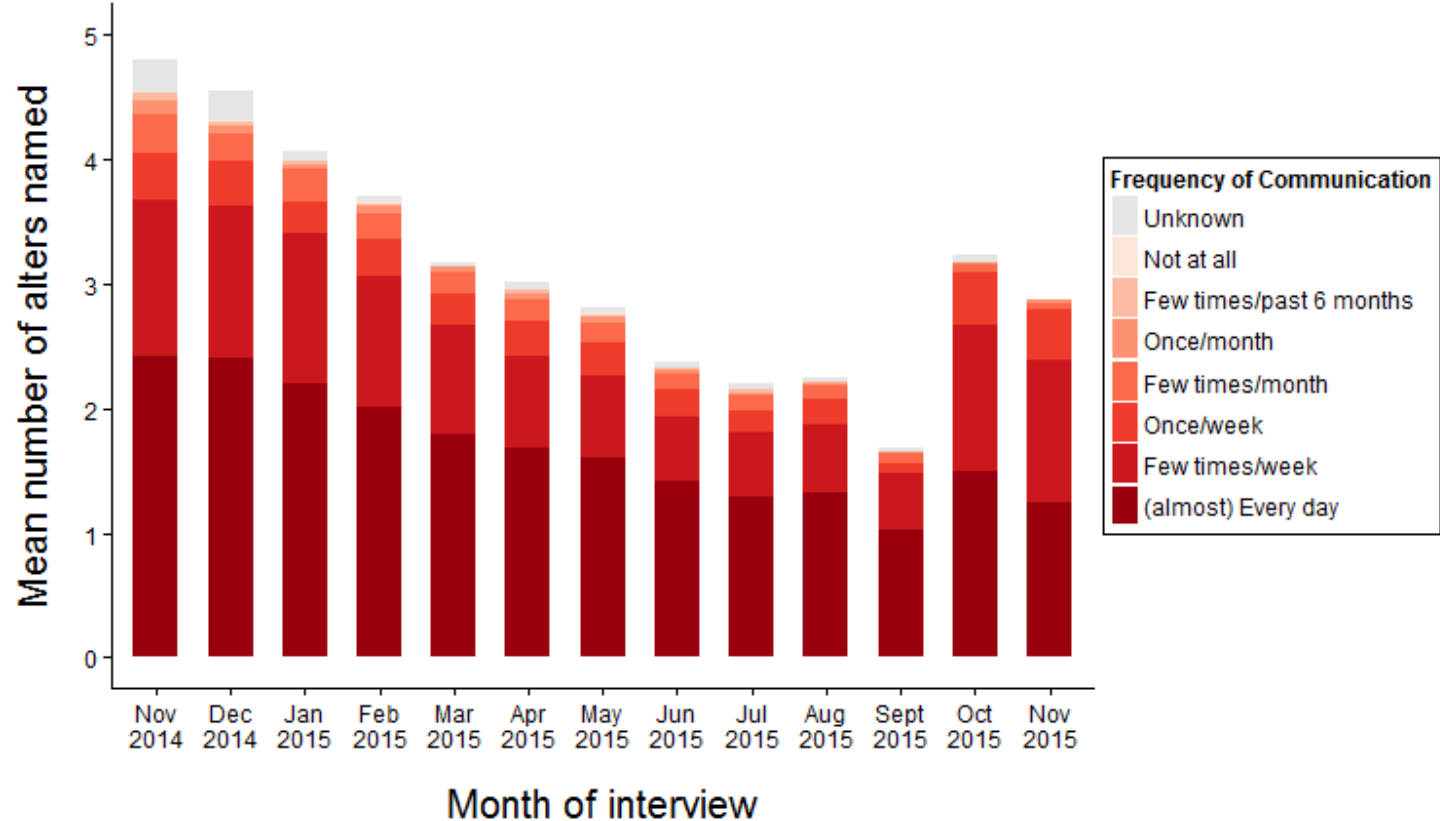
Values based on the more-frequent of in-person and telephone/electronic communication modes for each relationship