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Data Description

Describing the Dutch Social Networks and Fertility Study and how to process it

Gert Stulp

Contents

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Gert Stulp[1]

Abstract

BACKGROUND
The social networks of people play a prominent role in theories on fertility. Investigating how networks shape behaviour is hard, because of the difficulty in measuring (large) networks among representative samples. Therefore, comprehensive studies of the variation in the structure and composition of networks and their impact on fertility outcomes are lacking.

OBJECTIVE
I aim to, first, describe the Dutch Social Networks and Fertility Study, and, second, describe the R-package FertNet that processes data from this study and transforms it into an easy-to-use format for researchers.

METHODS
The data used are from the Longitudinal Internet Social Survey (LISS) panel, a representative panel of Dutch households. The focus is on the Social Networks and Fertility Study that includes a subsample of women between the ages of 18–40. Specific survey software was designed to capture each respondent's personal network comprising 25 individuals with whom they had a relationship. In total, 758 women reported on over 18,750 relationships. For each person with whom the respondent had a relationship, several questions were asked about fertility-related topics. Uniquely, the connections between these people were also assessed. The R-package FertNet corrects data issues and transforms unstructured network data into alter-attribute and alter-tie datasets that can be handled by a diversity of network analytical approaches.

CONTRIBUTION
The Social Networks and Fertility Study is a unique resource that allows for a comprehensive investigation of how networks shape fertility behaviour. It provides better estimates of network characteristics than earlier literature based on smaller networks. The R-package FertNet assists researchers in their analyses.

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1. Introduction

The social environment of people plays a prominent role in theories of fertility (Bernardi and Klaerner 2014; Bongaarts and Watkins 1996; Montgomery and Casterline 1996), with the idea that people's reproductive decision-making is affected by the opinions and behaviours of others. Substantial evidence exists that people's kin (Balbo and Mills 2011), friends (Balbo and Barban 2014), and colleagues (Pink, Leopold, and Engelhardt 2014) influence fertility outcomes. Measuring people's relationship networks can tap into different social mechanisms, such as social pressure, social support, and social learning (Bernardi and Klaerner 2014). For example, an individual's network can be mobilised to support raising children, but it can also exert normative pressures on ideal family size, or provide learning opportunities regarding the best time to have children. Thus, in addition to the importance of micro-level (e.g., education, income, partnership status) and macro-level (e.g., economic trends, welfare policies) determinants of fertility, the social relationships and networks that make up the meso-level are also important (Balbo, Billari, and Mills 2013).

Although there is an impressive body of research that investigates how fertility behaviour is affected by social influences, comprehensively investigating social processes in contemporary populations is not straightforward. Due to the difficulty of getting information on people's social networks, most evidence comes from studies that focus on small convenience samples (Bernardi 2003; Bidart and Lavenu 2005; Keim, Klarner, and Bernardi 2009), that only focus on a specific subset of the network (e.g., high-school class mates (Balbo and Barban 2014), colleagues (Pink, Leopold, and Engelhardt 2014), or kin (Balbo and Mills 2011)), or that only measure (relatively) small networks (Colleran 2020; Dykstra et al. 2016; Malter and Börsch-Supan 2013). This hinders generalisability. Moreover, although studies of small networks generate insights into possible social processes, estimates of the composition and structure of the network (e.g., proportion of kin, density) are probably biased. Studies examining the accuracy of estimating network characteristics show that estimates become unreliable when the network consists of fewer than 15–25 individuals (McCarty, Killworth, and Rennell 2007; Stadel and Stulp 2022).

The first aim of this paper is to describe the Social Networks and Fertility Study that addresses these limitations. This study contains data on large personal networks (of 25 individuals) for a representative sample of Dutch women. The large size of the network was chosen to: (1) capture many of the people in the network that are important (e.g., close) to the respondent, (2) capture network members who can be important in influencing fertility outcomes beyond the small, core network, and (3) get reliable estimates of the composition and structure of the network. A tool to collect personal networks online was used and further developed to reduce respondent burden (Stark and

Krosnick 2017; Stulp 2021). The second aim of this paper is to describe the R-package FertNet (Stulp 2023a). The sole purpose of this package is to process the data from the Social Networks and Fertility Study. The processing includes correcting errors in the data and transforming the unstructured network data into formats required for network analyses and visualisation. A short walkthrough is presented.

The Social Networks and Fertility Study can address several research questions on social influences on fertility behaviour. First, it can examine how the strength of relationships has an impact on behaviour. For example, closer relationships are more likely to provide support, resources, and pressure (Keim, Klarner, and Bernardi 2009), while weaker ties are more likely to be sources of novel information and ideas (Granovetter 1973), such as contraceptive uptake (Liu and Duff 1972). Second, this study can shed light on the importance of network composition for fertility outcomes. For example, a low number of kin in networks is considered to be an important reason for low fertility (Kavas and de Jong 2020; Newson et al. 2005; Stulp and Barrett 2021). Third, because this study assesses alter–alter ties, the importance of structural network characteristics can be assessed, which are considered key to understanding how information flows through networks (e.g., Watts and Strogatz 1998). The connectedness of the network, for instance, determines the opportunity for normative pressure. Only a few studies in fertility research consider ties between members of the network (for notable exceptions, see Kohler, Behrman, and Watkins (2001), Bernardi, Keim, and von der Lippe (2007), and Colleran (2020), albeit all focussing on small networks).

2. Methods

2.1 The Social Networks and Fertility Study

The Social Networks and Fertility Study was administered through the LISS (Longitudinal Internet Studies for the Social sciences) panel, organised by CentERdata (Tilburg University, The Netherlands). The LISS panel is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register by Statistics Netherlands (CBS). Every year the panel is asked to complete a longitudinal study consisting of ten core surveys covering a large variety of domains, including work, education, income, housing, time use, political views, values, and personality. Substantial effort went into obtaining high response rates and a representative sample, with the representativeness of the LISS panel similar to that of traditional surveys based on probability sampling (Knoef and de Vos 2009; Scherpenzeel and Bethlehem 2011). Initial

selection biases were substantially corrected by refreshment samples, and further refreshment samples were planned for attrition biases (Scherpenzeel 2009).

The LISS panel allows researchers to do their own survey within the panel. A study was added named the Social Networks and Fertility Study (*Sociale relaties en kinderkeuzes*). The aim of this study was to get information on the respondents' fertility outcomes and personal networks. All women in the LISS panel between the ages of 18 and 40 were invited to participate (N = 1,332) in February/March 2018. The average age of the 758 women that completed the survey was 29 years (SD = 6.5). The women who participated in the study were similar to the women that did not on various background variables, including birth year, position in household, number of children, marital status, region of living, income, educational level, and (migration) background (Stulp 2020).

Respondents received €12.50 for completing the survey, which on average took 22 minutes (Stulp 2021). Due to budget constraints and concerns about statistical power, we asked only women to participate rather than collecting data on smaller samples for both women and men. Ethical approval for this particular study was obtained through the ethical committee of sociology at the University of Groningen (ECS-170920).

Data from the Social Networks and Fertility Study became available on 1 March 2023, and can be accessed at https://www.dataarchive.lissdata.nl/study_units/view/1377. The data are freely available but registration is required. Data can be downloaded in both SPSS and STATA format. For a complete description of the questionnaire with the original Dutch questions and their translations, see Stulp (2020, 2021). For the codebook of the dataset resulting from the FertNet package, and the code to produce the descriptive statistics and figures in this manuscript, see Stulp (2023b).

2.2 Collecting personal network data via GENSI

Asking about people's relationships is burdensome. Respondents have to list people's names, answer several questions about them, and (sometimes) answer questions on the relationships between them. In this study each respondent was asked to list 25 names (or 'alters'), and then 16 characteristics of these alters were assessed (see Table 1). Respondents also had to evaluate the relationships between these 25 alters (evaluating 300 possible relationships).

A newly developed tool, GENSI [Graphical Ego-centered Network Survey Interface], was used to collect personal network data (Stark and Krosnick 2017; Stulp 2021). GENSI provides a specific visual survey interface that has been developed to reduce respondent burden when collecting data on respondents' social relations (see Figure 1 for an illustration). To get the names of people with whom the respondents had a relationship they were asked "*Please list 25 names of individuals 18 years or older with*

whom you have had contact in the last year. This can be face-to-face contact, but also contact via phone, internet, or email. You know these people and these people also know you by your name or face (think of friends, family, acquaintances, etc.). You could reach out to these people if you had to. Please name your partner if you have one. The names do not have to match perfectly; you can also use nicknames. It is important that you recognise these names in a future survey. For this research it is important that you actually name 25 individuals!"

This particular phrasing – a free list name generator (McCarty et al. 2019) – was based on earlier personal network studies (McCarty 2002; McCarty et al. 2007; McCarty, Killworth, and Rennell 2007). In contrast to name-generators that focus on specific affective (e.g., close) relationships, on specific roles (e.g., family members), on exchange relationships (e.g., who will lend you money?), or on interaction-based relationships (e.g., who did you see today?), this method aims to capture the broader, active network of the respondent (McCarty et al. 2019) but avoids the inclusion of people who are unlikely to have much influence (e.g., a cashier at a supermarket). The choice to ask for exactly 25 alters was deliberate. First, 25 is large enough to include weak(er) ties that are considered important social influences on fertility (e.g., colleagues (Buyukkececi et al. 2020), neighbours (Liu and Duff 1972)), but small enough for respondents to report on the network easily (McCarty 2002; McCarty and Govindaramanujam 2005). Second, leaving the respondent to choose the number of alters to report on may lead to differences in terms of motivation or how questions are interpreted. Some respondents will find listing 25 alters easy while other will find it harder, and this variation will be reflected in the characteristics of the alters (e.g., how close they are to the respondent, frequency of contact). This is exactly the kind of variation that network researchers try to tap into (McCarty et al. 2019). Third, smaller personal networks may provide unreliable estimates of the composition and structure of the network (McCarty, Killworth, and Rennell 2007; Stadel and Stulp 2022). Measures of the composition of a network summarise alter characteristics (e.g., the proportions of kin in the network, people with children, people who are close). Rather uniquely, information is also available on the ties between people in the networks, which can be used to measure the network structure (e.g., density, number of components). In total, 97% of respondents listed exactly 25 alters (738 out of 758).

The relationships between alters were assessed in the following way: "*With whom does the alter have contact? By contact we mean all forms of contact, including face-to-face contact, contact via (mobile) phone, letters, emails, texts, and other forms of online and offline communication.*" Respondents could select whether each alter had contact with all the other alters (see Figure 1c).

Figure 1: An illustration of the GENSI tool used to acquire the network data

Note: In an earlier question in the survey, respondents had to list 25 names that appeared as circles on the screen. Panel a is an example of a question where respondents had to select alters with a particular trait. For example, "Which of these alters have children?" Panel b is an example of a question with multiple answer options. Here, respondents are asked about the closeness to each alter. Panel c shows how relationships between alters are assessed. Respondents are asked to select who the person in the middle has contact with. For further information and code to produce the survey, see Stulp (2020, 2021).

2.3 Variables collected

Table 1 describes the variables collected, which are separated into variables about the respondent and variables about the people in the network (the alters). Variables collected about the respondent were motivated by research on important determinants of fertility and the measurement of fertility (Bhrolcháin and Beaujouan 2019; Hin et al. 2011). Given the central interest in fertility outcomes, several measures were included to measure the respondents' fertility behaviour and preferences. The most important person for fertility outcomes is a partner, which is why variables on the partner were assessed, including measurements of agreement on fertility preferences (Duvander et al. 2020; Testa 2012). Measurements were chosen to investigate four mechanisms of social influence (Bernardi and Klaerner 2014): social pressure, social support, social contagion, and social learning. Two questions about the perceived pressure to have children were used to assess the mechanism of social pressure. Social support was captured by asking about instrumental and psychological support from alters in relation to having children. The fertility outcomes of alters (number of children and age of youngest child) are important in investigating influence effects, and in combination with the closeness and frequency of contact with these alters, social contagion may be distinguished from social learning. The (perceived) fertility preferences of alters are key in investigating whether values spread in a network. Basic demographic characteristics are assessed for all alters (sex, age,

education), as influence processes may depend on these characteristics (e.g., alters similar to ego may have more influence).

An advantage of the LISS panel is that information on a suite of topics is available for the respondents (e.g., health, political views, wealth), which can be separately downloaded. Particularly worthwhile are the so-called background variables that are collected/updated monthly, and concern basic demographic variables (e.g., age, sex, marital status, education, income). Here we describe only the variables collected in the Social Networks and Fertility Study.

Table 1: All variables in the Social Networks and Fertility Study, separated into variables about the respondent and variables about the 25 people in the network of the respondent

Data on respondent	Data on individuals in respondent's network
Has partner?	Sex
Sex of partner	Age
Birth year of partner	Relationship to alter [e.g., sibling, colleague]
Duration of relationship	Closeness to alter
Living together?	Education of alter
Civil status [e.g., marriage, none]	Frequency of face-to-face contact with alter
Has children?	Frequency of other forms of contact with alter
How many children?	Is alter a friend?
How many biological children?	Does alter have children?
Has partner other children?	Number of children of alter
Do you think you will have (more) children?	Age of youngest child of alter
Desired number of children?	Happiness of alter after birth of last child
Strength of fertility desire	Does alter want children?
When would you prefer to have (next) child?	Does alter want to be childfree?
Discussed fertility desire with partner?	Can alter help with childcare?
Agreement on fertility desires with partner?	Can you talk to alter about having children?
Ideal family size for typical Dutch family	Does alter X know alter Y?
How do children impact happiness?	
Pressure from friends to have children?	
Pressure from parents/caretakers to have children?	
People in network with children happier?	
How did you list the people in your network? [e.g., from memory, using Facebook]	

Note: For the full codebook, please see Stulp (2023b).

2.4 Limitations of the data

A clear limitation of this study for understanding reproductive decision-making is that it only includes women. A focus on only women is, unfortunately, not uncommon in demography (e.g., Schoumaker 2019), and limits the kinds of research questions that can be asked. For example, this study cannot be used to corroborate the finding that social processes affect fertility outcomes differently for men and women (Buyukkececi et al. 2020).

A potential issue concerning the quality of the data is that respondents who have substantial experience in filling out surveys (as do some of the respondents in the LISS panel) and fresh respondents may give different answers to survey questions (Toepoel, Das, and Van Soest 2009). There is some evidence that this also holds for the LISS panel (Toepoel, Das, and Van Soest 2008), although differences between experienced and fresh respondents are small. The survey experience of respondents seems to impact answers to knowledge questions ("Do you know what X is?") and not answers related to questions on attitudes, actual behaviour, or facts (Toepoel, Das, and Van Soest 2009). Procedures are in place within the LISS panel to detect potential problematic survey behaviour, and respondents are approached when suspicions arise. Survey experience is unlikely to play a role in this particular study because both the content and the visual design (see Figure 1) were very different from traditional LISS surveys, and even experienced respondents would not have had experience with this type of survey.

In a previous study (Stulp 2021) the quality of the data was assessed by examining patterns of non-response, answers to open questions, and by verifying the consistency of answers across different questions. This gave little reason for concern, as did the finding that most respondents indicated enjoying completing the survey. Possible data issues that were uncovered are flagged in the variable "notes".

2.5 The R-package FertNet

The R-package (R Core Team 2018) FertNet (Stulp 2023a) was created to process the data from the Social Networks and Fertility Study. While this package is not needed to work with the data, it is recommended for the following reasons. First, it fixes data entry errors or errors that respondents themselves mentioned in the comments. Second, it categorises the outcomes on the 25 variables that describe the respondent's relation to the different alters (e.g., partner, parent, sibling, known from high school), including processing the 'qualitative' data that could be recorded via open text boxes (which occurred 1,159 times; see also Buijs and Stulp (2022)). Third, it translates LISS standardised variable names into interpretable, English variable names. Fourth, FertNet

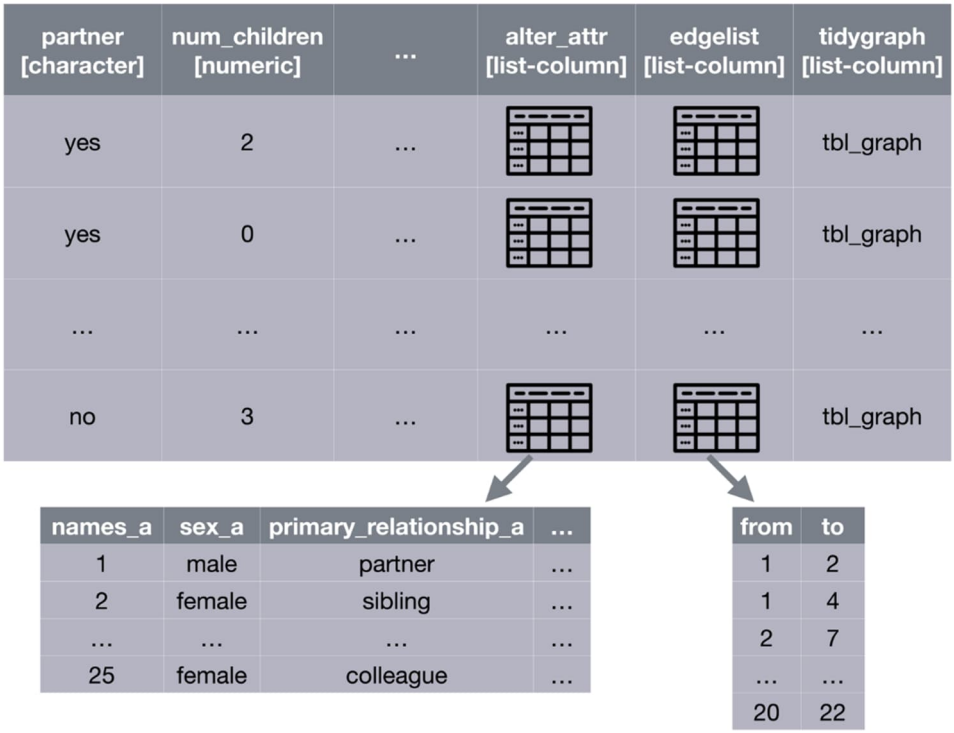
provides an easy interface for adding LISS background variables (which need to be downloaded separately). Fifth, and most important, it transforms the unstructured network data into formats that are easy to use and are required for many network analysis packages and programs. More specifically, it transforms the 400 variables on alter characteristics into a dataset of alter attributes (sometimes called node characteristics) for each respondent. These datasets are stored as a variable (a list-column) named 'alter_attr'. Additionally, it transforms the 25 variables on alter–alter ties into a dataset containing an edgelist. This is a specific type of dataset with only 'from' and 'to' columns, and alter identifiers as data. For example, a value of 5 in 'from' and of 19 in 'to' means that alters 5 and 19 know each other. These edgelists are also stored as a variable (a list-column) named 'edgelist'. This results in one dataset with a clear division between respondent variables, variables on alter characteristics, and variables describing the relationship between alters. The information captured in the variables 'alter_attr' and 'edgelist' are required for many network analysis and visualisation packages (e.g., Csardi and Nepusz 2006; Pedersen 2021, 2022). Transforming the data in this way facilitates analyses of both compositional effects (based on alter attributes) and structural effects (based on alter–alter ties). Figure 2 shows an overview of the structure of the data. For the full codebook of the dataset resulting from FertNet, see Stulp (2023b).

The ease of use of the package is now illustrated. Users of the package would, after installation, only need one function *FertNet::produce_data()*, and to have the original data downloaded (named "wj18a_EN_1.0p.sav") into their working directory.

The code below loads in and processes the data. Two examples are given for the creation of new variables: 'num_women' is a composition measure describing the number of women in the network and 'density' is a structural measure of the network describing the proportion of ties that exist out of all possible 300 (see Figure 3). The 'lapply' function applies a function to each element in the list (and each element in the variables 'alter_attr' and 'edgelist' is a dataset) and returns the outcomes of that function in a list. The 'as.integer' and 'as.numeric' transform the list of values into integer and double variables respectively.

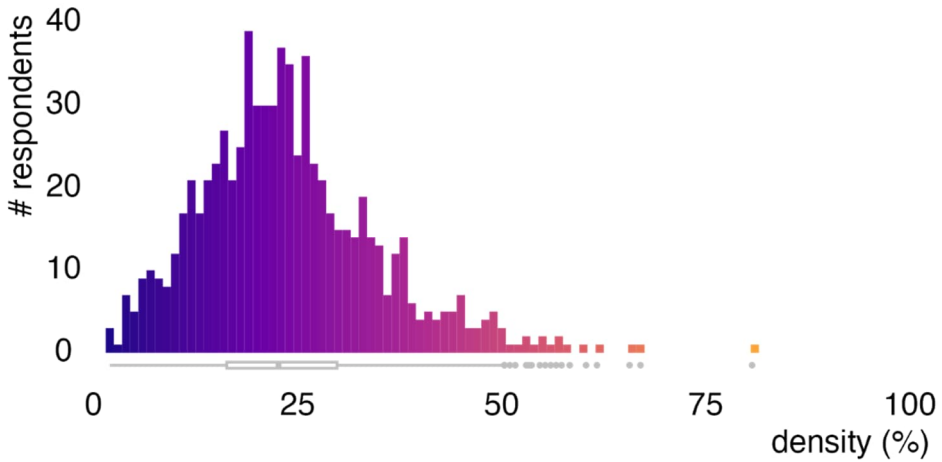
```
library(FertNet) # requires installation first: install.packages("FertNet")
data <- produce_data()
data$num_women <- lapply(data$alter_attr, function(x) sum(x$sex_a=="Female", na.rm = TRUE)) |>
as.integer()
data$density <- lapply(data$edgelist, function(x) nrow(x)/300) |> as.numeric()
```

Figure 2: Schematic overview of the dataset that is the result of the FertNet-package



Note: Within one dataset, there is a clear separation between respondent variables (e.g., partner, num_children), variables describing characteristics of alters (alter_attr), and relationships between alters (edgelist). Each cell within the alter_attr and edgelist column contains a dataset. The tidygraph column combines the information from alter_attr and edgelist into a tbl_graph object that facilitates analyses and visualisation. Table 1 shows all variables that are assessed about the respondent and the people in the network. For the full codebook of this dataset, please see Stulp (2023b).

Figure 3: Variation in density across all networks



Note: Histogram of density (% existing ties between alters relative to total possible number of ties [300]) across respondents. Box-and-whisker plot in grey.

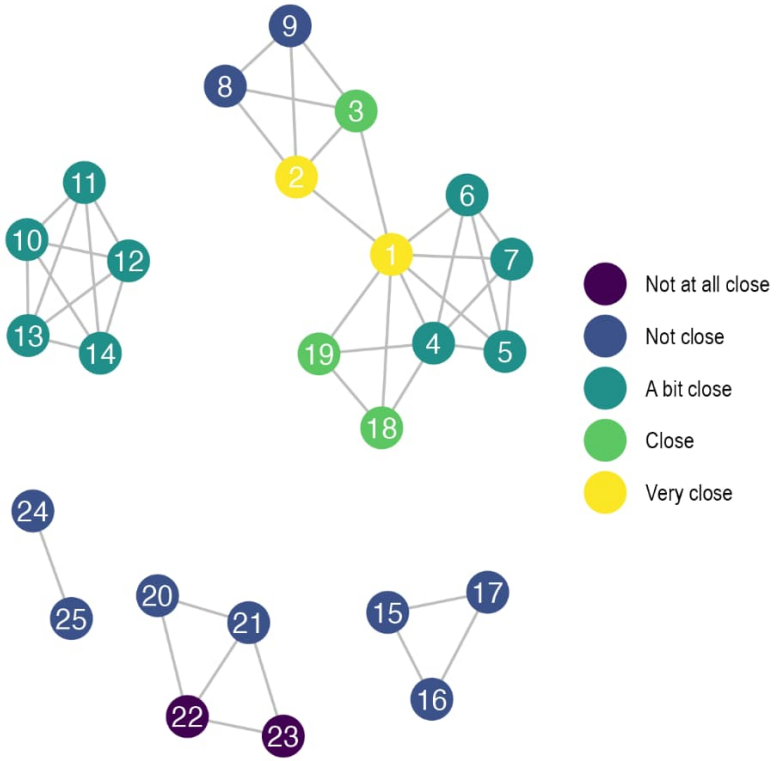
To take full advantage of the network analyses and visualisation capabilities in R, it is recommended to run:

```
data <- produce_data(tidygraph_col = TRUE)
```

The above function call also creates a new column, 'tidygraph', a list-column that includes a tbl_graph object for each respondent (Figure 2). This requires the installation of the 'tidygraph' package (Pedersen 2022). This tidygraph column facilitates analyses and visualisation. For example, the code below visualises the network of the respondent in row 13 of the data (Figure 4), with the closeness of the respondent to the different alters (1 to 25) coloured, and the ties between alters visualised with grey lines:

```
library(ggraph) # requires installation first: install.packages("ggraph")
ggraph(data$tidygraph[[13]], layout = "kk") +
 geom_edge_link(colour = "grey") +
 geom_node_point(aes(colour = closeness_a), size = 7) +
 geom_node_text(aes(label = names_a), colour = "white") +
 labs(colour = NULL) +
 theme_graph()
```

Figure 4: Visualisation of a personal network

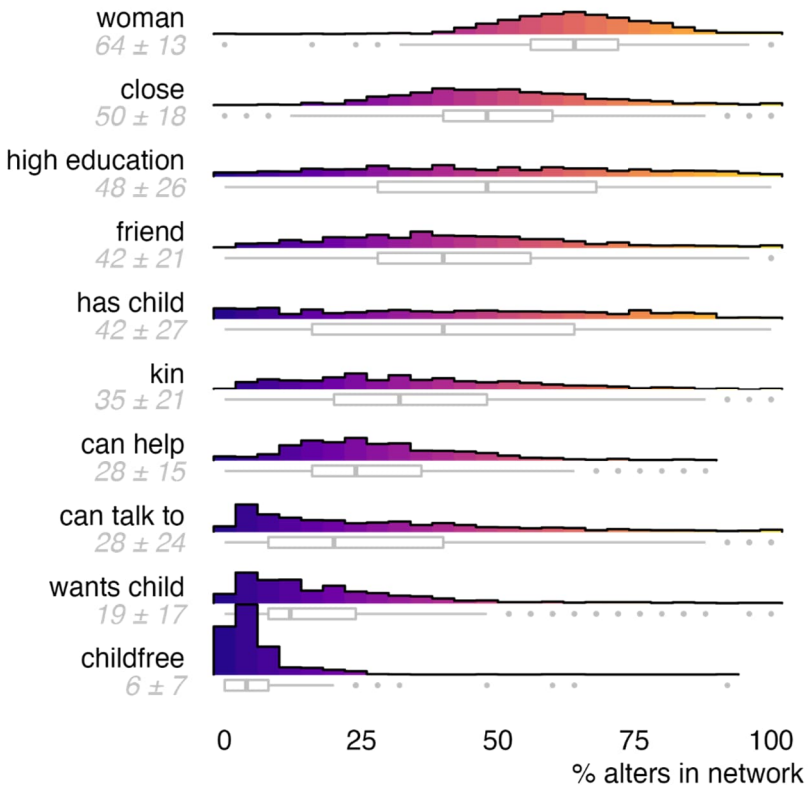


Note: Closeness refers to the respondent's perceived closeness to the alters. A grey line indicates that these alters know one another. The respondent herself is not included in the visualisation.

2.6 Variation across networks

To get a sense of the variation in the networks of these women, Figure 5 presents several compositional variables. For consistency in describing the networks, the focus is on a subsample of 706 women. Fifty-two respondents were excluded because they either reported on fewer than 25 alters or made errors in listing these names, took the survey on a handheld device rather than computer (against instruction), had more than 10 missing values on alter attribute questions, gave problematic responses to alter relationship questions, or reported no alter–alter ties.

Figure 5: Variation in several network composition measures



Note: The x-axis shows the percentage of alters (out of 25) in the network with particular characteristics. Boxplots in grey; mean ± standard deviation in grey text. 'Close' was defined as an alter being close or very close; 'high education' was defined as an alter having a degree in higher vocational training or higher.

3. Discussion

The social networks of people play a prominent role in theories on fertility. Investigating how networks shape behaviour is problematic due to the difficulty of measuring (large) networks among representative samples. Therefore, comprehensive studies of the variation in the structure and composition of networks and their impact on fertility outcomes are lacking. The Social Networks and Fertility Study is designed to address this gap.

The R-package FertNet helps researchers to process these data in a reproducible manner, reducing the data processing costs substantially and giving researchers more time to address scientific questions.

4. Acknowledgements

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