Measuring Mobility and Time Use among Adolescents in Guatemala and Brazil: Comparing Smartphones with Paper

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ABSTRACT

Mobile methods for collecting data have many advantages but also limitations. In resource-constrained settings, might simpler approaches produce data sufficient for decision-making? Working with adolescents in the rural Guatemala and urban Brazil, we compared smartphone-based approaches to measuring mobility and time use to more traditional, paper-based methods. Participants carried a smartphone with a GPS tracking app for 1-2 weeks. On 2 days they completed a self-administered phone diary. They also marked their activity space on pre-printed paper maps and completed 24-hour recall surveys. Guatemalan participants (n=74) were enthusiastic about the phones, but major technology and user challenges led to incomplete data. We found that traditional paper-based methods produced more complete data, but smartphones increased participant engagement and aided in fieldwork logistics in a remote area. Brazil data collection (target n=120) is ongoing. We expect more complete data from better GPS/cell signal but reduced logistical benefits in the urban setting.

EXTENDED ABSTRACT

Standard survey methods that capture behavior may struggle when activity and movement are not long-term and routine, or are on the margins, as is often the case in low- and middle-income countries (LMICs). Mobile methods provide opportunities to gather data on more elusive behaviors or populations but bring their own limitations. Working with adolescents in rural Guatemala and urban Brazil, we compare smartphone-based approaches to measuring mobility and time use to more traditional, paper-based methods.

GPS studies primarily come from high-income countries and urban settings. We know less about the feasibility of collecting GPS data on mobility and activity spaces in low-resource settings, rural areas, or among marginalized populations. GPS has limitations, including equipment, signal and user error; and time and effort required to collect and analyze new types of data. Equipment costs have decreased but costs in time, logistics, and human resources remain substantial. In resource-constrained settings, might simpler approaches produce data sufficient for policy and program decisions?

Time use studies from LMICs are also rare, but effective social policies for youth require accurate, local data, and therefore feasible methods for collecting it. Diaries are the gold standard, but literacy and language barriers pose challenges. The familiarity of typing messages on phones, however, may lower literacy barriers, making self-administered mobile phone diaries potentially more acceptable than other diary methods.

OBJECTIVES

We used mobile phones to compare two approaches to measuring mobility, and two approaches to collecting 24-hour time diaries. Though we worked with adolescents in LMICs, the methods we tested are equally applicable to research with other previously-neglected groups that are becoming more demographically important globally, including in high-income countries (HICs), such as those who are elderly, disabled, displaced, or unemployed, among others. Standard survey methods work well to capture the regular and predictable behavior of standard people but are less good at measuring activity and movement that is not long-term and routine or is on the margins. Mobile methods provide new opportunities to gather data on more elusive populations and behaviors. Our research will contribute to refining those methods.

Our methodological **research questions** are:

1. What is the value added of GPS over the static map? That is, how much additional information do GPS tracks give us?
2. What types of places are most and least likely to be captured by static map (vs. GPS)?
3. What is the best way to collect diary data from adolescents?

This paper describes our experience of using new technologies to conduct research with underserved populations and in low-resource settings, in particular focusing on the feasibility of the process, engagement of the study participants, and the quality of the data produced relative to more traditional methods. Substantive results (e.g. where and how adolescents spend their time, and differences between individuals and across genders) will be described in separate papers.

SETTING AND SAMPLE

Guatemala

With 15 million inhabitants, Guatemala is the most populous country in Central America. It has the youngest population and the highest population growth in Latin America. Approximately 40% of the population is indigenous Maya. The indigenous population predominantly lives in rural areas and has lower social and economic status than the non-indigenous population.

Population Council/Guatemala has been implementing the program *Abriendo Oportunidades* (Opening Opportunities, or AO) to counter the social exclusion of girls since 2004. The community-based program provides safe spaces for adolescent girls to meet to develop social support networks and life and leadership skills. AO specifically targets the "hardest to reach" girls by working in remote rural settings where most residents are poor and indigenous—areas that are seldom reached by other development programs. Former AO staff founded a non-governmental organization (NGO) called the *Red de Mujeres Indígenas, REDMI Aq'abal* or REDMI (Indigenous Women's Network), which took over implementation of AO in a number of communities around the country in late 2017. We selected four of these communities in the Boca Costa (piedmont) region of southwest Guatemala. The Boca Costa region is less developed than either the highlands or the coast, with poor transportation infrastructure. Most residents are indigenous and speak limited Spanish. (In the study area, Kiché is the main Mayan language.)

We invited all AO participants in the four villages to participate in the research, along with their brothers in the same age range (13-17 years). Due to low enrollment, we later expanded the pool of boys to cousins and some friends. Our sample was 54 girls and 19 boys.

Brazil

Brazil has the largest and most diverse population in Latin America. Although fertility has dropped dramatically in recent decades, Brazil's 45 million children under the age of 15 ensure that there will continue to be an enormous youth population despite the aging of the population as a whole. Brazil also represents the future for many developing countries. Its status as a middle-income country with modern cities masks high levels of inequality. The population is over 85% urban but transport systems and other infrastructure have not been able to keep pace with the growth of sprawling cities. High levels of urban crime have direct health effects in terms of injuries but also indirect effects by limiting access to public spaces that might be used for exercise, for example. Violence and obesity have been described as epidemics threatening Brazil's youth.

The *Centro de desenvolvimento e Planejamento Regional* or Cedeplar (Center for Regional Planning and Development) at the Universidade Federal de Minas Gerais (UFMG) works with public schools in economically disadvantaged areas of Belo Horizonte metropolitan region. Our Brazil sample is students aged 12-17 from two of these schools, as well as a magnet public school that attracts children from more educated and higher income families. Our target sample is 60 students from the magnet school and 60 from the other schools. Fieldwork is ongoing.

METHODS

Data collection

1. Snapshot / static mapping: Participants mark a satellite photo or map with places they travel to or visit at least once a week. Maps were created and digitized using the open source packages FieldPapers (fieldpapers.org) and Open Street Map.
2. GPS / dynamic mapping: Participants carry a smartphone with an app set to record GPS location every 3 minutes, 24 hours a day (while connected) for 1-2 weeks.
3. Self-administered time diary: Participants record all their activities through the day via smartphone app (2 days). We send multiple text reminders throughout the day.
4. Interviewer-administered 24-hour recall survey: With interviewer, participants list all their activities the previous day (1-2 days)

Brazil only:

5. Photo diary (photovoice): Participants are instructed to photograph things that are important to them and to document their day. They are free to decide what to photograph, and how often.

6. Ecological momentary assessment (EMA): participants receive periodic text messages asking what they are doing, where they are, and who they are with.

The Artificial Intelligence and Data Science Lab at Makerere University (Uganda) developed the app. They develop mobile applications for a range of health and development issues and are experienced with the challenges of mobile research in rural settings.

Our study was approved by the Princeton University IRB in Guatemala and Brazil, and IRBs at UFMG and the Ministry of Health in Brazil. We obtained parental consent and adolescent assent for participation.

Analysis

For each individual, we compare the relative size and concordance of two methods for measuring activity space, as well as the researcher and participant time required to prepare for and carry out data fieldwork. In theory, the GPS provides an objective measure

We cannot determine which time use method is more accurate because both are based on self-report and subject to recall bias, depending when participants complete the diary. Instead we compare number of different activities and average duration (activities of short duration are more likely to be forgotten) to get an estimate of precision, and gaps (time with no activity) to determine incompleteness.

PRELIMINARY RESULTS

Results are from Guatemala only. Brazil results will be available in early 2019.

Data quality

All 4 villages are surrounded by steep hills and trees, which present obstacles to satellite GPS signal. There are no urban centers nearby; thus cell network coverage is much more limited than other parts of the country, limiting the effectiveness of A-GPS using cell towers. In 2 of the villages, many participants did not have any signal at their houses.

Out of 73 participants, 67 had some GPS data. Several of those had minimal data points, while others had hundreds. All participants, however, had long stretches of time with no data, which might be due to poor signal, the battery running out, or the participant turning off the phone. Some turned off wifi or location services.

Another major problem with the GPS data is that the reported accuracy is generally very low.

Most filled out some activities on at least one diary day, with the majority completing diaries for both days, though most have gaps. We expected that in a setting where clock time is not culturally important, a diary completed in real time would pose a lower cognitive burden, but we believe that most filled out the diary at the end of the day or the following morning.

All participants completed the paper map and the time recall survey.

Participant engagement

Nearly all participants were happy to do the diary. None complained about it (though many complained about other things, like lack of unlimited mobile data.) They did not seem to find it burdensome but, when asked, some said they found it hard. It was not clear whether it was the diary itself that was difficult, or remembering the activities. In both interviews and the diary training

sessions, many participants had trouble remembering what they had done in the previous 24 hours, and estimating how long activities took.

The research team was inundated with WhatsApp messages (related and unrelated to the data collection activities), requests for photos, and audio and video calls during the study period. We believe that part of their enthusiasm and engagement with the study staff was the novelty of having a phone and data, and not having many other friends with phones. The exchanges allowed us to build rapport with participants in a way that is not possible in a one-time interview, and the participants shared unsolicited information about their daily lives.

Logistics

Interviews and paper maps are much easier and less time-consuming, even from the point of arrival at the field (i.e. if we leave out deciding what equipment we need, getting it, etc.) Phones require at least 1 orientation and 2 visits to ensure things are working correctly (our participants required more support than this) as well as connection.

An important advantage of participants having phones with unlimited WhatsApp (when they had network connection and responded) was that we could troubleshoot problems with the diary and GPS app remotely and arrange in-person visits. Being able to communicate with participants in advance of (or instead of) a visit facilitated fieldwork in a rural area with poor transportation infrastructure. Though some participants always responded to text messages, when we really needed to get in touch, calls were most reliable.

Technology

Participants don't always have signal, either at home or elsewhere e.g. when participants are in remote areas to pick coffee.

Almost none of our participants had a phone of their own. Limited experience with smartphones meant there was some accidental logging out from the app and difficulty typing password to log back in. All but one had access to electricity to charge their phones. We provided her with charged external batteries every few days.

Phones and screens suffered a lot of wear and tear in one month, and there were many malware infections. Though no phones were lost or stolen, 2 stopped working due to malware. Batteries ran down quickly and sometimes overheated. We believe this was because phones were constantly searching for weak or absent signals, though malware may also have been a factor.

CONCLUSIONS

Giving participants smartphones can allow researchers to collect new types of data—for example, to add the dimension of time to activity spaces—but also introduces new challenges, particularly in areas with limited cellular networks. We found that traditional paper-based methods produced more complete data, but the smartphones increased the engagement of the participants and aided in the logistics of data collection. Based on our WhatsApp interaction with participants, we think smartphones offer great promise for gaining insight into aspects of daily life of populations that are physically remote, as is the case for many indigenous groups, and for making research more participant directed, which we believe is particularly important when working with marginalized groups.