Estimating fertility indicators in low- and middle-income countries: Evidence from a network reporting online survey in Senegal

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Abstract

The availability of timely administrative or survey data to assess population development varies globally, with a lack of data in low- and middle-income countries. In this study, we conduct a survey data collection via social media to estimate fertility indicators in Senegal by employing a network reporting approach. The goal is to investigate the potential benefits of using this methodology to estimate fertility indicators in Africa. This approach will additionally expand the so far limited knowledge about the reliability of data collection via social media surveys in low- and middle-income countries and the applicability of the network reporting approach to gain insights into demographic outcomes from an offline population.

1 Introduction

Over the course of this century, significant population growth is expected to take place in sub-Saharan Africa (Gu et al. 2021). However, there are several sources of uncertainty around population estimations in this region. Firstly, estimating demographic indicators can be difficult due to a lack of data and varying levels of data quality (Alkema et al. 2012). Secondly, many assumptions about the fertility transition observed in other parts of the world, such as Asia or Latin America, do not translate directly to the development in Africa (Bongaarts and Casterline 2013).

To address this lack of data and uncertainty we propose a novel survey recruitment and estimation approach. In the first step this involves recruiting survey participants through social media, via targeted advertising campaigns. To recruitment survey participants through social media the plattform Facebook is currently

a useful tool, due to its cost-effectiveness, speed of implementation, and broad reach (Pham, Rampazzo, and Leah R. Rosenzweig 2019). Facebook advertising, originally designed for business purposes, has been repurposed for survey recruitment in various studies (Iannelli et al. 2020, Grow et al. 2020, Pötzschke and Braun 2017).

While extensively used in high-income countries, the utilization of social media surveys in low and middle-income countries, especially in Sub-Saharan Africa, has been relatively scarce (Olamijuwon 2021,Pham, Rampazzo, and Leah R. Rosenzweig 2019, Leah R Rosenzweig et al. 2020, Leah R. Rosenzweig, Bago, et al. 2021 and Leah R. Rosenzweig and Zhou 2021). We aim to bridge this research gap by introducing the "Senegal Demographic Survey" (SDS), a cross-sectional online survey conducted via Facebook in Senegal. This study represents a collaboration with researchers from the Regional Consortium for Generational Economics Research (CREG) in Thiès, Senegal, who bring invaluable local insights and cultural understanding to our research.

Secondly, we explore the feasibility of a network reporting approach to estimate fertility indicators, such as the mean number of children (Feehan and Cobb 2019). In this approach, survey respondents report about themselves and three individuals from their regular social network, providing unique insights not accessible through a conventional Facebook survey.

Our study not only seeks to address the lack of data and accuracy in fertility estimations in African countries but also sets a precedent for new data collection methods using social media. By comparing our findings with existing Demographic Health Survey data (Demographic and Health Survey 2022), we aim to evaluate the potential of this approach to provide timely fertility estimates in the African context, ultimately contributing to a better understanding of population trends in the region.

2 Study design: Senegal Demographic Survey

We leverage Facebook advertising to recruit survey participants, using targeted ads that appear in users' Facebook feeds. Facebook's targeting options allow us to focus on specific user characteristics such as age, gender and interests (Kühne and Zindel 2020). For our study, we are targeting Facebook users in Senegal who are 18 years or older. Each ad consists of a short caption, an image and a link to our survey. When users click on the ad, they are taken to an external website that contains our questionnaire implemented in LimeSurvey.

In the first part of our questionnaire, participants are asked about their socio-demographic characteristics, including age, gender, education level, employment status, region of residence, marital status, household size, number of children, and age. In the second part of our questionnaire, participants are randomly assigned

to one of the two network definitions, i.e. people who have either eaten together or spoken to each other the day before the survey. These definitions have been established in previous research, which has shown that the conversation definition is expected to be larger, while the meal definition tends to result in more accurate reporting (Feehan and Salganik 2016, Feehan and Cobb 2019). Once participants have entered the number of network contacts, they are asked to report some further details for up to three of them (or fewer if they reported fewer than three contacts). This includes most of the socio-demographic questions initially asked of the participants themselves, such as age, sex, education level, number and age of children. Participants who instead report zero contacts on the previous day are asked how they spent the day (e.g. traveling, housework, sick leave).

Our project largely builds on a previous study by Feehan and Cobb 2019, where they developed a network reporting method to estimate internet penetration in the US, UK, Indonesia, Colombia and Brazil, and compared their estimates with ground truth data from the World Bank. This methodology provides indirect information about the population that cannot be reached directly through Facebook (Feehan and Cobb 2019). The estimator uses the number of connections from Facebook users to internet users, divided by the number of times each internet user is reported, to finally infer the total number of internet users. In our study, we use this network reporting approach to estimate demographic outcomes related to the average number of children in Senegal.

Specifically, for our estimation, the numerator quantifies the number of respondents with a given number of children, and the denominator quantifies the visibility of these categories within the online sample. Visibility describes how often a respondent with a given number of children would be reported in a census of the Facebook population. That means, it is a measure that takes into account how often respondents with a given number of children interact on Facebook. This concept requires us to assume that respondents with a certain number of children on Facebook do not selectively interact with other parents on Facebook.

If we apply this network estimator created by Feehan and Cobb 2019 to estimate the mean number of children, we get the following:

$$\hat{N}_H = \frac{\hat{y}_{FH}}{\hat{\bar{d}}_{FF}} = \frac{\sum w_i \frac{d_i}{r_i} o_i}{\sum w_i \frac{d_i}{r_i} f_i} \sum w_i$$

- $\hat{N}_H$: Estimated number of respondents in the broader population with a specific number of children.

- w_i: Expansion weight for respondent 'i.' It accounts for the survey's design and is used to extrapolate the findings from the online sample to the larger population.

- d_i: Network size (degree) of respondent 'i'.
- r_i: The number of detailed alters from respondent 'i.' Detailed alters are individuals with whom the respondent interacts and can range from 1 to 3.
- o_i: The number of detailed alters reported by respondent 'i' who have a specific number of children.
- f_i: The number of Facebook users that respondent 'i' reports among her detailed alters.

Respondents' network size (d_i) is captured in the survey by the question: "How many people did you eat/talk to yesterday? We derive o_i from the survey question: "How many children does this person have?", which is asked for each network contact as part of the network reporting. Finally, the quantity f_i is measured by asking whether the respective contact uses Facebook (corresponding survey question: "Do you think this person has used Facebook in the last 30 days? "). Our estimates of the number of children are compared with data from the Demographic Health Survey, which serves as a benchmark.

This project received ethical approval from the Ethics Council of the Max Planck Society (application number: 2023%_10) and the Universtiy of Bielefeld (application number: 2023-197). We conducted two pretests in early May (04.05.-06.05.2023) and early June (29.05.-03.06.2023) of this year. We used stratification by gender, age group and region to ensure an even distribution across demographic groups and to mitigate the influence of Facebook's advertising algorithm. The survey was simultaneously available in French and Wolof. Due to a low response rate in the first pre-test, the second pre-test was conducted exclusively in Dakar, the capital of Senegal.

3 Preliminary results

The performance of our recruitment campaign on Facebook is comparable with other Facebook surveys conducted in Sub-Saharan Africa (Olamijuwon 2021, Leah R. Rosenzweig and Zhou 2021). Unfortunately, less than 1% started to fill in our survey. Here we offer some preliminary results based on the survey data collected during the two pretests.

Figure 1 compares the age and gender distribution of the respondents of our pretest data (solid line) with the 2019 United Nations population estimates for Senegal (dashed line) (United Nations 2022). Notably, our data skews towards younger women, constituting 31% of our sample compared to the general population's 18%. Conversely, men in the 18-29 age group make up only 11% of our sample, six percentage points lower than in the general population. This is unexpected as prior

research indicated higher internet and mobile phone usage among men in low- and middle-income countries (Fatehkia, Kashyap, and Weber 2018).

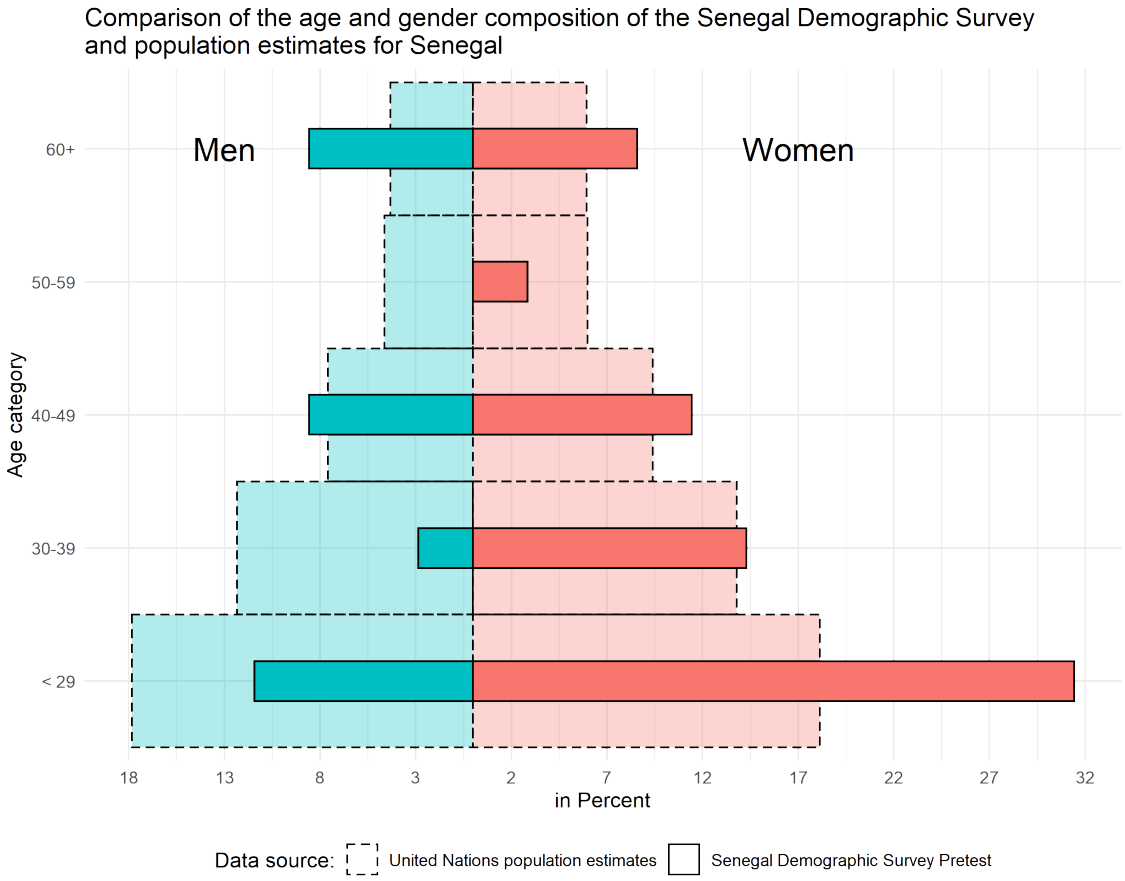

Figure 1: Population pyramid comparing the age and gender composition of the respondents of the Senegal Demographic Survey (n=35) (solid line) and the 2019 population estimates for Senegal provided by the UN Worlds Population Prospects 2019 (dashed line).

In contrast to the population pyramid table 1 shows the gender and age distribution of the network members that our respondents reported about. The gender distribution is more balanced among the network contacts than it is among the respondents themselves, with an equal amount of men and women in the sample (each n=38). This is encouraging regarding this reporting approach as it serves the purpose of balancing previous under-coverage issues among the respondents. Regarding the age composition, the largest age group is below 29 years old with 40% and between 30 and 39 with 29%. Previously we were not able to recruit men between the ages of 50 to 59, however, in the network reporting this age group is included with about 8% of the respondents.

Age	**Men**	**Women**	**No answer**	**Total**
under 29	14 (36.8%)	16 (42.1%)	2 (50.0%)	32 (40.0%)
30-39	9 (23.7%)	13 (34.2%)	1 (25.0%)	23 (28.7%)
40-49	8 (21.1%)	4 (10.5%)	0 (0.0%)	12 (15.0%)
50-59	3 (7.9%)	3 (7.9%)	0 (0.0%)	6 (7.5%)
60+	3 (7.9%)	2 (5.3%)	0 (0.0%)	5 (6.2%)
No answer	1 (2.6%)	0 (0.0%)	1 (25.0%)	2 (2.5%)
Total	38 (100.0%)	38 (100.0%)	4 (100.0%)	80 (100.0%)

Table 1: Age and gender composition of the network members of the Senegal Demographic Survey reported by the survey respondents (n=35).

Finally, table 2 shows the mean number of children of the respondents and the network members.[1] Our sample's average number of children is lower than the DHS data. Women in our sample have 1 child on average, and women in their networks have 1.3. Men have more children than women, with network members at 1.6 and respondents at 2.7. There are several reasons for this underestimation. Our sample mainly consists of urban residents as we targeted Dakar specifically during the second pretest.

Number of children	**Sample mean**	**Standard Deviation**	**Sample size**
Respondents: Women	1.0	1.3	24
Respondents: Men	2.7	1.8	11
Network: Women	1.3	1.9	27
Network: Men	1.6	2.4	22
Demographic Health Survey 2020: Women	2.4		

Table 2: Mean number of children of the respondents and network members of the Senegal Demographic Survey by gender. The data from the Demographic Health Survey 2020 serves as a population representative comparison standard (Demographic and Health Survey 2022). Note: The information about the number of children for the network members was missing in 11 cases for the women and in 16 cases for the men.

[1] This is a preliminary mean estimate and does not address concerns like multiple reports about the same network member, which will be handled using the estimator developed by Feehan and Cobb 2019 once we have a sufficient number of respondents.

4 Discussion

This study aims to enhance our understanding of new data collection and estimation approaches to estimate fertility in Sub-Saharan Africa, using Senegal as a case study.

Our pretest findings have given us an understanding of the challenges and opportunities presented by using Facebook surveys for primary data collection in this region. They revealed challenges in attaining a sufficiently large sample size. These challenges may be attributed to various factors, such as a lack of respondent interest and trust, especially given our foreign institutional base in Germany, or the absence of adequate incentives for participation. To tackle these concerns, our upcoming data collection efforts in fall 2023 will place a greater emphasis on data protection policies, highlight our collaboration with local researchers in Thies, and enhance the overall survey experience. Moreover, we intend to introduce participation incentives to encourage greater engagement.

While we acknowledge the selectivity of our sample, the pretests have provided us with invaluable insights. Respondents generally exhibited a willingness to report on network characteristics, resulting in low item non-response rates, and all participants successfully passed the attention checks incorporated into the survey. Nevertheless, challenges persist in obtaining a geographically representative sample, as a significant proportion of Senegalese Facebook users are concentrated in Dakar. In response, we are leveraging Facebook's targeting options to extend our reach to users across all 14 regions of Senegal. Despite these challenges, the pretests have demonstrated the effectiveness of our survey instrument, with minimal instances of item non-responses.

Despite the obstacles encountered, our research promises to yield valuable insights into Senegal's current fertility patterns. Moreover, it offers the potential to establish a new data source that proves useful to address the lack of data and accuracy in fertility estimations in African countries, especially during crises like the COVID-19 pandemic, when traditional, in-person data collection methods are not possible.

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