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2019

It’s about Time: Improving the Measurement of Time Use in Low-resource Settings

Marin, Margaret Celeste

Princeton, NJ : Princeton University

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It's about Time:

Improving the Measurement of Time Use

in Low-resource Settings

Margaret Celeste Marin

A Dissertation

Presented to the Faculty

of Princeton University

in Candidacy for the Degree

of Doctor of Philosophy

Recommended for Acceptance by

the Program in

Population Studies

Adviser: Elizabeth M. Armstrong

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Abstract

Most of our knowledge about adolescent time use comes from high-income countries. Different social norms, living conditions, and infrastructure make this knowledge unlikely to be generalizable to low- and middle-income countries (LMICs), home to 90% of the world's adolescents. This dissertation describes methodological and substantive findings from time diary studies with low-income adolescents in rural Guatemala and urban Brazil. Chapter 1 describes striking differences between indigenous Guatemalan girls and boys. Girls did far more unpaid family work and more economic work than boys, leaving boys with more time for recreation and with friends. Healthy adolescent development requires time with peers and supportive social networks, but most girls had little or no time with friends. In Chapter 2, Guatemalan and Brazilian respondents completed both interviewer-administered 24-hour recall surveys and self-administered diaries in a smartphone app. The mobile diary was feasible and acceptable, and could be completed in real time. However, mobile diaries had lower coverage and more errors, indicating the need for automated validation checks. Chapter 3 describes how I measured multidimensional time use in Brazil. How people experience time is determined by a combination of factors including what they do, why they do it, and how they feel while doing it. Yet researchers typically classify activities according to their own assumptions about purpose and enjoyment. Using locally-relevant concrete examples to standardize responses, we asked respondents about subjective wellbeing and motivation for each activity, and about general time pressure. Though most leisure activities were motivated by enjoyment, having nothing better to do was also a common reason for watching TV and "messing around on my phone." Motivation for work and school varied much more, suggesting that knowing activity alone is insufficient. Together these papers

show that time diary studies in LMICs are challenging but possible. Researchers must rise to the challenge.

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Introduction

A low-resource setting may be in a low- or middle-income country (LMIC) or a remote location, or may refer to contexts where populations are disadvantaged or socially vulnerable. Working in low-resource settings presents challenges for researchers. But this is not a reason to avoid working in such settings or with such populations. Ninety percent of the world's adolescents live in LMICs (UNDESA, 2017). The three papers of this dissertation together demonstrate that it is possible to collect standard 24-hour time diaries from low-income adolescents in rural Guatemala and urban Brazil. It is even possible to introduce innovations. I tested a self-administered smartphone diary app in both countries, and multidimensional measures of time in Brazil only. While my dissertation research has its limitations, it clearly indicates that with locally-adapted tools, careful training and supervision (including regular debriefing) of the research team, and a certain amount of flexibility, time use researchers can and should aspire to conduct studies using the same rigorous methods they use in easier settings.

Why Study Time Use?

The study of time use is the study of routine behaviors—what people do on a daily basis. Understanding how people spend time can tell us about their wellbeing, and potential risk or protective factors. It can also highlight differences between subpopulations. The gender division of labor within couples is one such example. Differences in time use can highlight disparities by education or employment status (whether type of employment, or employment vs. unemployment), or disadvantages among populations such as the disabled, the elderly, migrants, or those living in remote areas.

Disparities do not remain constant over time, and time use data can elucidate changes over time. In the past, women's primary caregiving role was taking care of their children. Families now have fewer children, but as the population ages, more women are becoming caregivers for their parents. Compared to previous generations, today's youth spend more of their time in structured, supervised activities, with more years in school, more hours in front of screens, and fewer hours outdoors. This may exacerbate differences between families that can and families that cannot afford structured activities for their children, or safe neighborhoods for them to play.

Time use data is important in evaluating public health policies, such as those aimed at increasing time spent outside or engaging in physical activity, and in developing policies to address competing demands among children who drop out of school.

Why Adolescents?

The World Health Organization defines adolescence as ages 10–19. Children's lives go through profound changes during adolescence. Within a few years, children go from being highly dependent on their families to having much greater physical, social and psychological independence. As they pursue their own interests, and gain knowledge and life skills through activities and interpersonal relations, they develop their own sense of identity (Larson & Verma, 1999). As they age, adolescents increasingly take on adult responsibilities, but they may begin to do so at much earlier ages in low- and middle-income than in high-income countries. Healthy adolescence requires opportunities for education and developing life skills, creative outlets (such as sports and hobbies), and supportive social networks.

Weaknesses of Time Use Research in LMICs

We have rich time use data from many countries. The Multinational Time Use Survey, based at the UK Centre for Time Use Research, has harmonized data from 17 European countries plus the United States, Canada, Australia, Israel, Korea and South Africa. A 2015 United Nations Development Program review found at least one national-level diary study from 65 countries. However, most data are from high-income countries (HICs): only 11 of 54 African countries and only 9 of 48 Asian countries had data. No Latin American country had national-level diary data, but 7 countries had other studies (Charmes, 2015).

Among the LMIC studies that exist, many use stylized questions because they are believed to be simpler (Esquivel et al., 2008). For example, UNICEF's Multiple Indicator Cluster Surveys ask mothers or guardians about their children's work using stylized questions. Stylized questions are those that ask something like, "How many hours per week do you spend doing _____?" or "In a typical day, how many hours do you _____?" In contrast, the 24-hour recall survey is the standard methodology of most large, representative surveys: the American Time Use Survey, the Multinational Time Use Survey, the Harmonised European Time Use Survey, and other smaller or less frequent surveys, including the British Cohort Study, Growing Up in Australia and the Child Supplement of the Panel Study of Income Dynamics (PSID). Respondents typically list the start and end times of each thing they did throughout the day, along with other information that varies according to the research goals—for example, who the respondent was with, where they were, whether they were taking care of a child. This narrative format matches the way people talk about their experiences naturally, reducing the cognitive burden.

While stylized questions can be appropriate for some research goals, the consensus is that even in HICs, where people might be used to accounting for their time, stylized questions work best for regular, structured activities such as salaried employment. The respondent must decide which actions fit into the activity category being asked about, estimate how much time they spend, and summing that over the reference period. These challenges can lead to different biases among different demographic groups, such as women with children compared to women without (Kan and Pudney, 2008; Juster, Ono and Stafford, 2003).

In LMICs, the challenges of stylized questions are compounded: work schedules, and schedules in general, may be less structured. Levels of salaried employment are lower, with more people working in the agricultural or informal sector. The concept of a "typical" day may be difficult for respondents to understand. There is a substantial cognitive burden for a respondent in identifying which activities match the activity categories listed, determining what a typical day is, and estimating the amount of time spent (see e.g. Shulz & Grunow, 2012; Seymour, Malapit & Quisumbing, 2017). Seymour and colleagues found that, in Uganda and Bangladesh, stylized questions actually took longer to administer well, because interviewers had to probe and assist respondents.

Stylized questions only collect information about a specific activity rather than the totality of a person's day. In asking about a limited set of activities over a longer reference period, stylized questions are prone to over- or under-reporting of pertinent activities, as they cannot check that days add up to 24 hours. Stylized questions are especially subject to social desirability bias, with respondents likely to overreport "good" behaviors and underreport "bad." Researchers recommend "person-centered" study of time use that measures all activities and analyzes them holistically rather than in

isolation (see e.g. Charmes, 2015; Hunt & McKay, 2015; Seymour, Malapit & Quisumbing, 2017).

The 24-hour time diary, whether interviewer- or self-administered, is considered to be the most comprehensive way to measure complete time use. It provides complete activity data along with contextual features of each activity. It preserves the sequence and timing of activities, key characteristics of time use. Diary methods are generally considered to be less vulnerable to social desirability bias because the respondent gives a narrative description of their day.

Dissertation Structure

This dissertation consists of three papers describing methodological and substantive findings from a time diary study with low-income adolescents in rural Guatemala and urban Brazil. I worked in four villages in the Boca Costa region in Guatemala, which is between the highlands and the coast, and in four public schools in the city of Belo Horizonte, Brazil. The samples are not representative, but they have characteristics in common with many populations in LMICs such that we can expect similar issues and challenges in other low-resource settings.

Chapter 1: Gender Differences in Time Use among Indigenous Adolescents in Boca Costa Region, Guatemala

This is one of few studies to examine gender differences in adolescent time use in rural indigenous communities, in Guatemala or elsewhere in Latin America. In a country with a population that is young and has a large indigenous component, this is an important step.

In our sample, we found that girls face a double burden of work: following traditional gender norms, they perform more food preparation and other domestic tasks, and they also do more economic work. This is in contrast to the usual expectations that women work inside the home while men work outside the home, but it is consistent with the notion of the "second shift," describing how women entering the paid workforce continue to do the bulk of the domestic labor. Our respondents come from poor families, and make important and necessary contributions to their households in terms of chores and income. But in so doing, they sacrifice their own social and emotional development if they have inadequate time for recreation and interaction with peers.

Chapter 2: Comparing a Smartphone Diary App to 24-hour Recall Survey to Measure Adolescent Time Use in Guatemala and Brazil

Time diaries are most often completed with interviewers, covering the preceding day. More and more programs, particularly in Europe, are developing tools and protocols to provide respondents with alternative modes of completing time diaries on their own. A self-administered diary completed prospectively would decrease the dependence on the respondent's memory, and the cost of interviewers. However, self-administered diaries place a large burden on respondents, assuming the ability to read, understand, and follow written instructions, and the ability to navigate and complete a complicated form. Fewer people living in LMICs are likely to have all of these capacities. To reduce this burden, we developed a simple smartphone application for adolescents in rural Guatemala and urban Brazil. The aim of this project was to pilot a flexible, affordable tool that researchers in LMICs could use to collect data on a local or regional scale for evidence-based decision-making. Future researchers could adapt this open source tool to their population or setting.

In this chapter, I compare time use reported in the self-administered mobile diary to time use reported in an interviewer-administered diary, both completed by the same individuals. We found the mobile diaries to be less complete (in terms of number of days completed and number of hours of activities per day) and to have many obvious errors (conflicting simultaneous activities, mixing up AM and PM). Nor did mobile diaries lead to savings in contact time, or on labor or transport costs. Nonetheless, this pilot suggests that self-administered mobile diaries could be implemented in these settings, with some improvements. In particular, self-administered electronic diaries should have a layout that makes it easy for users to spot errors and correct them, validation checks to reduce errors, and streamlined input. Even so, researchers will need to invest in training and motivating respondents.

Chapter 3: Multidimensional Measures of Time: An Example with Brazilian Children

The final chapter moves beyond measuring a single dimension (minutes spent on an activity, often referred to as a "time budget") to additional dimensions of time (in this case, subjective wellbeing and motivation, or purpose, for each activity). Studies that measure subjective experience or quality of time are not common, and many either rely on the experience sampling method or ask about a subsample of activities in a time diary (typically three activity episodes). In this chapter I describe the participatory process we used to develop age-appropriate, culturally relevant tools to operationalize abstract concepts. We then incorporated these tools into the standard interview-administered time diary format. Other researchers can use similar processes to adapt our tools or create their own. I demonstrate that measures of subjective meaning (motivation and enjoyment) are associated with age and gender, and that they capture dimensions of time

beyond the usual lists of activities. They do not map directly onto the usual broad categorizations of time (such as committed, free, and personal) nor even much narrower activity domains. I conclude that motivation and mood provide valuable data that cannot be deduced from knowing the activity alone. Rather than using activity type as a proxy for quality of time (or work vs. leisure, for example), we need to ask the people about their own experiences.

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Chapter 1

Gender Differences in Time Use among Indigenous Adolescents in Boca Costa Region, Guatemala[1]

1.1 Introduction

Adolescence is a time when children increasingly take on adult roles and responsibilities and make decisions with lasting consequences. But they are still developing skills, knowledge and a sense of their identity. The social and emotional development (that is, the ability to manage emotions and successful relationships) that occurs during adolescence is critical to subsequent wellbeing as an adult. Understanding the challenges particular groups of adolescents face is essential if we are to create programs and policies that reduce inequalities and increase the likelihood of improved outcomes.

Until recently, adolescents—defined by the World Health Organization as children aged 10–19—have been largely absent from research in low- and middle-income countries (LMICs). Large surveys such as the Demographic and Health Surveys or UNICEF's Multiple Indicator Cluster Surveys (MICS) are concerned with the health and wellbeing of children from birth to age five, while girls become "women of reproductive age" at 15. Since the adoption of the Sustainable Development Goals (SDGs) in 2015, adolescents have become a higher priority, but it is widely acknowledged that we lack data on many aspects of their lives (see, e.g. McCarthy, Brady & Hallman, 2016).

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[1] An earlier version of this chapter was presented at Congreso Internacional de la Asociación Latinoamericana de Población in Puebla, Mexico in October 2018. Rosa Noemi Güit Antonio was a co-author of the presentation.

The aim of this paper is to describe the gender differences in the burden of work—both family work and income-generating activities—as well as time spent in recreation and with friends, among indigenous boys and girls in a rural area in Guatemala. Knowing how adolescents spend time on a daily basis can give us important insights into their needs and potential vulnerabilities.

1.1.1 Adolescent Development and Gender Norms

Adolescence, particularly early adolescence (around ages 12–14), is a window of opportunity for changing attitudes and behaviors. Although children are subjected to gender norms from birth, gender norms do not become entrenched until their later teen years (John et al., 2017; Lundgren et al., 2008). Earlier, they are more open to new ideas and changing norms.

Worldwide, gender norms dictate that girls spend more time on household chores and care work than their brothers (Bruce & Hallman, 2008; Mmari et al., 2017; Charmes, 2015). This is especially true in low- and middle-income countries. While primary school enrollment has reached gender parity in most countries, girls still tend to leave school earlier than boys in low-income countries, often citing competing demands on their time from household chores (Putnick & Bornstein, 2016; Bruce & Hallman, 2008; Larson & Verma, 1999). In Guatemala, enrollment of indigenous girls begins to diverge from their non-indigenous and male peers around age 13 (McCarthy, Brady & Hallman, 2016).

This time burden of family work limits girls' opportunities to study and develop marketable skills. It also limits opportunities to develop interpersonal and life skills through friendships, interacting with people outside their families, and taking on new challenges (Larson & Verma, 1999). Researchers have identified two of the most important goals of this life stage as developing a positive sense of self-efficacy and

acquiring decision-making and life skills (Blum et al., 2014). To accomplish these goals, adolescents need to spend time with peers as well as supportive adults (within or outside the family) (McNeely & Bose, 2014).

Having a supportive social network is protective for adolescents (Hallman & Roca, 2007; Erulkar et al., 2004). Research in multiple countries in sub-Saharan Africa and South Asia has shown that girls have fewer close friends than boys. Weak friendship networks are associated with, among other things, negative sexual and reproductive health outcomes including young age of sexual debut and of marriage, domestic violence, and HIV infection (Bruce & Hallman, 2008). Developmental psychologists Larson and Verma emphasize the value of social interactions for building social and emotional competencies, but their 1999 review found data on companionship "regrettably…much less complete" than data on activities (p.703).

1.1.2 Time Use

The study of time use is the study of routine behaviors—what people do on a daily basis. Information about routine behavior can highlight social norms and differences between subpopulations.

Studies of adult gender differences in time use from HICs have consistently found that, among couples, women do the large majority of unpaid work. Furthermore, women do more unpaid work than their male partners even when they also do paid work (Bianchi et al., 2012; Lewis, Campbell & Huerta, 2008; Bitman et al., 2003; Bianchi et al., 2000). This is true in LMICs as well (Charmes, 2015; Seymour, Malabit & Quisimbing, 2017; Esquivel et al., 2008). The unequal distribution of labor and the emphasis on unpaid work leaves women with less time to do paid work, increasing their dependence on men.

This dependence can leave them vulnerable to a range of threats including partner violence.

Among children in HICs, researchers have found similar gender disparities, though the absolute differences are small due to low amounts of time spent on household work—even girls spend less than one hour per day on housework (Hillbrecht, Zuzanek & Mannell, 2008; Hunt et al., 2014; Wikle, 2014). Research on child time use in HICs has tended to focus on issues such as excessive screen time, exercise or substance use (see e.g. Wong et al., 2017; Ferrar et al., 2013; Foley et al., 2012), as nearly all children in wealthier countries spend most of the day in school, with their afterschool time often highly structured.

1.1.3 Children in LMICs

In contrast, children in LMICs often leave school at a younger age. Children in LMICs must perform much more manual labor, such as fetching water or firewood or taking care of crops or livestock. Many household chores are done by hand rather than by machine. In addition to family work, children are more likely to work outside the home, often in irregular or informal jobs. Research findings from HICs are therefore not generalizable to LMICs, where 90% of the world's adolescents live (UNDESA, 2017).

We particularly lack data from marginalized subgroups within LMICs, who may be disadvantaged by poverty, ethnicity, location, or a combination of intersecting factors. Within-country disparities may be as great as those between countries. This is true, for example, in Guatemala, where 40% of the population is indigenous Maya. The national poverty rate is around 60%, but 80% for the indigenous population (CIA, 2019).

The Young Lives longitudinal study is an exception, targeting poor infants and children in Peru, Vietnam, Ethiopia and India and following them over 15 years (Barnett et al.,

2012). But like many other time use studies in LMICs, Young Lives uses stylized questions to measure time use.[2] Researchers agree that 24-hour diary data is superior to data from stylized questions (Eurostat, 2019; Hunt & McKay, 2015). In addition to providing a time budget, or summary number of hours or minutes, it can tell us about time of day, sequence and contextual variables that can vary across activity episodes, such as who else was present. It also shows tradeoffs: when more time is spent on one type of activity, such as housework, less must necessarily be spent on another. (A shortcoming of stylized questions is that respondents often report time spent in excess of 24 hours per day.)

While researchers have collected diary data from children in Europe and Anglophone countries, there is a paucity of diary studies of children in LMICs. A 2015 review by Hunt and McKay found no adolescent diary study from an LMIC. Larson and Verma's 1999 review primarily relied on stylized measures or qualitative methods from LMICs.

1.1.4 Boca Costa Diary Study

We collected time diary data from 77 indigenous adolescents in four villages in the Boca Costa region of the department of Sololá, Guatemala. With over 17 million inhabitants (INE, 2019), 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 of Guatemala is indigenous Maya. The indigenous population lives predominantly in rural areas. Poverty levels are far higher than for non-indigenous

[2] Young Lives measures time use with an adapted stylized approach, where respondents are given 24 people to divide up into categories in accordance with how they spend their time on a typical day.

Guatemalans, requiring children to begin contributing to the family at a young age. Existing data on the wellbeing of indigenous Guatemalans is drawn primarily from the highlands. This study provides information about the lives of indigenous youth outside the highlands.

Rural indigenous girls are the most disadvantaged group in Guatemala. They are disadvantaged by poverty, gender, ethnicity, and location. Many studies and programs aspire to reach the most vulnerable but frequently reach only the most advantaged among those groups. This "elite capture" can present a misleading picture of the lives of the research subjects. I purposely targeted the poorest of the poor, those most neglected by existing research.

We conducted fieldwork in November and December 2017, during coffee harvest season when school was not in session. The timing was chosen largely for practical reasons: access to the villages in September and October was difficult due to flooding from severe rains, and members of the research team and participants were busy with a program evaluation in the months prior. In this agricultural area, the availability of paid work is seasonal. Since men and boys tend to engage more in the paid labor market, we would expect the extensive availability of paid work during coffee harvest to increase the time spent by boys on work. We would expect this increase to balance the greater burden of family work on girls.

1.2 Methods

1.2.1 Setting and Sample

This study was a collaboration with the non-governmental organization (NGO) REDMI (short for Red de Mujeres Indígenas, REDMI Aq'abal or Indigenous Women's Network).

REDMI grew out of a program called Abriendo Oportunidades (Opening Opportunities, or AO) that the Population Council (Guatemala office) began implementing in 2004 to counter the social exclusion of indigenous girls in rural areas. 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. Among other things, the program seeks to improve self-esteem and decision-making abilities; transform beliefs around social and gender norms; and increase close female friendships outside of the family. Former AO staff founded REDMI and took over implementation of AO in a number of communities around the country in 2017.

With REDMI and Population Council, I selected four communities where REDMI was beginning to implement AO. Initial criteria for selection were: (1) adequate numbers of AO participants, (2) enthusiasm among participants, families and community leaders for the program, and (3) willingness of families to participate in a recently completed evaluation of the program. We expected that those who were reluctant to participate in the evaluation would not consent to participate in a second study.

Of the five communities that met these criteria, one was geographically distant from the others and spoke a different language. Given our limited resources and target of four communities, we dropped that village from the sample.

The selected villages are in the Boca Costa 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. The main form of employment is hired labor on large farms growing coffee or sugar cane. Education levels are low even

compared to other parts of Guatemala: today most children complete 6 years of primary school, but mothers of AO participants have on average only two years of formal education.

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). We decided to invite only AO participants' brothers, rather than all community boys, for both theoretical and practical reasons. Working with siblings strengthens the design by reducing unmeasured sources of variability that we would expect if we added additional families. REDMI staff knew the parents and girls so were able to reach their brothers easily. Parents or guardians had a greater understanding of AO and what their children would be involved in and felt comfortable asking questions of REDMI study staff.

1.2.2 Procedures

Our study was approved by the Princeton University Institutional Review Board (Protocol 10160). In accordance with ethical standards, we obtained parental consent and adolescent assent for participation (Schenk & Williamson, 2005).

To help design the study and conduct the fieldwork, I hired four REDMI staff. These four young indigenous women had been employed by the Population Council for at least one year. One was a regional coordinator for AO, another was a district supervisor, and the other two were local community leaders. Three of the team lived in study villages, so were well known to respondents' families. All were fluent in Spanish as well as Kiché and conducted the interviews in Kiché. I trained the team in Spanish and they practiced administering the consent/assent process and the interview in Kiché. I accompanied the field team to the field and observed interviews. We debriefed as a team after each day's data collection.

Interviewers visited each participant at home, or at another agreed-upon location, to record all of their activities from 4am the previous day to 4am that day, in 15-minute increments. Interviewers recorded (in Spanish) what the respondents said they were doing. I subsequently coded responses into 30 activities, in consultation with Population Council staff. The 24-hour recall interview is the standard protocol used for time use surveys by national statistics offices in most countries that carry them out. In line with protocols for time use surveys with children in Australia, New Zealand and Hungary (Hunt et al., 2013; Viragh, 2018), the interviewer first asked what time the participant woke up and what time they ate meals. Such "anchor points" help reduce the cognitive burden on respondents because these activities are often done at regular times. This is especially useful in settings where clock time is not culturally important, such as rural Guatemala, and with children, who may struggle to estimate time accurately. Along with each activity, we recorded who the participant was with. They could be: 1) alone, 2) with child family members, 3) with friends, 4) with adult family members, 5) with others, or combinations thereof. Interviews took 10–15 minutes.

Nearly all interviews were about a weekday. Several in one village were about a Saturday, but because it was during school holidays, the respondents' activities were comparable to a weekday. (These respondents worked Monday through Saturday. Since the interview could only take place on Sunday, and was about the previous day, we necessarily described their Saturday activities.) We have therefore analyzed all of the days together, rather than separating weekdays from weekends.

1.2.3 Definitions

We organized activities into the seven domains of activities shown in Table 1. We adapted activity lists from surveys with adolescents in Peru (Young Lives, 2013) and

adults in Mexico (INMUJER, 2010). They correspond fairly closely with those used in surveys of adolescents from Canada (Hilbrecht, Zuzanek & Mannell, 2008) and Ireland (Hunt et al., 2014) but detail more types of work and fewer types of entertainment.

Table 1. List of Activities and Domains

Personal Necessity: personal hygiene, sleeping, eating, medical care, resting without doing anything else
Recreation: sports, dancing, physical activity, club or program, tv, videogames, internet, texting or talking on phone, hanging out/talking with friends, reading, listening to music
Community: family visit, religious activity, community event, participating in research study[3]
Food Preparation: going to mill to grind corn, building a fire, cooking, making tortillas
Other Housework: domestic chores other than food preparation e.g. washing dishes, laundry, cleaning, taking care of children or adults
Family Chores Outside: unpaid chores outside the house, shopping
Economic Activity: embroidery, work for pay/family business

There are many ways of categorizing different types of work. Studies of children typically divide work between family or household work, and income-generating work (Putnick & Bornstein, 2016; Larson & Verma, 1999), while studies of adults may have many more categories, particularly in informal economies (Charmes, 2015). In our setting, children did income-generating work for which they did not get paid directly, but which contributed to family earnings. For example, the family would pick coffee together and get paid for the combined amount picked, or they would all contribute to cleaning and drying coffee, and then the family would sell it. Some families had a shop or other small

[3] Two respondents spent time with the research team on study activities not related to this paper, that were coded as "community" because we considered them to be more of an obligation or service than fun.

business where the children helped, and some boys worked with their fathers on construction. Girls embroidered skirts and blouses to sell. For simplicity, I have grouped these under “economic activity.”

Family work consisted of housework such as cleaning, washing, laundry (all done by hand), child care, food preparation, and chores outside. Families cooked with firewood so boys were often sent out to gather wood. Tortillas are a staple food and girls are usually responsible for soaking corn, taking it to the mill to grind, and making tortillas once or several times a day. Among children, playing with siblings may be child care, or it may be recreation. We coded each activity according to how the respondent described it—“taking care of my brother” was child care and “playing with my brother” was playing.

“Family chores outside” included gathering firewood as well as agricultural tasks for the family, except those relating to harvesting and processing coffee. Coffee is a cash crop and is not consumed by the family.

A researcher of adolescent time use in the United States said that their respondents tend to describe their leisure time as “hanging out with friends” and need to be prompted to find out what specifically they are doing with their friends (Boettner, 2016). Therefore we trained our interviewers to elicit specific activities, but they also had an option for “talking with friends,” when respondents were not doing anything else. Similarly if a participant was resting and doing something else, like texting or watching TV, the other activity was listed. Only if they were “resting without doing anything else” was it coded as resting.

I included texting or talking on the phone as one category, and placed internet with TV and videogames as a separate category: the former require interaction with another person, whereas the latter may involve interaction only with the screen. Many of these activities were only available to our respondents because we gave them smartphones to

participate in another study component. Because I was attempting to compare interviews to a self-administered phone diary (as described in Chapter 2), the interviews had to be conducted when respondents had access to phones as well.

1.2.4 Analysis

I present standard time use indicators of participation rates and mean times spent on activities, divided by gender. To test for differences by gender, I used the non-parametric Wilcoxon rank sum (Mann-Whitney U) test. To show the distribution of participation rates and of whom the respondents were with throughout the day, I present tempograms, or area graphs, with time on the x-axis and proportion of respondents on the y-axis.

One of the research aims was to examine differences by age as well as gender. I divided the girls into two age groups: 13–14 years and 15–17. (There were too few boys to divide.) I chose these age groups because they correspond with different development stages—early adolescence and middle adolescence (McCarthy, Brady & Hallman, 2016; Blum et al., 2004), but also because the 15th birthday is an important milestone for girls in Latin American culture. The small sample sizes (31 and 24) limited the possibility of finding statistically significant differences; however there were no meaningful differences evident between age groups except for time spent with friends. I have therefore presented only “time with friends” and “time alone” broken down by age group; all other variables compare all boys to all girls.

1.3 Results

1.3.1 Sample

Table 2 shows the number of respondents by gender and age.

We aimed for a gender-balanced sample, but we were more successful at recruiting girls than boys. Most girls who were in the village at the time of the study chose to participate (55 in total). Only 8 brothers were willing to participate, so we expanded our recruitment. The remaining boys were cousins or nephews of AO participants (7) or friends of other boys participating (4).

Many girls did not have brothers in the target age range; others had brothers of the right age but did not want to participate. We got parental consent from about twice as many boys as wanted to participate. Although we did accommodate work schedules for those in the village for the week of data collection, some boys said they had to work or were otherwise busy. Other boys said they were not interested; we suspect this was because AO is known as a program for girls. Because the villages were so homogeneous, we believe that the boys who were not brothers were comparable to brothers, but the sample is too small to test statistically.

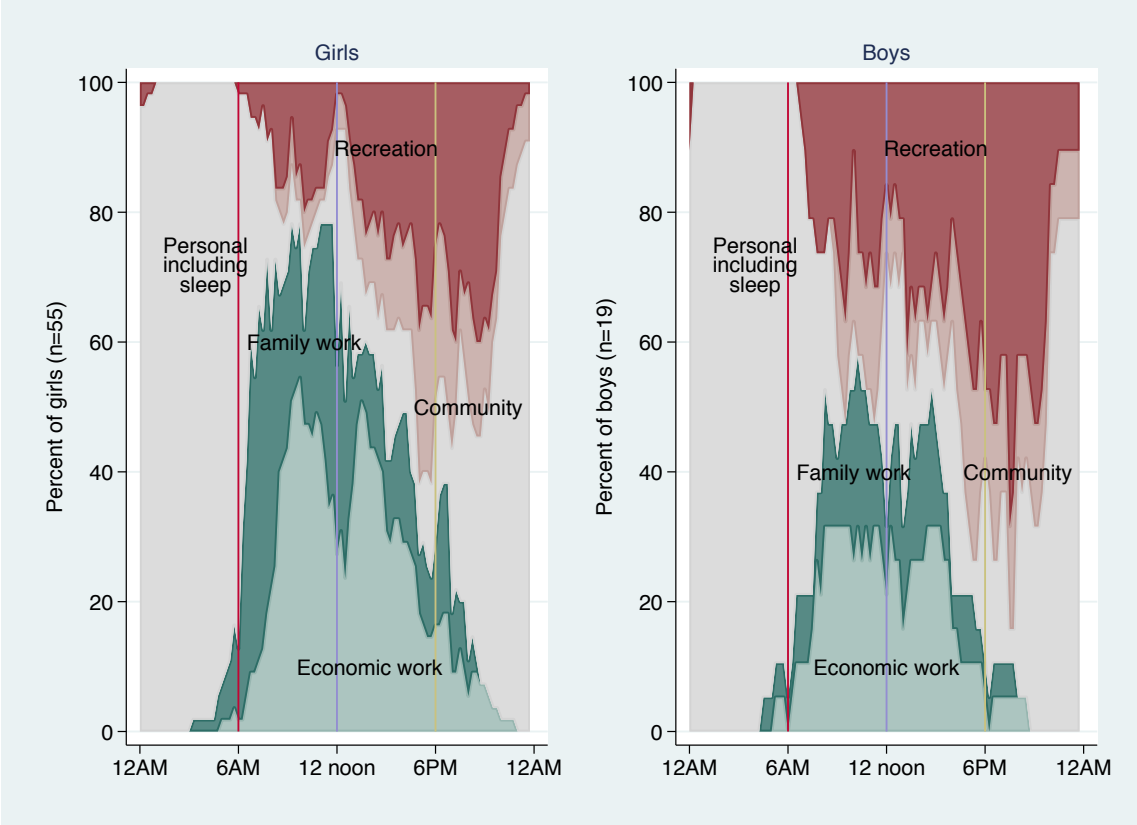
Table 2. Sample Characteristics

	TOTAL	GIRLS	BOYS
TOTAL	74	55	19
Age			
13	20	14	6
14	17	10	7
15	19	16	3
16	8	7	1
17	10	8	2

1.3.2 Overall Time Use Patterns

One of the advantages of collecting 24-hour data is that it can show not only the amount of time spent but also patterns in the timing and sequence of activities. Figure 1, below, depicts the proportion of girls and boys doing each type of activity during each 15-minute increment during the day, beginning and ending at midnight. Most girls rise earlier and begin working soon after they wake—usually preparing breakfast for the family. Boys tend to begin their work later and finish earlier than girls. This gives them more time for recreation and community activities, especially in the afternoon and the evening.

Figure 1. Distribution of Time Spent on Main Activity Domains throughout the Day

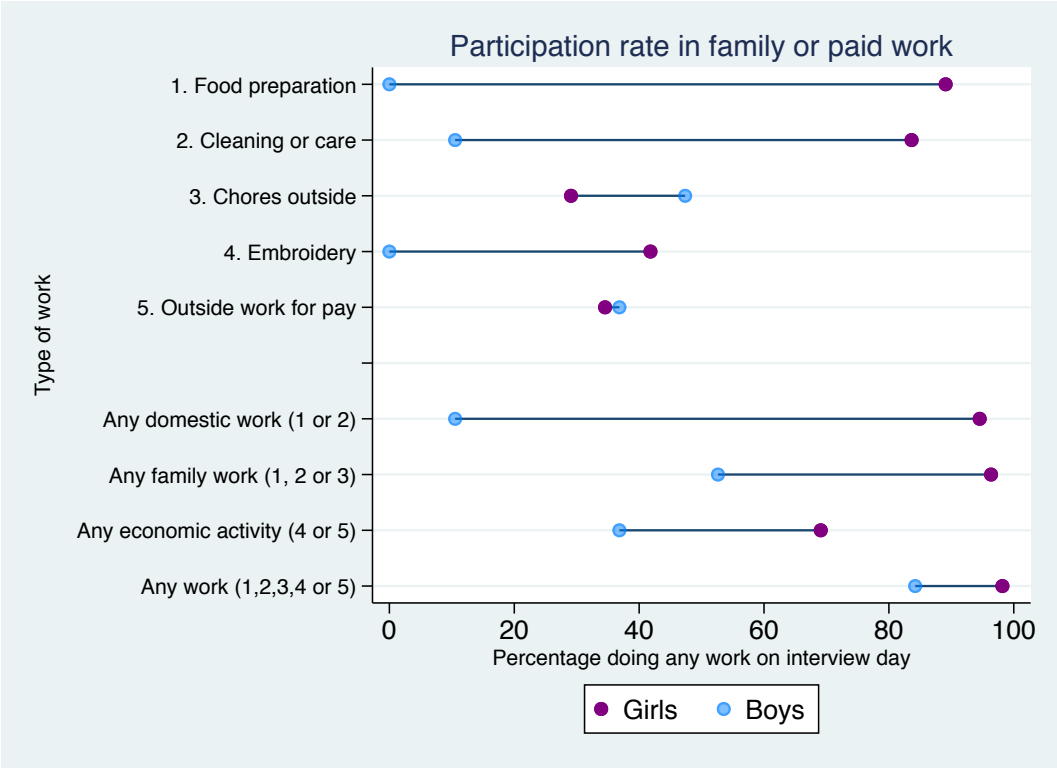


1.3.3 Time Spent Working

The "participation rate" in an activity is the percentage of the sample that reported taking part in an activity at all (for at least one 15-minute period) on the diary day. Figure 2 presents participation rates in different types of work, as well as composite domains. ("Any Domestic Work" consists of those who did food participation or cleaning or care, or a combination. "Any Family Work" consists of those who did any domestic work and/or chores outside.) Economic activity (other than embroidery), such as picking or processing coffee or helping in a family business, was the only type of work where the participation rate of girls was not substantially higher than boys. Here participation was equal. The differences in participation rates for Any Domestic Work and Any Family

Work were statistically significant using a Wilcoxon rank sum test. The difference in participation in Any Economic Activity was not statistically significant.

Figure 2. Participation Rate in Family or Paid Work



There were large and statistically significant differences between boys and girls in mean time spent on food preparation and other household chores. Boys did no food preparation, whereas girls spent an average of one and a half hours. In addition, girls spent a similar amount of time on other housework, including cleaning, washing dishes or clothes, and taking care of siblings or other family members. Boys spent an average of less than half an hour on housework.

Boys spent nearly two hours on unpaid work outside, which included shopping for the family—far more than girls. But when all family work is combined (food preparation,

housework, and chores outside) girls spent an average of four hours whereas boys spent only two.

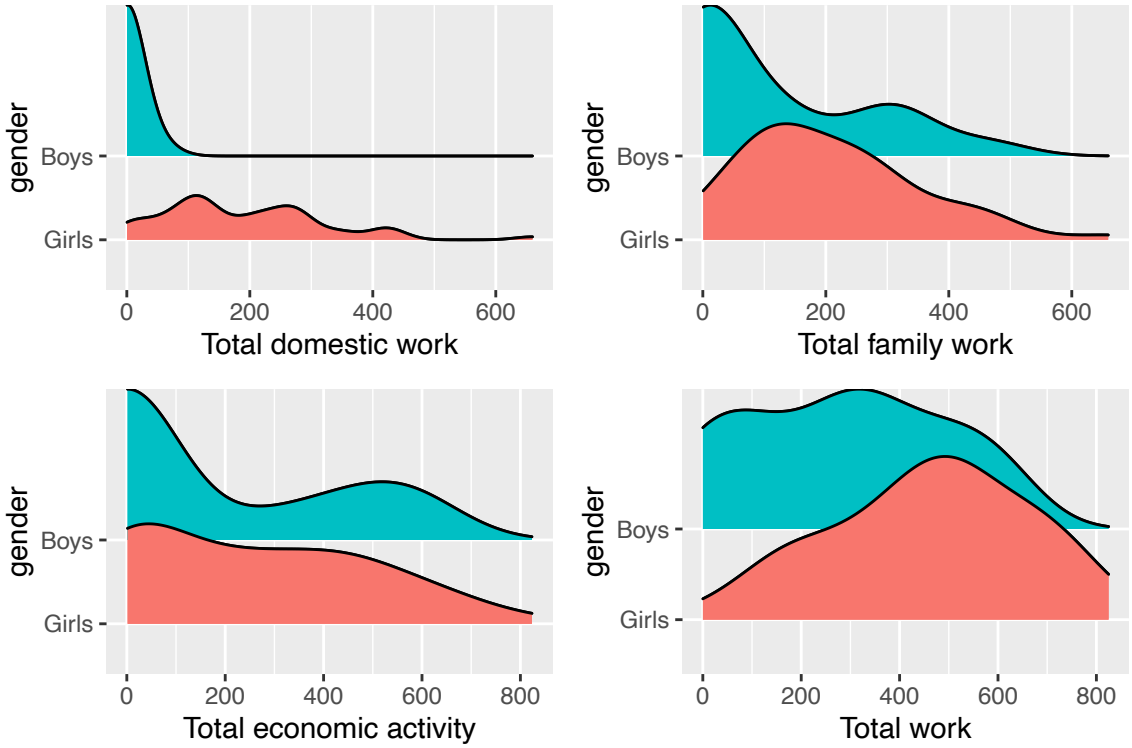
Girls also spent over an hour more on economic activities—an average of more than four hours compared to three for boys. As Table 3 shows, girls tended either to do embroidery or to do outside economic work but not both. The mean time spent on both types of work for pay was similar. Boys, on the other hand, had a higher mean time than girls for outside economic work and did not do embroidery. The economic return on time spent picking coffee is more immediate and higher than for embroidery. When all work is combined, girls spent an average of seven and a half hours working, significantly more than the four and a half hours boys worked on average.

Table 3. Mean Time (in Minutes) Spent on Work

	Boys		**Girls**	
	mean	**SD**	**mean**	**SD**
Food preparation	**0**	**0.0**	**91**	**68.6**
Go to mill	0	0.0	11	12.2
Cook, make fire	0	0.0	79	63.7
Other housework	**5**	**15.0**	**100**	**92.0**
Cleaning, laundry	5	15.0	86	75.1
Childcare	0	0.0	13	39.7
Chores outside	**110**	**152.0**	**17**	**39.9**
Shop for family	28	82.0	15	39.2
Chores outside of house	81	144.2	2	9.2
Economic activity	**173**	**243.9**	**254**	**233.7**
Embroidery	0	0.0	119	175.5
Outside work for pay	173	243.9	135	230.7
Total housework	5	15.0	190	132.9
Total family work	114	150.4	207	140.0
Total work	287	205.5	461	197.8

Time diaries are a sample of person-days, not people. Therefore, when people do something regularly but not every day—i.e. when the participation rate is not high—the distribution may be very skewed due to a large proportion of zero values. In Figure 3 we see, for example, that some boys did no family work or economic work on the diary day, while others did a great deal. This may represent between-person variation, or day-to-day variation; it is not possible to distinguish without additional questions. However, we can see gender differences: though there is still wide variation, the distribution of time spent working is much more normal for girls than boys. The small sample size for boys may contribute to the variance, but the pattern is typical of the gender division of family work among adults in HICs. Men's unpaid labor (e.g. home repairs, yard work) can be often be postponed, whereas women's unpaid labor (e.g. food preparation, cleaning) must be done on a daily basis.

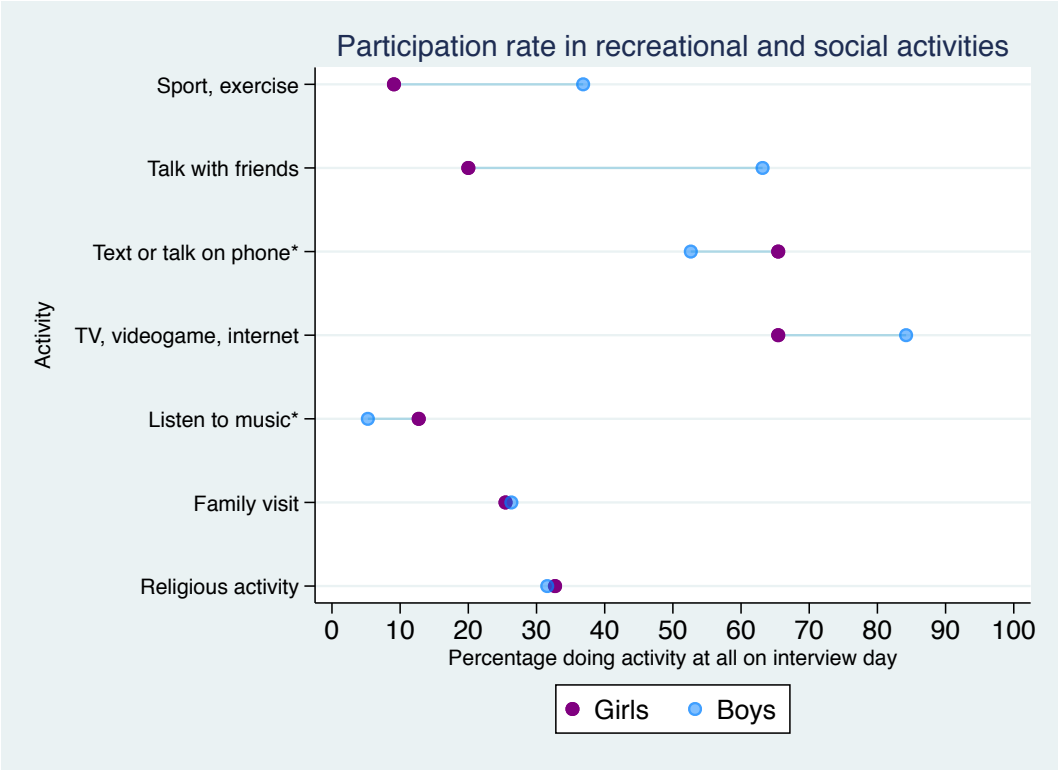
Figure 3. Distribution of Minutes Spent on Work



1.3.4 Time Spent Not Working

Girls spend more time working than boys, and all days must sum to 24 hours, so boys spend more time on non-work activities. Participation in sleeping, eating, and personal hygiene was 100%. Participation rates for family visits (one in four) and religious activities (one in three) were equal for boys and girls. (Diaries were for weekdays; participation in religious activities would be higher for a Sunday.) More boys than girls participated in watching TV, playing videogames, or using the internet (84% for boys vs. 65% for girls), talking with friends in person (63% vs. 20%) and sports or physical activities (37% vs. 9%). Girls participated more than boys in texting or talking on the phone (53% for boys vs. 65% for girls) and listening to music (9% for boys vs. 13% for girls). These are both activities that can be done without leaving the house. Using the phone was only possible because we provided phones for the week of the study.

Figure 4. Participation Rate in Recreational and Social Activities



*Respondents had study-provided smartphones but did not normally have their own phones.

Boys and girls spent equal amounts of time sleeping or resting (roughly eight hours), as shown in Table 4. Boys spent slightly more time on personal hygiene and on eating than girls—an hour and a half rather than an hour and a quarter.

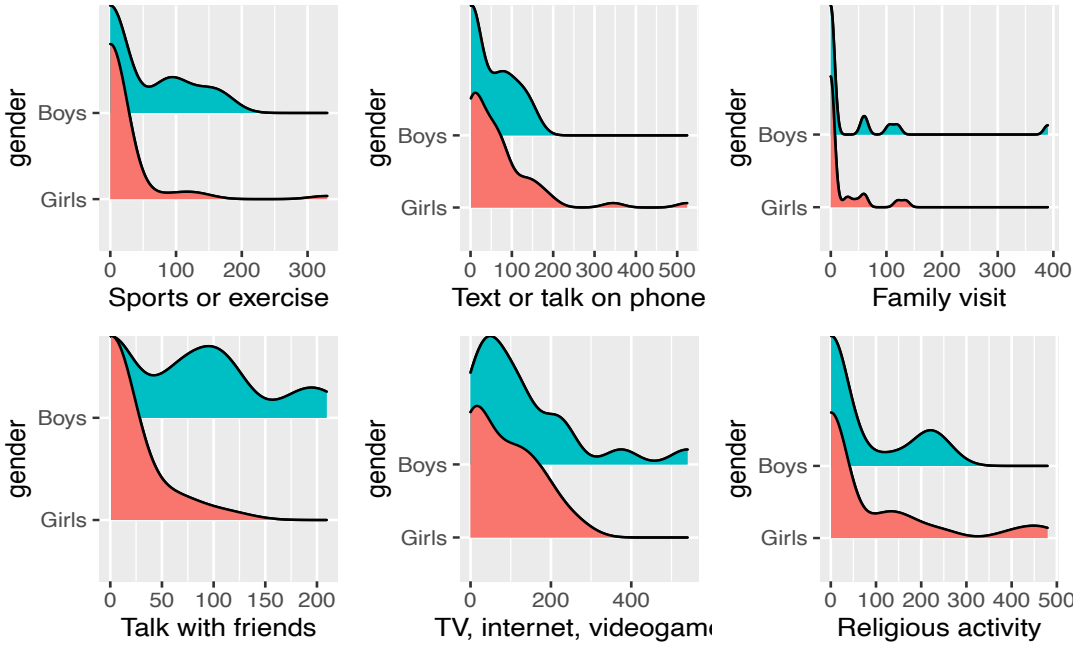
Differences in recreation were much larger: boys spent an average of five hours compared to three and a half for girls. The bulk of this time was spent on TV or videogames. Boys also spent an average of an hour more talking with friends in person, and half an hour more doing sports or exercise, such as playing football, walking or biking. Girls spent an hour—a quarter of an hour more than boys—texting or talking on the phone, usually to friends who were also participating in the study and so also had study-provided phones.

Figure 5 shows the density distribution of time spent on recreation and community activities. Again, this should be considered as a sample of person-days and not people. The two activities that show the most dramatic difference between boys and girls are the two that involve face-to-face interaction with peers: talking with friends and sports or exercise.

Table 4. Mean Time (in Minutes) Spent on Non-work Activities

	Boys		Girls	
	mean	**SD**	**mean**	**SD**
Personal	**637**	**132.1**	**612**	**100.9**
Personal hygiene	89	69.7	76	34.0
Eat	89	38.9	72	27.9
Sleep	459	119.9	464	92.2
Rest, doing nothing else	28	52.0	17	56.8
Recreation	**320**	**184.1**	**203**	**156.4**
Sports, exercise	43	62.2	13	51.3
TV, videogame, internet	127	139.5	83	81.5
Text or talk on phone	46	53.5	63	90.6
Talk with friends	73	70.3	12	28.2
Music	2	10.3	7	20.6
Community	**99**	**115.1**	**95**	**141.2**
Family visit	39	93.2	17	36.1
Religious activity	58	95.0	77	136.0

Figure 5. Distribution of Minutes Spent on Non-work Activities



1.3.5 Time Alone and With Friends

We asked respondents who was physically present with them during each activity. They could be with any combination of people, or alone. Here I present results for time spent awake and alone, and time spent awake and with friends, regardless of who else might also have been with the respondent along with friends. The mean time alone for girls was six hours and 40 minutes, compared to five hours for boys. This was not a statistically significant difference.

There was a statistically significant difference, however, in time spent with friends: boys spent a mean of almost four hours with friends, whereas girls spent one. As Figure 6 shows, many girls spent no time with friends. Figure 7 shows the proportion of boys and girls spending time alone, with friends, and either with others or asleep over the 24-hour period. (Most respondents shared a room or a bed with family members but this analysis

only includes companions for waking hours, per the American Time Use Survey protocol.)

Figure 6. Time (in Minutes) Spent Alone and With Friends

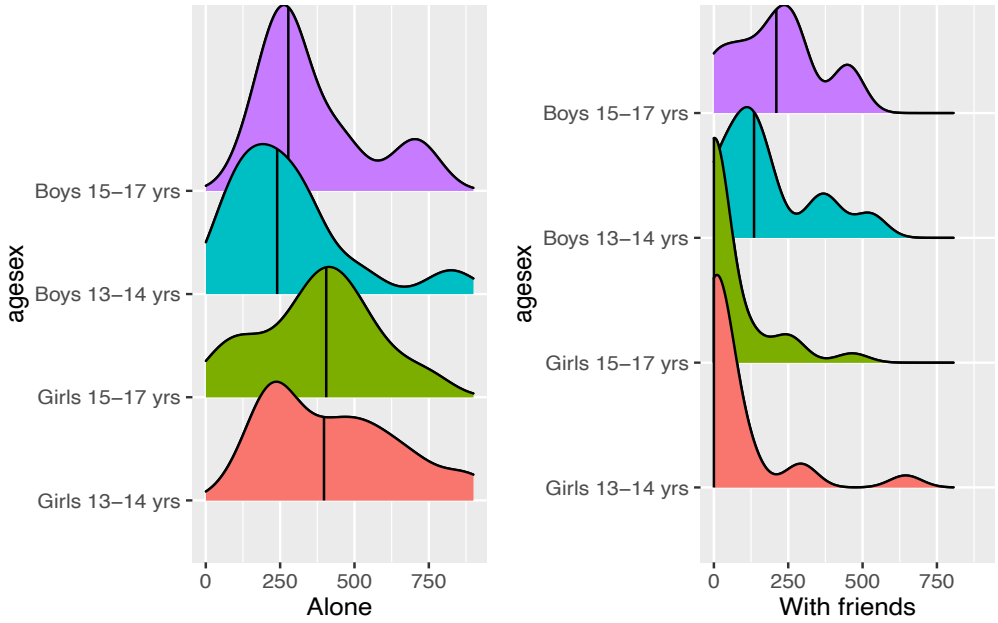
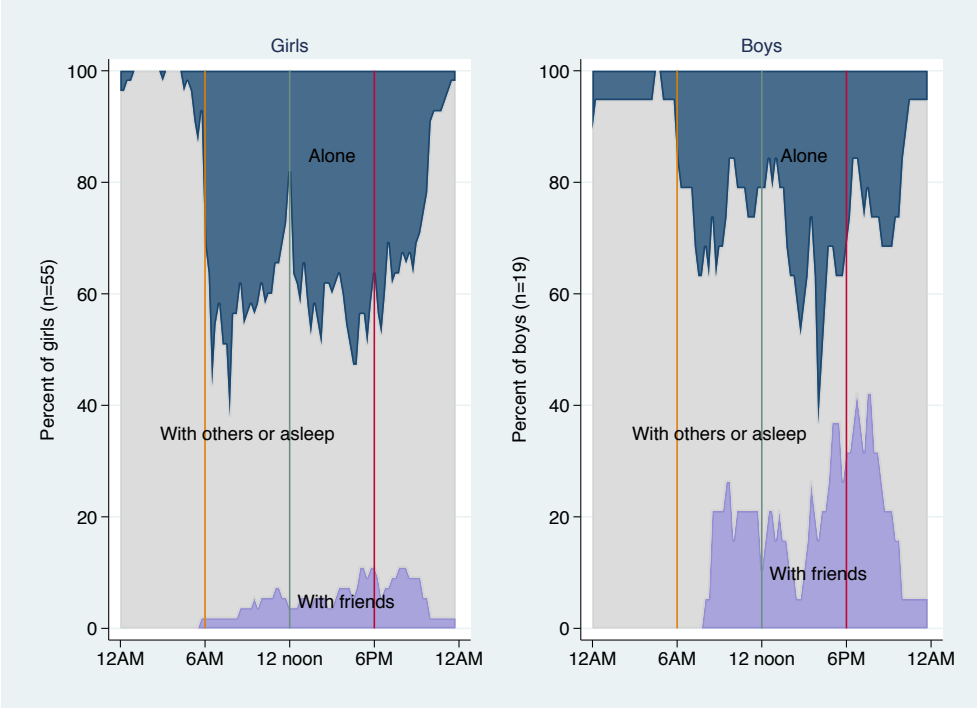


Figure 7. Time Alone and With Friends throughout the Day



1.4 Discussion

There were striking differences in the amount of time boys and girls spent doing household chores. Few boys spent any time doing chores inside the house, while virtually all girls did some household chores. Nearly all girls did a combination of food preparation (including building fires, cooking and making tortillas, going to the mill to grind corn for tortillas) and other housework like cleaning. Some also took care of younger siblings. The main chore that boys did was collecting firewood. Girls spent an average of approximately three and a half hours a day on family work and four on economic activity, while boys spend two hours on family work and three on economic. This left boys with over five hours for recreation, two hours more than girls.

Our findings are somewhat consistent with recent studies among adolescents in the US (Wikle, 2014), Canada (Hilbrecht, Zuzanek & Mannell, 2008) and Ireland (Hunt et al.,

2014). Like these studies, we find the same gendered patterns of unpaid family work as we are familiar with in adults: girls spend more time caring for the house and family members, and boys spend more time outside the home. In contrast to these studies, however, girls in our sample also did more income-generating work than boys. This is unusual even in LMICs: Young Lives (Espinoza Revollo & Porter, 2018) found girls did more paid work than boys only in one country of four (Vietnam). A 1993 report by the International Labor Organization found employment rates for boys to be higher than for girls across LMICs (Larson & Verma, 1999). One possible explanation for our findings is that half of the girls who did economic work did embroidery, which is done inside the home and is "women's work." Different patterns of land ownership and cultivation may also contribute. In the highlands, as in many other development settings, poor families are more likely to have small plots of land and grow crops for family consumption, which is classified as non-market work. In the Boca Costa region, agricultural work is more likely to be on large plantations rather than a family plot, i.e. informal daily labor for a wage rather than unpaid family production.

Our respondents had much longer working hours than those in the higher-income countries. This is attributed to the general level of development and poverty (e.g. cooking over firewood, handwashing laundry), as well as it being school holidays. In their review of child labor in LMICs, Putnick and Bornstein (2016) use 14 hours of paid work or 28 hours of family work per week as the threshold for child labor among children 12–14. (They do not specify but presumably this is during the school year, not holidays.) The number of hours worked by our respondents was more consistent with studies from non-industrial settings in Larson and Verma's review (1999). Two recent studies of adolescents in Karnataka, India, found that girls spent much more time indoors and did more housework than boys (Gibby, 2019; Thummalapally et al., 2014). The Young Lives analysis of 15-year-olds in four countries did not find gender differences in total time

spent working (on a typical day when school is in session) except in India. However the analysis did find gender differences in the type of work their respondents did (Espinoza Revollo & Porter, 2018). They also found that among children who were not in school, boys in Peru worked an hour more per day than girls, while boys in Vietnam worked less than girls. Both genders worked similar amounts of time in Ethiopia and India.

Time alone and with others can have different meanings for adolescent girls depending on the setting. In southern India, Gibby (2019) found that girls are almost constantly monitored, making time alone particularly desirable. In contrast, Mayan girls spend a great deal of time alone, contributing to social isolation and early marriage. AO specifically aims to increase girls' time with peers in order to build a social support network. Such social networks are essential for healthy adolescent development (McNeely & Bose, 2014). One of the manifestations of social exclusion of girls is that boys often have more close friends than girls.

Girls and boys spent comparable amounts of time alone, but girls spent much less time with friends than boys. Nearly all boys spent some time with friends (including time with others present, such as adult or child family members). Most girls, in contrast, spent no time with friends. Girls who spent time with friends spent much less time than boys. This finding is in contrast to HIC studies, where girls often have more close friendships than boys. Larson and Verma (1999) note the difference between LMICs and HICs in terms of gender patterns of free time: boys from LMICs spend much more time on leisure than girls, whereas leisure time is similar in HICs.

1.4.1 Limitations

This study has some important limitations. One limitation is lack of generalizability. Our sample is small, selected from four fairly isolated, very homogeneous Kiché communities

in the Boca Costa region of Guatemala. It cannot be considered representative of Guatemalan youth, nor even of indigenous youth in Guatemala. The economy and transport networks differ from other parts of the country, among other things that affect how people spend their time. The indigenous population in the highlands are more likely than our population to be subsistence farmers, for example. Boca Costa is less developed, limiting the economic work available. Selecting our sample from AO program participants also means that our sample is perhaps not representative of all families even in this region: we might expect that AO families differ from those who refuse to let their daughters participate. However, there may be no selection effect; the large majority of girls in the AO age range in these communities do participate, because it is the only program targeting girls of this age. (Boys often complain that there is no corresponding program for them.) In contrast, there are many NGO programs in the highlands.

Seasonality has a greater impact on time use among schoolchildren than people not attending school. Seasonal variation is also greater in agricultural settings or places with strong seasonal weather differences. All of these were relevant to this population. Because all respondents in our study slept at home, we did not get any information about adolescents who migrate to work during school holidays. Many adolescents travel with their families from estate to estate, picking coffee, while others go to the city to get paid work. We would expect that those who travel for work spend longer hours than average doing economic work, and less time on unpaid work or leisure. Much of the economic work our participants did was picking coffee. Local coffee producers use a great deal of hired labor during the harvest, which lasts several months in Guatemala, but much less during the rest of the year. Half of the girls who did economic work did embroidery. Embroidery is not seasonal as such, but girls may be more likely to do it outside the harvest season, when better-paying coffee jobs are not available and when bad weather keeps them indoors.

Our methods are subject to the usual limitations of 24-hour recall surveys in development settings: there is a certain cognitive burden in remembering the previous day, and the amount of time spent on each activity, in a setting where days are not structured around clock time. We attempted to minimize the burden by beginning the interview with key activities (waking and sleeping, meal times) that are less likely to vary, and adding less structured activities around them. Further, we do not expect difficulties in estimating time to differ by gender in this setting.

Diary studies reduce the likelihood of social desirability bias, but the potential remains. We believe that having questions asked by known, local research staff who already have a rapport with respondents may reduce respondents' susceptibility to social desirability bias, as they share values and culture with interviewer. Social desirability bias may be further reduced by interviewing children directly, rather than interviewing a parent (as in surveys like MICS.)

While mobile phone ownership is high and growing throughout the world, none of our respondents had their own phone (though most families had a phone), and all knew they would have to return the project phones after one week. Without our study there would have been almost no phone usage. I assume that the phone displaced other leisure activities—or possibly sleep—rather than work, but there is no way to know from the data.

1.4.2 Future Research

The adolescents in our study come from families that support their daughters taking part in a girls' empowerment program. It can be assumed that these families adhere less strongly to gender norms than other families in comparable settings. We therefore expect that if we find these differences among AO participants and their male peers,

bigger differences should be found among boys and girls in similar communities that have not benefitted from AO. But we do not know.

Indigenous children leave school earlier than their non-indigenous peers. Though ethnic and gender differences in enrollment have diminished for children aged 8–12, school attendance for Mayan girls begins to diverge from Mayan boys and non-indigenous boys and girls around age 13. Mayan girls begin dropping out of school at this age, while indigenous boys and non-indigenous boys and girls remain in school longer. A 2006 study of the effects of gender, ethnicity, poverty, and residence on education in Guatemala found that the main reason given for girls not attending school was competing household responsibilities, whereas for boys it is paid work (Hallman et al., 2006). My study took place in summer vacation. One of the primary motivations for my study was to learn whether time use bears out the stated reasons for girls dropping out of school—a question that urgently needs to be answered—but the timing did not allow that.

Distinguishing between time spent alone or with others is somewhat problematic, all the more so with increasing use of social media, phones and other devices. The American Time Use Survey has two separate questions: physical presence of people and then whether the respondent was using a device. Fisher (2015) describes some of the issues: When a person is texting or talking to friends, are they alone? If they are in a room with someone who is interacting with a device but not with them, are they alone? If they leave the house, walk to a shop and then return home, are they alone for all or any of that time? Fisher describes such situations, or being on public transport, for example, as "alone with others." In our case, interviewers asked, "Who were you with?" and recorded the response, but if there was a need for clarification, we used physical presence and not "interacting with." We need to better understand the implications of these changing

patterns of interaction for social isolation. This is especially so for today's young people who interact virtually more than older generations.

1.5 Conclusions

This is one of the only studies to examine gender differences in adolescent time use in rural indigenous communities, in Guatemala or elsewhere in Latin America. In a country with a population that is young and has a large indigenous component, we believe this is an important step. Another important strength of our study is that we used a 24-hour time recall survey, which allows for analysis of competing demands on time.

In our sample, we found that girls face a double burden of work: following traditional gender norms, they perform more food preparation and other domestic tasks, and they also do more economic work. This is in contrast to the usual expectations that women work inside and men work outside, but it is consistent with the notion of the "second shift" as coined by Hochschild (1989) to describe how women entering the paid workforce continue to do the bulk of the domestic labor. Our respondents came from poor families, and made important and necessary contributions to their households in terms of chores and income. It would not be reasonable to suggest that they do less work in the absence of some other improvement in the families' livelihoods. But we can recommend a combination of efforts to change gender norms to create a more even balance in the burden of labor, as well as targeted interventions to address girls' developmental needs in the short term. To develop socially and emotionally into healthy adults, girls as well as boys need to have time for recreation and to interact with peers.

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Chapter 2

Comparing a Smartphone Diary App to 24-hour Recall Survey to Measure Adolescent Time Use in Guatemala and Brazil[4]

2.1 Introduction

Though different methods are appropriate to different research questions, time use researchers broadly agree that time diaries are the best method for person-centered (as opposed to activity-centered), full-day time use data (Eurostat, 2019; Hunt & McKay, 2015). But there are a number of different ways to collect time diaries, each with particular challenges that may be exacerbated in low-resource settings.

Most of the national time use programs, including the American Time Use Survey (ATUS) and the Harmonized European Time Use Survey (HETUS), use 24-hour recall surveys ("yesterday" diaries). Such surveys are retrospective and administered by an interviewer, either by phone (common in HICs) or face-to-face (common in LMICs). Disadvantages of retrospective interviews include the cost of interviewers, particularly when they have to travel to conduct interviews, and the need for respondents to remember everything they did the previous day and how long it took.

An alternative is a prospective or real-time diary ("today" diary) that the respondent can complete on their own. More and more programs, particularly in Europe, are developing

[4] An earlier version of this chapter was presented at the International Association for Time Use Research Conference in Washington DC in July 2019. Rosa Noemi Guit Antonio, Vanessa Lima Caldeira Franceschini and Veronica de Castro Lameira were co-authors of that presentation.

tools and protocols to provide respondents with alternative modes of completing time diaries on their own. The 2019 conference of the International Association of Time Use Research had presentations by researchers from Belgium, Finland and the United Kingdom on self-administered web applications they are testing. Eurostat also presented on their inventory of innovative tools that are being planned, piloted or deployed around the region (IATUR, 2019).

However, self-administered diaries place a large burden on respondents, which may lead people to refuse to participate or to do so poorly. The European applications assume the ability to read, understand, and follow written instructions; the ability to navigate and complete a complicated form; and access to a computer with a stable internet connection. Few people living in LMICs are likely to have all of these capacities.

To reduce the respondent burden in collecting real-time diary data, we developed a simple smartphone application for adolescents in rural Guatemala and urban Brazil. The aim of this project was to pilot a flexible, affordable tool that researchers in LMICs could use to collect data on a local or regional scale. While time use surveys tend to be national and occur only every few years, decisionmakers often need data on a smaller scale and at shorter intervals. Future researchers could adapt this open-source tool to their population or setting.

In this chapter, I compare time use reported in the self-administered mobile diary to time use reported in an interviewer-administered diary, both completed by the same individuals. Both methods are based on self-report so we cannot say whether one mode is more accurate. Instead I compare them in terms of completeness and obvious errors (e.g. conflicting simultaneous activities), and the researcher contact time required to collect data. We found the mobile diaries to be less complete and to have many obvious errors. Nor did they lead to savings in contact time, or on labor or transport costs.

Nonetheless, this pilot suggests that self-administered mobile diaries could be implemented in these settings. I conclude the chapter with recommendations for future researchers to improve data quality and ease of use for alternative mobile diaries.

2.1.1 Considerations for LMICs

Much time use research around the world is conducted at the national level, with the aim of measuring economic production. The Working Group on Gender Statistics of the Statistical Conference of the Americas held a meeting in 2015 to harmonize Latin American activity codes for time diaries, to better measure progress toward Sustainable Development Goal 5, Target 5.4 of valuing unpaid care and domestic work (Gomez Luna, 2016). This effort indicates the growing importance being given to time use research in the Latin American region, but to date large studies have been irregular, due in large part to their cost. Furthermore, such national-level studies are not necessarily useful for identifying needs or disparities of specific populations at a sub-national level. Researchers need affordable, flexible tools for collecting high-quality data on a smaller scale that are appropriate to particular challenges common in LMICs. Table 5 summarizes some of the key strengths and weaknesses of self-administered and interviewer-administered diaries in these settings.

Table 5. Relative Strengths and Weaknesses of Interviewer- and Self-administered Diaries

	Weaknesses	**Strengths**
Interviewer-administered 24-hour recall survey	Remembering what they did and for how long is harder in informal work settings, where clock time is not important Cost of interviewers, especially if traveling to remote settings	Easier to train and supervise interviewers than respondents (Good) interviewers can assist respondents
Self-administered diary	Cognitive burden especially for respondents with low literacy: • Understanding concepts and classifying activities correctly • Navigating forms May reduce response rate or increase errors Lack of consistency across respondents	No recall bias if completed in real time Can build automated checks into electronic diaries Potentially save on interviewer salary and travel costs

Even within low-income countries, the factors that most affect the reliability and validity of time diaries are not equally distributed. It is easiest for people to remember their activities when they have very regular routines, as with paid work or school, and harder when they are not in school, not employed, or do informal or irregular work. More education and experience with filling out forms, or at the very least the ability to read in the relevant language, makes it easier to fill out forms required for self-administered diaries. In low-income countries, many people may have completed only basic education. Fluency or literacy in an official language is lower among marginalized sub-populations. Guatemala, like many LMICs, has dozens of indigenous languages. A large proportion of the population speaks Spanish as a second language. Multiple local languages are even more common in Asia and sub-Saharan Africa than in Latin America.

Though activity codes increasingly incorporate types of informal work and home production common in LMICs, the activity distinctions important to economists and sociologists do not necessarily resonate with the general population. Respondents may have a hard time identifying which activities fit into researchers' categories.

A simple self-administered mobile phone diary may be more acceptable than other diary methods (Marcano Belisario et al., 2015; Hunt & McKay, 2015), leading to higher rates of compliance in low-literacy populations. Daum and colleagues (2019; 2018) developed a mobile diary app for illiterate agricultural workers in Zambia, using pictures rather than text. They collected 2,790 diary days from families where adult men and women, and children as young as seven took turns using the app.

A self-administered mobile diary is desirable because it has the potential to reduce costs for interviewers, travel, and data entry. Whereas costs for interviews increase in direct proportion to sample size, a single research assistant could instruct a group of respondents to use such a mobile diary either in person or remotely. Chatzitheochari et al. (2018) collected three types of diaries (via app, internet, and paper) remotely in the UK, providing only written instructions except where the respondent contacted the study team for support. Educational and cultural differences make such a strategy unlikely in LMICs, except for a study targeting elites. Nevertheless, a self-administered tool requiring only an initial group contact for consent and training, and then possibly one for data transfer, could be more economical than face-to-face interviews.

I tested a self-administered smartphone diary app against the standard interviewer-administered retrospective diary, the 24-hour recall survey. My app was developed for users with basic literacy but not necessarily any computer experience. I sought to determine whether a simple phone diary would be feasible for a study with adolescents

in rural Guatemala and urban Brazil, and to assess the performance of the mobile diary in terms of completeness and face validity of findings.

2.1.2 Diary Modes Being Compared

Time diaries consist of a chronicle of activities over a designated time period—usually 24 hours. The respondent lists the start time of each activity, the end time (or duration), and what they did. Most diaries also ask some additional contextual questions, in addition to these fundamental items. These most commonly address copresence (who the respondent was with) and location. A diary day may start and end at any time, but 4AM is a common standard because respondents are likely asleep at that time.

Beyond these core features, researchers must make a number of decisions about the design of the diary and how the data are collected. Diaries may be interviewer-administered or self-administered, prospective or retrospective, pre-coded or open-ended, paper or electronic. Each of these decisions is likely to influence the data the respondents provide, whether for social, psychological, or technical reasons (Jans, 2008).

The diaries I compare are essentially "mode packages" rather than modes; they differ on many features. The features of each are shown in Table 6. Below I describe the tradeoffs, and how the features might be expected to affect results, based on time diary and mode effects research.

Table 6. Features of Diaries Tested

	Mobile diary	Interview
Administration	Self-administered	Interviewer-administered
Timing	Prospective (same day)	Retrospective (previous day)
Format	Light (checklist with 25–30 activities)	Open-ended; activities coded later
Medium	Smartphone	Paper
Simultaneous activities	Multiple simultaneous or overlapping activities possible	One main activity only

2.1.3 Expected Effects of Diary Mode Choices

2.1.3.1 Administration

Diaries may be self-administered, interviewer-administered, or some combination such as self-administered in a group setting with supervision or assistance. Children in a classroom setting, for example, could complete individual diaries under the direction of the researcher (Thummalapally et al., 2014; Fisher & Gershuny, 2013). The first part of the Day Reconstruction Method consists of the respondent listing their activities independently; this is followed by an interview (Kahneman et al., 2004).

The main problem with self-administered instruments in development settings is the cognitive burden for respondents. The cognitive burden for self-administered diaries can be quite high; even the simplest time diary forms tend to be complex and require training to use. The longer and more complicated a survey is, the greater the likelihood of item non-response and early termination (Bowling, 2005). Unit non-response (where the sampled individual does not participate) and early termination (where the sampled individual does not complete) are generally higher in self-administered than in interviewer-administered surveys. Self-administered diaries are also subject to

measurement error even when the respondent answers all of the questions, due to different understandings of instructions and response options.

Practiced interviewers can probe for commonly forgotten activities or sequences that do not make sense (e.g. eating breakfast at home and being at school without traveling in between). Stewart and colleagues (2016) in New Zealand found that children could easily remember routine activities on their journey to and from school, but were more likely to forget irregular stops along the way unless prompted. Although Daum and colleagues' respondents corrected less than 1% of their diaries, researchers from the Ohio State University's Adolescent Health and Development in Context study said that respondents very often corrected activities when they reviewed them with the research team (Boettner, 2016).

Research on mode effects in health surveys has found that self-administered questionnaires may be less subject to social desirability bias than interviewer-administered (Bowling, 2005).

2.1.3.2 Timing

Retrospective diaries about the previous 24 hours are most common because prospective diaries are only feasible if self-administered. Retrospective diaries are subject to recall bias as the respondent must remember all their activities. It is difficult to assess the magnitude of recall bias as there is no objective record against which to measure. (Observation would introduce other biases.) Studies of diary reliability in which individuals complete multiple diaries over time have found that retrospective diaries are most reliable for activities where external organizations structure the hours—for example, in paid labor or school (Juster, Ono & Stafford, 2008). Recall bias is generally accepted to be higher for infrequent activities, short activities, and those of low salience

or unimportant to the respondent (Seymour, Malapit & Quisumbing, 2017). The shorter the recall period, the less time there is for the respondent to forget.

2.1.3.3 Format

Diaries may be "light," offering a limited list of categories to choose from, or ask the respondent to list each activity in their own words. The interviewer or other researcher later codes open-ended responses. Self-administered diaries are more likely to be light in order to take up less space and require less writing. A light paper diary might fit on a single sheet of paper. With open-ended text fields, respondents may give shorter written responses than if they are speaking (Jans, 2008). In a diary study among UK secondary students, Walker et al. (2009) found that some respondents were reluctant to record information either because they had limited literacy in English or were embarrassed about their handwriting. Without sufficient detail, it may be difficult for researchers to later classify open-ended responses. While lists of activities reduce the need for typing or writing by respondents, and coding by researchers, respondents do not always know what activities fit into which category. Long lists of activities can make important distinctions that are lost if respondents fail to grasp them, or simply fail to read to the end of the list. Researchers can provide instructions but respondents are not as motivated as researchers and might not read the instructions as carefully as we would like. The lighter the diary, the fewer distinct episodes will be recorded, as similar activities are grouped together under one heading.

2.1.3.4 Medium

Both self-administered and interviewer-administered diaries may be paper or electronic. Electronic diaries may or may not be web-based applications requiring a constant internet connection. They may be designed for a computer screen or a handheld device. The larger format allows the user to see multiple questions, episodes, or other features

(e.g. a long list) at once. Smartphone apps generally have one question per screen. Compared to the inconvenience of carrying (or remembering to carry) a paper diary, respondents are more likely to have a phone with them, facilitating real-time completion (Marcano Belisario et al., 2015).

A primary advantage of electronic diaries is the potential to reduce measurement error through validation checks. Soft checks are messages requiring the user to confirm that they meant to do something—for example, enter two concurrent activities, or add an unusually long activity. After confirming, the user is allowed to proceed. Hard checks are those that prevent the user from advancing. Hard checks prevent invalid responses but can lead to user frustration and early termination. Electronic diaries can reduce costs and data entry errors by eliminating data entry as a separate step.

2.1.3.5 Simultaneous Activities

Diaries can record either a single primary activity or multiple simultaneous activities. Depending on the design of the diary, concurrent activities may or may not need to be coterminous (starting and ending at the same time). More and more surveys are including concurrent activities, as multitasking is common, particularly among women. If a single activity or hierarchical[5] format is used, it is necessary to have rules about how to prioritize. For example, the developers of the Multimedia Activity Recall for Children and Adolescents tool are primarily concerned with exercise and obesity, so their order of priority is: physical activity, screen time, active transport (foot, bicycle or scooter),

[5] A hierarchical format would have a primary and a secondary activity, with the secondary activity often not analyzed. A non-hierarchical format simply has activities at the same time, with no distinction of importance.

passive transport, and then any other activities (Ridley, Olds & Hill, 2006). It is easier to train interviewers to adhere to such rules than respondents.

In interviews, some respondents spontaneously list multiple activities and others need prompting. Self-administered diaries will therefore vary in the frequency with which multiple concurrent activities are reported.

2.1.4 Desirable Characteristics of a Mobile Diary App

Based on the literature and my previous field experience, I sought the following characteristics in a mobile diary app.

1. **Streamlined input:** Although as researchers we always want to know more, I chose to ask for as little data as possible and concentrate on quality. Therefore we would only ask for start and end time, and activity; no contextual questions.
2. **Pre-populated list of activities:** To minimize the effort of entering each activity, we would have a light format, with a locally-adapted list of activities for each site.
3. **Multiple concurrent activities:** As adolescents frequently multitask, I chose to allow multiple activities, with no hierarchy or validation rules for which activities are compatible or incompatible. Indeed, any time we tried to think of examples of two impossible concurrent activities, we almost always thought of an exception.
4. **Flexibility of when to add activity:** Although the ideal would be for respondents to record end and start times immediately whenever they changed activities, I was not confident they would always do so. They might forget or they might not always have their phone with and turned on—for example, at

school or somewhere they thought it might get lost or stolen. I did not want to miss activities for those reasons, so respondents could add activities at any time, even in advance.

5. **Ability to review and correct:** I expected respondents to make typos and also to make errors of memory (they made both of these types of errors in training sessions) so it was important that there be a possibility to correct.
6. **No connection needed:** Given the expected connectivity issues, the app needed to operate without cellular or internet connection, and store data on the phone. This made tools like Google Forms not an option.
7. **Remote syncing of data:** The ideal self-administered tool would not require a visit to transfer the data if respondents were using their own phones. Remote syncing allows the research team to monitor submission of diary data, if respondents upload periodically throughout the day.
8. **Data format:** In order to be useful to other researchers, the app should produce a simple data file in a versatile format such as .csv.
9. **Open source:** Other researchers should be able to access the app at no cost, and build on the app or adapt it to their populations.
10. **Clear visual display:** A simple, clear display would allow respondents to see clearly what they had recorded and recognize any errors or gaps between activities.

At the time I began the study, I could not find any satisfactory app. I hired the Artificial Intelligence and Data Science Research Group at Makerere University to develop an app for me, combining the time diary as well as GPS tracking for another part of the study.

Solomon Nsumba did the programming. The code for the app is available at https://gitlab.com/snsumba/mobility-study-app

2.1.5 Activity Categories

For Guatemala, we adapted categories from surveys with adolescents in Peru (Young Lives, 2013) and adults in Mexico (INMUJER, 2010). They correspond fairly closely with those used in surveys of adolescents from Canada (Hilbrecht, Zuzanek & Mannell, 2008) and Ireland (Hunt et al., 2014) but have more types of work and fewer types of entertainment.

For Brazil, we began with the Guatemala list. During the interviewer training, the research team adapted the list. We then did a group free listing activity as part of the pre-test at the first school to ensure that the categories were exhaustive and mutually exclusive, and used the correct vocabulary. The Brazilian list had most of the same categories as Guatemala, plus more leisure activities, as shown in Table 7, below.

Table 7. List of Activities and Domains

Domain	Guatemala	Brazil
Personal	Personal hygiene, eat, sleep, medical care, rest without doing anything else	Personal hygiene, eat, sleep, medical care, rest without doing anything else
Family, religious	Family visit, religious activity, community event	Family visit, religious activity, volunteer work
Sport, exercise	Sports, dancing, physical activity	Sports, dance, physical activity, active transport
Social, outings	Hang out/talk with friends	Hang out with friends, boy/girlfriend, go to park, sports club, public place like shopping mall or bowling alley, party, concert, wander around with no particular destination
Phone, screen	TV, videogames, internet, text/talk on phone, social media	TV, videogames, internet, text/talk on phone, social media
Music, art, read	Read, listen to music	Arts, play music, listen to music, read
School	School, study outside of school, travel to/from school	School, study outside of school, travel to/from school
Cook, housework, care	Go to mill to grind corn; build a fire, cook, make tortillas; domestic chores other than food preparation (e.g. wash dishes, laundry, clean); take care of children or adults	Cook; domestic chores other than food preparation (e.g. wash dishes, laundry, clean); take care of children or adults
Chores outside	Shop for family, family chores outside (e.g. collect firewood)	Shop for family, family chores outside (e.g. pet care, wash car, garden)
Paid work	Work for pay or for non-family members, embroidery	Work for pay
Other		Motorized transport

2.2 Methods

2.2.1 Settings

My research sites are both in Latin American countries but in other respects offer strong contrasts. Data collection was conducted in Guatemala in late 2017 and in Brazil in late 2018.

Brazil is the largest country in Latin America and one of the most urbanized. It is a middle-income country with a multi-racial population. Belo Horizonte, the third-largest metropolitan region in the country, has a population of over 5 million. In the 2010 census it was approximately 40% white, 10% black and 48% mixed race (IBGE 2010).

The study respondents were students at two public schools in the municipality of Belo Horizonte. One was a local school in a low-income neighborhood and the other was a magnet school. The magnet school had lottery-based admissions and the student body included all socioeconomic levels, but with a much higher proportion of higher socio-economic status (SES) children than most public schools. The quality of education was considered to be more on the level of private schools, and parents had higher education levels on average than parents from most local public schools. Students were in grades 7 through 10. Approximately 75% of respondents from both schools owned their own smartphones.

The Guatemala sample came from two villages in Sololá department, several hours by public transportation from the nearest city. Their living conditions were much more basic than the Brazil sample. Respondents were all indigenous Kiché. The study took place during the summer holidays but most respondents were planning to continue in school the following year, enrolling in grades 4 through 8. A few had stopped school after the 6 years of primary. All could speak, read and write in Spanish, their second language,

but with varying levels of proficiency. Many families had a cellphone but the respondents did not, so we provided them with one for the week of the study.

2.2.2 Sampling

The samples were purposively selected to offer a contrast in SES, urbanization, cultural background, literacy and experience with technology, with an emphasis on those with limited resources and high social vulnerability, as these groups are most likely to be missed by research. The samples are not representative of their countries nor even local areas, but they have characteristics in common with many populations in LMICs and thus we can expect many similar issues and challenges in other low-resource settings.

In Guatemala, we first selected four villages that were part of an adolescent girls' empowerment program called Abriendo Oportunidades (AO). AO had been implemented by the Population Council for one year and was on hiatus as it was being transferred from Population Council to local NGO Red de Mujeres Indígenas, REDMI Aq'abal (REDMI). Thus respondents knew the REDMI staff hired for the research team and were eager to have activities while waiting for AO to resume. Through visits to their homes and speaking to the mother first, we recruited all AO participants in the village, most of whom chose to participate, and brothers, cousins or male friends in the same age range (13–17 years old). We conducted the mobile diary study in the first two villages.

In Brazil, we selected four schools that had previously participated in UFMG research and were willing to continue to do so. We conducted the mobile diary study in the two schools where the administration seemed most interested, as it required much more contact time with the students. Administrators in each school invited 30 students to participate, evenly divided between genders and classes in the right age range. Interested students volunteered and the teachers selected (in an unknown manner) from the

volunteers. We explained the study to these students and gave them consent forms to bring home. Those who wanted to participate, and brought the signed consent form by the designated date, were enrolled.

This chapter reports on only the two schools and two villages that did both the mobile diary and the interview. Chapters 1 and 3 describe findings based on interviews from all four villages and all four schools.

2.2.3 Study Design

All respondents were assigned to do both the mobile diary and interview, on different days. The original design of the study was to collect diaries on one weekday and one weekend day, and conduct interviews about the same days of the week during a separate week. I planned to randomize half the respondents to do the mobile diary the first week and half the second, in case there were order effects.

The logistics of fieldwork required some changes, including abandoning the randomized order. These changes are summarized in Table 8, and described below. In both countries, the first interview took place before the first mobile diary day so that we could install the app and train respondents on the first interview day.

Table 8. Study Design as Planned and Implemented

Planned	**Changes in Guatemala**	**Changes in Brazil**
Study period: 2 weeks per site	1 week per site	As planned
Order: Randomize order of mobile diaries and interview	Interview – mobile diary – mobile diary	Most assigned to interview – mobile diary – mobile diary – interview
Mobile diaries: 1 weekday, 1 Saturday	As planned	As planned
Interviews: 1 weekday, 1 weekend day, conducted on following day	Interviews: 1 weekday or Saturday (during school holidays)	Interviews about Saturday conducted on Monday (2 days after); weekday interviews as planned
Respondent training: interactive group session on activity categories, hands-on practice with app	As planned	Brief review of activity categories, hands-on training as planned
Phones: Provide phones to participants	As planned	Most had own phones; only provided phones to those who did not
Support: WhatsApp, in person if needed	More in-person visits needed	Most support via WhatsApp but in-person visits needed to encourage completion
Reminders: messages every few hours on mobile diary days	Several messages per diary day	Several messages per diary day, and on subsequent days for those who did not submit a diary

In Brazil, we followed students for two weeks or more and so could designate separate Saturdays for the mobile diary and interviews. For comparability, we assigned the mobile diary for the same day of the week as the interview. However, some students were not able to meet with us on the interview day, so we interviewed them another day. Many did not complete the mobile diary on the designated day and we asked them to complete it on other days. The exact day depended on when we were able to communicate with them

either in person or via phone or text, and also when they finally decided to do it. Therefore the weekday diaries and interviews are not on the same day of the week, except by chance.

A further difference is that the interviews about Saturday were conducted on Monday. This was because we could only meet the respondents Monday–Friday. The initial plan was to interview them on a Monday about the Sunday (and also have them do the mobile diary on a Sunday). Because of a series of unusual events on Sundays (two national elections and two all-day national exams), we decided to interview them Monday about the Saturday, and also assign the mobile diary for a Saturday.

In Guatemala, respondents only had phones for one week. Providing a teenager with a smartphone and data credit is guaranteed to change their behavior. To maintain comparability of activity patterns, we also had to interview them that week. This left us one Saturday. We assigned the mobile diary for the Saturday as the mobile diary was the innovation being tested against the standard interview.

2.2.4 Procedures

The study was approved by the Princeton University Institutional Review Board for each country separately (Protocol numbers 10160 and 10620). In Brazil, it was also approved by the UFMG Comitê de Ética em Pesquisa (Research Ethics Committee; CAA 95214318.6.0000.5149, Parecer Consubstanciado de Nº 2.929.372). In accordance with ethical standards, we obtained parental consent and adolescent assent for participation (Schenk & Williamson, 2005). Respondents were told they could opt out of any portion of data collection they chose.

I was present for most activities and assisted the local team with mobile diary training, but local researchers conducted all interviews in the respondents' native languages

(Kiché in Guatemala and Portuguese in Brazil). The research team in Guatemala were staff members of REDMI and previous staff members of the Population Council. All were from Sololá department and two were from the two study villages. The research team in Brazil were students or graduates of UFMG in demography or economics. Most were most were graduate students; two had doctorates.

2.2.4.1 Interview

Interviewers visited each respondent at home or at school to record all of their activities from 4AM the previous day to 4AM that day, in 15-minute increments. Activities were recorded as described by respondents and then grouped into categories matching those used in the mobile diary app. (See Table 7, above.) The interviewer first asked what time the respondent woke up and what time they ate meals. Such "anchor points" help reduce the cognitive burden on respondents because these activities are often done at regular times. Interviewers then proceeded to record all of the respondent's activities in sequence, asking about the start time, end time and length. When respondents had difficulty estimating times, the interviewers prompted them with the above anchor points or others, such as TV programs shown at regular times. After listing the activities, the interviewer returned to the morning and asked any relevant contextual questions.

The interviewers recorded the activity in the words of the respondent. For the Guatemalan interviews, I did the data entry and coded the activities into the categories used in the mobile diary. I discussed some doubts with the local research team and with Population Council researchers. The Brazilian interviewers entered the Brazil data, and one research assistant reviewed the database against each paper questionnaire and corrected any errors. One member of the research team and I each coded the activities using a list of codes adapted from the 2016 update of the United Nations International Classification of Activities for Time-Use Statistics (ICATUS) to make it comparable with

other time use studies and the mobile diary categories. We discussed any differences in the codes and together agreed on the correct classification.

2.2.4.2 Mobile Diary

As discussed above, self-administered instruments can be challenging for respondents to understand and complete, so we planned several training sessions.

In Guatemala, almost none of the respondents had their own phone, and many had never used a smartphone. To get them used to the phone and the functionalities we wanted them to be able to use (WhatsApp to communicate with us, taking screenshots to share difficulties they were having, the calendar to practice entering start and end times), we did an introductory activity the week before the study started. It was a sort of scavenger hunt where they had to find different things in the community and record them—for example, they had to take pictures of a medicinal plant and the youngest baby in the village, find someone who had done a sport that week and enter it into the calendar, and send us a screenshot of the remaining battery life. Because they had fun with this activity, respondents were eager to do the mobile diary and were generally enthusiastic about the study.

We did a separate hour-long training on the activity list, to teach respondents what belonged in each category. In small groups, respondents wrote down activities on post-it notes. They then stuck these into what they thought were the correct categories listed on large sheets of paper hung on the wall. Reconvening the full group, we all discussed whether the activities were assigned to the right category or whether they should be moved. We also gave each respondent a handout with all the activities listed along with examples, and another with instructions for adding and correcting entries, and syncing data. These “simple” instructions were too complicated, so in Brazil we gave respondents tutorials using screenshots.

In the neighborhood school in Brazil we attempted the same group activity to teach the categories, but the setting was somewhat chaotic with respondents arriving at different times, so some benefitted more than others. At the magnet school, we did not have time for the activity at all, but gave respondents the list of examples that we quickly reviewed with them as they installed the app. We felt more comfortable doing this at the magnet school because of the higher educational standard but still would have preferred a more interactive training.

Respondents were instructed to fill out the self-administered time diary as often as they could on the designated day, or at least every few hours. We instructed them to review their activities at the end of the day to see if they had missed anything, and to add or correct activities as needed. We sent them several messages on WhatsApp throughout the day, as well as the night before and the morning after, reminding them to add activities. The diary had a reminder alert that could be set to beep at a selected interval, but we turned it off in favor of more personal messages. In Guatemala, we also visited many respondents at home to make sure they remembered how to fill out the app. By early afternoon, none that we met had added any activities before our arrival.

2.3 Results

The goal of this study was to determine whether a self-administered smartphone diary could feasibly and affordably replace interviewer-administered recall survey for collecting 24-hour time data from adolescents in two low-resource settings. In their Cochrane review of self-administered survey questionnaires using mobile apps vs. other methods, the primary outcomes Marcano Belisario and colleagues (2015) sought to measure were response rates, data completeness, data accuracy and equivalence of responses. I attempted to measure the same.

First I compare the response rate for mobile diaries (proportion who submitted any diary and both diaries, and who submitted a "full" day consisting of 12 hours of activities excluding sleep). and compare that to interviews. Next I describe the most common types of errors in the diaries. I then assess the quality of the diaries using various measures of completeness: time with any activity recorded; start and end time of diary day; and number of activity episodes. I conclude by comparing the amount of time spent on different activities as measured by the two methods.

Because the sample sizes are so small, I present results only by country, not by age or gender. There is no theoretical reason to expect the results to differ by gender, or by age within the range of 12-17. While I cannot support any differences statistically, the main differences I noted between younger and older respondents were that the younger respondents, and those with the least phone experience, paid the most attention to instructions and made the greatest effort to do the mobile diary correctly.

2.3.1 Coverage

Table 9 shows the number of respondents of each age and gender by country. In both countries, I aimed to recruit a sample of half boys and half girls, but more girls were willing to participate than boys.

Table 9. Sample Size

	Installed app and completed interview		Submitted any mobile diary data	
	Guatemala	**Brazil**	**Guatemala**	**Brazil**
Total	43	38	24	32
Girls	22	21	14	20
Boys	12	17	10	12
12-14	31	25	12	19
15-17	12	13	12	13

The interview response rate was 100% for one interview in Guatemala and 95% for both interviews in Brazil.

Of the 81 respondents who installed the app, 25 did not submit any mobile diary data, yielding an overall response rate of 69%. A few had problems with their phones that resulted in the diaries being erased, and one Brazilian girl reformatted her borrowed phone before syncing her diaries, but most did not give any reason for non-response.

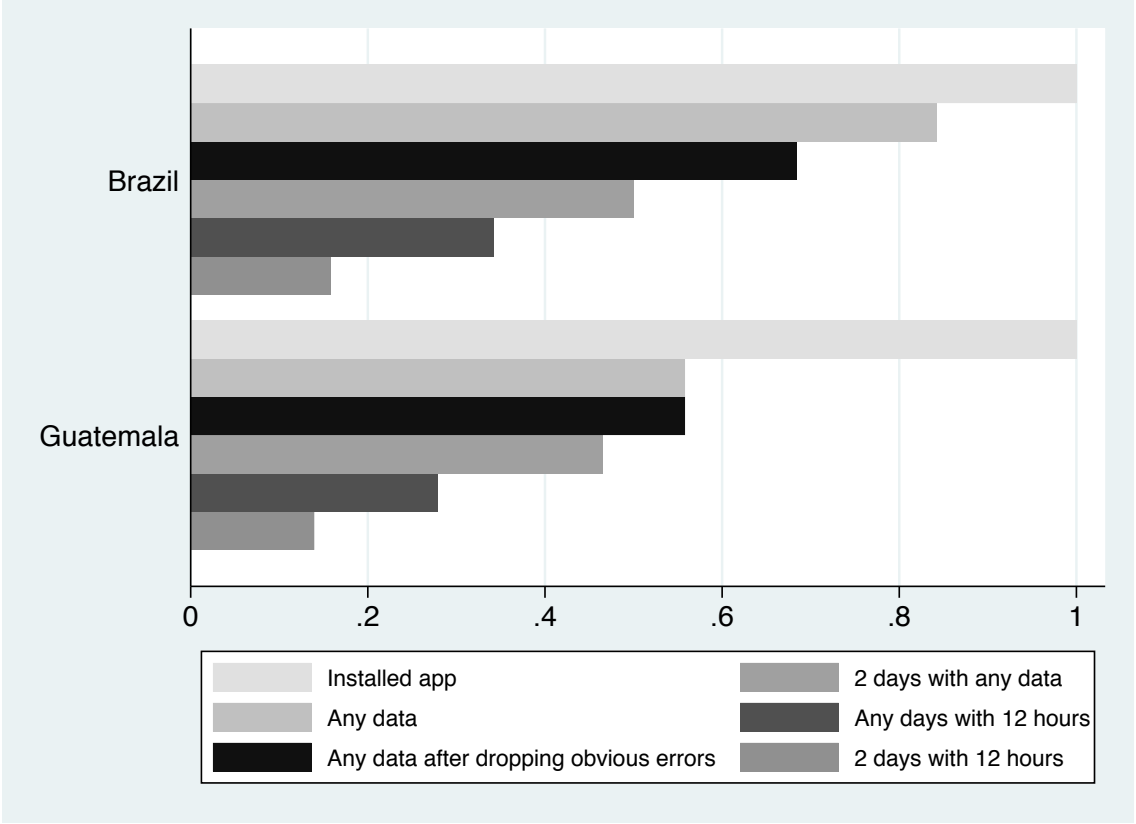
Figure 8 shows the proportion of respondents whose diaries met criteria of quality and completeness, out of those who installed the app. We considered diaries with 12 hours of activities accounted for as being complete. Most respondents slept for eight or nine hours, so should have been awake for close to 15 hours on the diary day.

Of those who submitted any mobile diary entries, many did so for more than the designated two days. Some did so because they wanted to, despite knowing it was not required. Others did only a few hours in the morning, and then they recorded a more complete day later. In these cases, I used the most complete day to replace incomplete

days (considering incomplete days as “training days”). After keeping only the longest weekday and longest weekend day per respondent, I ended up with 89 mobile diary days.

Some respondents filled out the mobile diary from getting up to going to bed, which is what we asked for, while others included sleep. I have therefore removed night sleep from most analyses. After I remove nighttime sleep, only about half of respondents recorded 12 hours’ worth of activities for the day, which we would consider the threshold for a “full day.” Of the days with any mobile diary data, 44% had at least 12 hours of data excluding sleep.

Figure 8. Response Patterns for Mobile Diary



2.3.2 Errors in Diary

This study does not allow us to assess the accuracy of either diary mode, but it is possible to identify some definite errors. The most prevalent errors evident were recording multiple unlikely or impossible simultaneous activities, and mixing up AM and PM.

A number of the diaries were of such poor quality that they had to be completely rejected. Figure 9, below, shows the server view for an extract of one such diary. This respondent said they spent 22 hours simultaneously shopping, reading, studying, visiting relatives, on social media, at the doctor, eating, sleeping, etc.

Figure 9. Rejected Mobile Diary

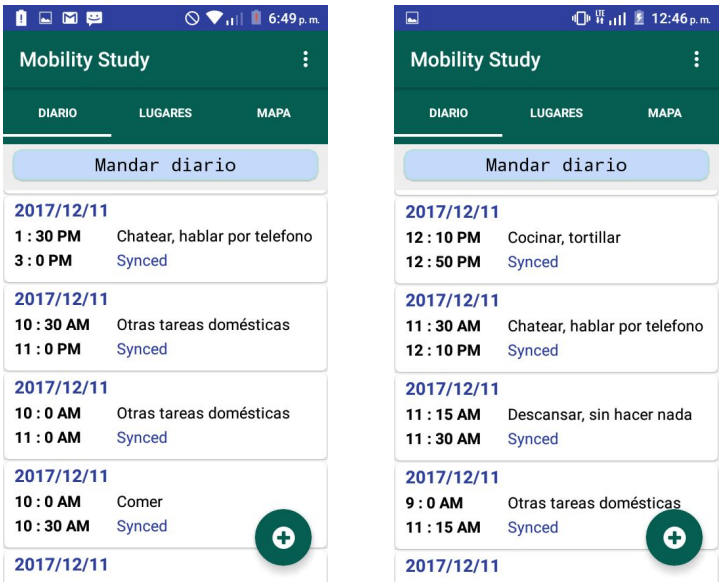
No.	User	Date	Start Time	End Time	Activity
1	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Compras para familia
2	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Ler
3	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Estudar fora da escola
4	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Visita familiar
5	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	TV, videogames, internet
6	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Midias sociais/falar ao telefone
7	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Consulta médica
8	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Comer
9	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Higiene pessoal
10	Harry Potter	2018/10/06	11 : 32 AM	9 : 35 AM	Dormir

Figure 10 shows less extreme examples of several types of errors. In the screenshot on the left, it appears that the respondent wanted to correct the start time for the third activity block from 10AM to 10:30AM; they were eating (*comer*) from 10:00–10:30 and probably started doing housework (*tareas domésticas*) at 10:30AM and finished at 11:00AM and not 11:00PM. In cleaning the data for this diary, I removed the 10–11AM episode and coded it as an error. I changed the 10:30AM–11PM episode to 10:30AM–11AM.

Following this, there is no activity from 11:00AM to 1:30PM. (If the respondent entered activities out of chronological order, they remain out of order. This flaw in the app likely contributed to some user error, or at the very least made it more difficult to spot errors, though the respondent could scroll through all activities recorded.)

Guatemalan respondents had more days with AM/PM errors than Brazil, as shown in Table 10. In Guatemala, I initially set phones up with a 24-hour clock. The field team said Guatemalans do not use 24-hour time so we switched the phones to AM/PM. However, judging by the number of inconsistencies I think perhaps most respondents do not understand AM and PM but rather the difference between, for example, 7 in the morning and 7 at night. In Brazil, most respondents used their own phones, so their time settings were whatever they customarily used. Many of the AM/PM errors in both countries involved the hours of 12 noon or 12 midnight.

Figure 10. Sample Time Diary Extracts with Errors(Left) and without (Right)



Several respondents listed only one or two time intervals spanning the day and recorded many activities during this time. It is impossible to be certain whether they did these activities but misunderstood the time function, or whether they just entered activities arbitrarily. For at least some (as in Figure 10, above), I suspect the latter. I flagged these as "obvious errors" and report them in the bottom section of Table 10, below. I also removed them from all analysis and counted the time as missing. For several respondents (8 in Brazil and 1 in Guatemala), this required dropping all of their diary data.

There were also many situations where simultaneous activities appeared incorrect, but I was not sufficiently certain to delete them. In some cases, several activities recorded as concurrent were probably done in sequence—for example, a two-hour interval consisting of cooking, eating and using the phone. While it is likely that the respondent was using the phone while cooking and/or eating, I expect that they probably first cooked and then ate rather than doing both simultaneously for 2 hours. If the combination of activities seemed credible and the activities were things they likely did in sequence or alternation rather than simultaneously (e.g cooking, eating, washing up; doing homework and texting friends; playing videogames and using social media), I divided the time between the activities. If they were things that they could do simultaneously, I designated one activity as primary and the other as secondary. For listening to music while riding the bus, for example, listening to music would be secondary and riding the bus primary, as riding the bus is the essential activity.

Table 10. Errors in Diaries

	TOTAL	Guatemala	Brazil
AM/PM errors			
% of **episodes** with any	8%	12%	5%
% of **days** with any	31%	43%	27%
Mean (SD) number, per diary day with any	1.1 (3.0)	5.2 (5.6)	1.8 (1.6)
Obvious errors (e.g. conflicting concurrent activities) needing to be dropped			
% of **episodes** with any	23%	15%	31%
% of **days** with any	50%	45%	53%
Mean (SD) number, per diary day with any	4.6 (4.2)	4.0 (3.6)	4.9 (4.4)

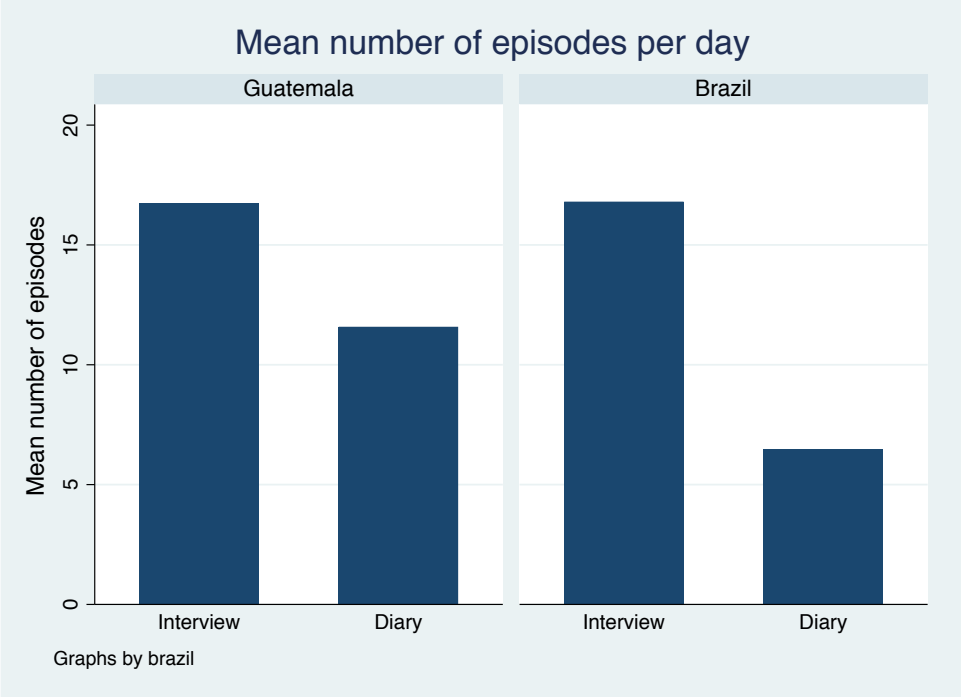
If a single activity was recorded for a time interval, I did not assess how likely it was to be true, unless it was for an excessively long time. For example, if a Brazilian respondent only recorded one hour of school, I did not flag that as an error. Even if an activity went on for a long time, there were few instances where I could say confidently that it was an error. Eating or personal hygiene normally would not take more than an hour but most other activities could be done for any length of time. Interview respondents in Brazil reported going to parties or events for many hours, or spending much of Saturday watching TV or using their phones.

2.3.3 Number and Timing of Episodes

In theory, completing a mobile diary in real time should encourage respondents to record more activities of short duration that they would likely forget about by the following day. If this were the case, diaries would have more episodes per day than interviews. Instead, the opposite was true (once poor-quality entries were excluded): the

mean number of interview episodes in both countries was 17, much higher than the mean of 12 (SD=6.3) for diaries in Guatemala and 6 (SD=3.4) in Brazil. See Figure 11. These differences were both significant ($p<0.001$) in independent samples t-tests. The much lower mean for Brazil is mostly due to the high level of errors.

Figure 11. Number of Episodes per Person-Day

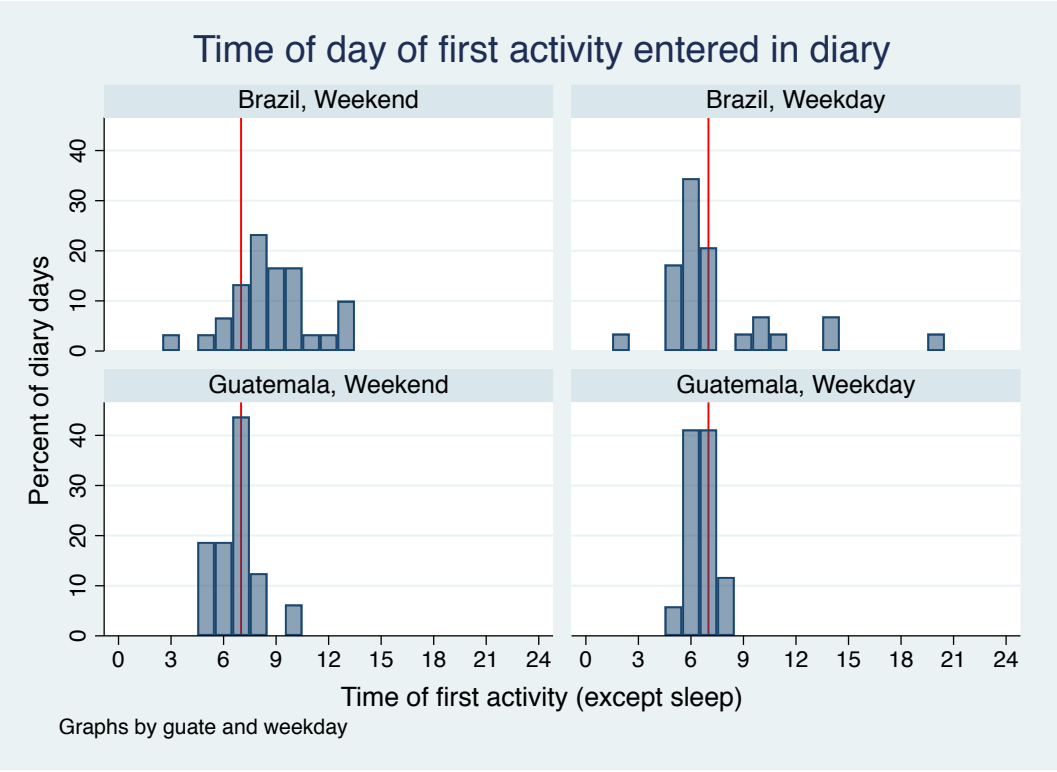


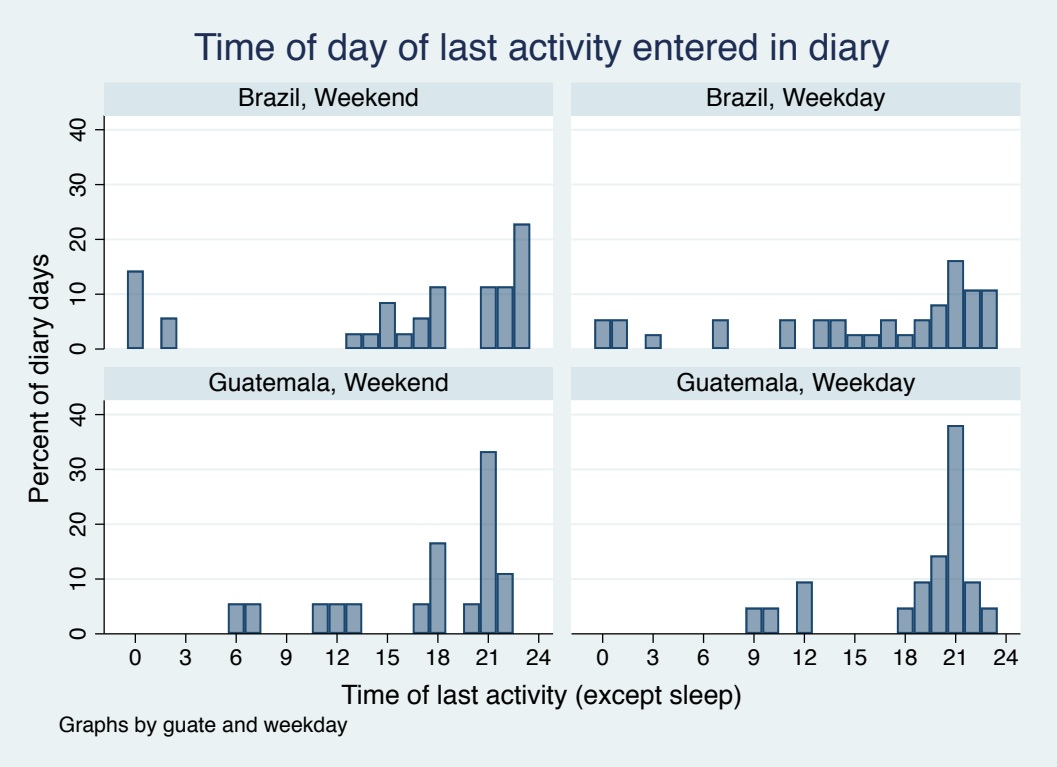
Another measure of completeness is the timing of the first and last episodes. Respondents were supposed to record from their time of waking to sleeping[6]. Figure 12, below, shows the distribution of the time of day of the first and last recorded activity, separated by day of the week. The timing of the first activities in both countries was generally consistent with waking times reported in the interviews: early on weekdays in

[6] Some also included sleep but I have removed it.

both countries and on weekends in Guatemala, with times extending to around noon on weekends in Brazil. The timing of the last activity recorded was much more varied, particularly in Brazil. This can be attributed to declines in both adherence to completing the mobile diary at all, and to a higher rate of errors or conflicting activities later in the day that were deleted. This is consistent with findings that structured activities (chores or work in Guatemala, school in Brazil) are recorded more reliably than less-structured activities. Most structured activities took place early in the day.

Figure 12. Timing of First and Last Diary Entry





2.3.4 Differences in Time Use by Mode

The overall mean time reported on the mobile diaries[7] was approximately 11 hours, compared to 15 hours for interviews. The mean time for each activity domain was therefore generally higher for the interview, as shown in Table 11. The only exceptions were family and religious activities, and in Guatemala, outside chores and paid work.

Table 11. Mean Daily Time (in Minutes) by Activity Domain

	Guatemala					Brazil				
	Diary n=41		Interview n=27		Difference (%)	Diary n=42		Interview n=62		Difference (%)
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Personal excluding sleep	118	88	172	61	**31%**	94	124	165	108	**43%**
Family and religious activities	77	83	72	112	**–7%**	33	95	25	81	**–32%**
Sports and physical activity	11	38	35	75	**69%**	28	63	33	86	**15%**
Social and outings	34	51	45	67	**24%**	61	122	131	205	**53%**
Phone and screen time	95	85	159	107	**40%**	162	219	227	193	**29%**
School						173	200	253	251	**32%**
Cooking, housework, care	79	92	138	158	**43%**	27	61	53	88	**49%**
Chores outside, paid work	170	207	155	205	**–10%**	11	74	25	79	**56%**

[7] Among the longest 2 diary days. Among all days submitted, the mean was 10 hours.

2.3.5 Contact Time with Research Team

In neither country did the app reduce face time with respondents. Although respondents could quickly learn to enter an activity during individual or group training, many in both Guatemala and Brazil had forgotten how to do it by the time we visited several days later. More important, though, was the time needed to train on the activities list, and the time to remind and encourage respondents to fill out the diary at all. Some responded to group WhatsApp messages but others required individual messages, phone calls or even visits. When these are taken into account, the mobile diary did not take less staff time than the interview, nor even reduce travel. The mobile diary also involved increased costs in terms of incentives (phone credit) in both countries, and equipment in Guatemala. It is possible that asking for more diary days per person would yield better quality diaries at a similar cost, but it is also possible that response rates would drop as the novelty of the tool wore off.

2.4 Discussion

A smartphone app to collect self-administered time diaries, completed in real time and possibly even submitted remotely, has the potential to make time use research more affordable and less subject to recall bias than an interviewer-administered retrospective survey. I found that a smartphone diary was acceptable to respondents with and without smartphone experience, but fewer respondents actually submitted a diary than did the interview. Diaries that were submitted were also less likely to be complete: while all interviews had a full 24 hours of activity data, only one-third submitted even one diary with 12 hours of credible activities recorded (out of a maximum of approximately 15 waking hours). The Multinational Time Use Survey consider 90 minutes to be the maximum amount of time unaccounted for, and seven the minimum number of

episodes, for a diary to be considered of adequate quality (Fisher & Gershuny, 2013). One-third of Guatemalan mobile diaries and half in Brazil had fewer episodes than seven. All of the interviews surpassed both thresholds. “Light” diaries, where activities have a limited number of pre-coded categories, generally have fewer episodes than diaries with open-ended responses as they potentially aggregate similar consecutive activities into a single episode (Chatzitheochari et al. 2018), but this should not be the case in my study; the interviews were coded into the same categories.

Most respondents began their mobile diary when they got up in the morning but activities later in the day were less likely to be recorded and/or more prone to errors. The most common errors identified were mixing up AM and PM, and recording unlikely concurrent activities. Brazilian respondents were much more likely to record concurrent activities, both correctly (e.g. riding the school bus, listening to music and eating a snack) and incorrectly (doing paid work while at school). Some respondents clearly did not understand how to—or did not want to—do the mobile diary correctly, but it seemed that most errors were things that could be prevented with a combination of hard and soft checks. Chatzitheochari et al. had a soft check on any activity longer than three hours that was not sleep or school, for example, and a hard check on any time interval that did not begin when the last ended.

My study, conducted in late 2017–2018, demonstrated that a self-administered smartphone diary app is acceptable to adolescent respondents in two very different LMIC settings and is feasible to implement, but had some weaknesses in terms of completeness and quality assurance. A number of these weaknesses could be addressed with some changes to the app, while others would require changes in the interpersonal part of the fieldwork, in particular training and supporting respondents.

In terms of app design, I recommend the following:

1. Unlimited simultaneous activities should not be possible. Researchers should consider what they want to know about and what is most relevant in their setting when deciding how to limit activities. Daum et al. (2018) had a maximum of three concurrent activities. Other studies ask for a single primary activity and then whether or not specific other activities are taking place simultaneously. An app should have some hard limit (three activities seems reasonable) as well as a soft check message that multiple activities are being recorded, allowing the respondent to deselect one of the activities if they chose it by mistake.

2. There should be a simple way for respondents to correct their own errors or to retrospectively add or delete activities. Daum and colleagues (2018) found their agricultural families were diligent about starting and ending activities in real time, but I doubt this level of compliance could be replicated in most settings. The Adolescent Health and Development in Context study at Ohio State University had a prompt to adolescents to record a new activity any time their GPS location changed, but still they had very high rates of respondents changing activities or locations when reviewing their time-space budget with a research assistant at the end of the week (Boettner, 2016).

3. The app should be visually clear and simple to help respondents spot errors. Activity blocks should be displayed in chronological order, regardless of the order they are entered, and there should be a clear gap marked whenever there is a block of time without an activity. Daum's Time Tracker app does this well.

4. A better visual layout might help with the AM/PM issue. Also helpful would be a hard check preventing the end time from being before the start time, and a soft check if the duration were too long.

5. Some feedback to the user such as summary statistics might be interesting for the respondent and possibly aid them in recognizing errors. The MARCA software automatically calculates a few statistics such as minutes active and energy expenditure. Totals of activity time, or numbers of meal/snack times, might also be interesting to respondents. On the other hand, they might encourage social desirability bias, as anyone who has ever cheated on a food diary can attest.
6. The app would ideally be available from the Google Play store or other source where respondents can easily find it to reinstall if needed. Our app was not there. This was not a problem in Guatemala, as we usually had to visit in person respondents who had a problem with the app, but it would have made providing remote support a bit simpler in Brazil.
7. Be cautious of "feature creep," or adding too many new features or questions.

In terms of non-technological aspects of diary implementation, I recommend:

1. Make sure to adequately train respondents. Our more experienced respondents were easily able to manage the functions of the mobile diary but less attentive to instructions about activity categories, compromising data quality. Even communicating which days they were supposed to complete the mobile diary was difficult.
2. Recognize that a self-administered diary, even a simple one, requires more motivation to complete than an interview. The Guatemalan respondents were much more careful about doing the mobile diary correctly. They made some errors with start and end times, but did not seem to completely misunderstand the mobile diary, as did some Brazilian respondents. Our respondent pool in Guatemala was very different from that in Brazil, not only culturally. The

> Guatemalans joined the study through a program they participated in during their free time and enjoyed. They also valued highly the reward of getting a phone for a week. The Brazilians were participating as a school activity, and approached the activity more as homework. Some did it and others did not, and those who did it invested different levels of effort. We gave all the Brazilians phone credit as an incentive for participating, but those who borrowed phones seemed more committed to the study and to meeting our expectations than those who used their own.

Apps will require more support in low-resource settings than in high-income countries or among the educated middle class. Smartphones are ever more common, but even in urban Brazil, 20% of our respondents did not have one. Ownership will be still lower in certain populations, especially the most marginalized. Our Guatemalan respondents were eager to commit to doing diaries in exchange for a week with the phone, but not all of them submitted a mobile diary. Importantly, by giving respondents phones, we ensured that one of their activities was using the phone, accessing the internet, social media, etc. Much as with direct observation, by studying their behavior we changed their behavior.

Even with the best app, researchers will need to consider the tradeoff between quality assurance and cost. To ensure consistency in how respondents code activities, it is essential to train them. Educated users who are accustomed to reading instructions and FAQs may be able to self-teach, but many study populations will have limited capacity to do this. Children tend to learn by doing, and some of the creative diaries we received suggest that they do so even when you try to train them.

Interviewers are certainly not infallible, but well-trained, skilled interviewers can improve consistency in coding as well as completeness, and check for common errors.

Although they tested MARCA as a self-administered tool, Olds, Ridley and colleagues now only use it with interviewers. In a personal communication, Olds recommended I do the same. Interviewers can also ask additional questions. There is increasing consensus among time-use researchers that we need better measures of the quality of time, not just activities. Chatzitheochari's app included contextual questions as well—who the respondent was with, where they were, and how much they enjoyed the activity—and Daum's added nutrition questions. But additional questions would require additional training of respondents, and it would be hard to be confident the respondents were interpreting the questions in the same way.

Finally, it is important that time-use researchers share their diary apps. Certainly apps may need to be adapted to different settings and audiences, but starting with Chatzitheochari's or Daum's app and modifying it would likely result in a better app than creating one from scratch. Eurostat's inventory is an important step toward sharing tools and should be more widely publicized. Time use data describes daily life and behaviors and so is of value to many who are not time-use specialists. With a reliable off-the-shelf tool, they would be more likely to collect such data.

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Chapter 3

Multidimensional Measures of Time: An Example with Brazilian Children[8]

3.1 Introduction

We know how to measure some aspects of time use relatively well. The previous chapters have outlined some of the gaps in time use research in LMICs that have to do with reaching neglected populations with existing methods, or refining existing methods (a different mode for a time diary, but still essentially the same time diary). There is broad agreement that diary studies are essential to measure time holistically, detailing a full day's activities, and their sequence and duration (Eurostat, 2019; Hunt & McKay, 2015); that stylized questions are best for infrequent activities and longer reference periods (Seymour, Malapit & Quisumbing 2017; Gershuny 2011); and that experience sampling or ecological momentary assessment (ESM or EMA) is ideal for transient states or activities (Robinson & Gershuny, 2015). However, there is as yet little consensus on the best ways to measure multidimensional aspects of time—that is, related to various aspects of quality of experience in addition to number of minutes—although researchers in Europe and Anglophone countries have increasingly been attempting to do so over recent years.

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[8] An earlier version of this chapter was presented at the International Association for Time Use Research Conference in Washington DC in July 2019. Veronica de Castro Lameira and Vanessa Lima Caldeira Franceschini were co-authors of that presentation.

Why is it important to measure quality of experience along with the activity and its duration? As I show in this chapter, in my study of Brazilian young people I found that the reason for doing the activity and subjective wellbeing experienced during the activity are associated with age and gender, indicating that different demographic groups experience them differently. I further demonstrate that particular activities or activity domains typically used to classify activities do not map directly onto these variables. Therefore, when we only measure the activity done and make assumptions about motivation—school and paid work are always instrumental, childcare is to benefit others—we do not fully capture the experience, and therefore miss gender and other disparities in time use. To reduce the assumptions we make—particularly in the context of studying the lives of people from different cultures or backgrounds—time use research needs to expand beyond lists of activities and routinely include subjective measures (e.g. purpose, value, enjoyment).

Incorporating these measures into time use research is important if we want to detect change over time. Multidimensional measures allow us to better assess disparities in time-related quality of life, by demographic variables such as gender, race or life stage. My research looks at one period of major life changes—a time when children gain increasing independence—but one could imagine asking similar questions about how the increasing population of older adults experiences time as they grow more dependent, or for those still in the labor force who carry the burden of caring for them.

Asking about subjective aspects of time can also help us to identify possibilities for social and behavior change interventions. For example, Gordon and Caltabiano (1996) and others have found that “leisure boredom” is correlated with adolescent smoking. Krueger (2005) notes that people watch a great deal of TV despite low affect ratings. He speculates that perhaps they are tired or TV is easy, but since he did not ask the

respondents why they watch TV, he cannot propose initiatives that might replace a sedentary activity (that people do not even seem to enjoy that much) with something healthier and more satisfying.

In this chapter I describe how I built on the literature to develop tools to operationalize abstract concepts ("motivation" or choice to undertake an activity, and subjective well-being) in a culturally-relevant way, for a specific population that I had not previously worked with—a process that others can easily replicate. I do not offer my approach as a new standard for measuring time. Rather, I assert that subjective measures must be flexible enough to adapt to a variety of populations while still measuring some core concepts, e.g. motivation or purpose, activity-related subjective wellbeing (also called hedonic affect or instant utility or mood), time pressure and control of time. As an example, I present measures that can easily be incorporated into a standard time diary format, the interviewer-administered 24-hour recall survey.

I make two main contributions in this chapter.

1. I demonstrate that measures of subjective meaning (e.g. purpose, value, enjoyment) are associated with age and gender, and that they capture dimensions of time beyond the usual lists of activities; they do not map directly onto the usual broad categorizations of time (such as committed, free and personal) nor even much narrower activity domains. This leads me to the conclusion that motivation and mood measure something distinct from what we learn from knowing the activity alone. Rather than using activity type as a proxy for quality of time (or work vs. leisure, for example), we need to ask the people who are experiencing it.
2. I describe the tools to measure qualitative aspects of time that we created in a participatory process with urban Brazilian youth. We then incorporated these

tools into the standard interview-administered time diary format. Other researchers can use similar processes to adapt our tools or create their own.

3.1.1 Background

Time use researchers have a familiar set of tools to measure what people are doing. They then typically apply their own judgements to categorizing the activities: cooking is housework, exercise is leisure, bathing is a necessity. A number of international initiatives in recent decades have attempted to harmonize now-standard diary methods, indicating something of a consensus on how to measure what people are doing when, and with whom. These include the United Nations Statistics Division's International Classification for Time-Use Statistics (ICATUS) and regional initiatives such as the Harmonized European Time Use Study (HETUS) and the Classification of Time-Use Activities for Latin America (CAUTAL). ICATUS and CAUTAL expanded activity codes used in HICs to include types of work more often performed in development settings, such as carrying water, subsistence agriculture, and home production and informal trade. However, all of these systems consist of pre-determined categories defined as work, household work and care, study, personal care, and other non-work activities. Juxtaposing work and leisure makes sense from an economic perspective, but less so as a measure of quality of time. As Krueger (2005) points out, we cannot assume that all work is equally unpleasant and all leisure equally enjoyable, or that activities are always done for the same reason. How people experience time is determined not only by what they are doing, but by a combination of factors including why they do it and how they feel while doing it. To better measure subjective dimensions of time, we need approaches that incorporate the perspectives of the study population. All researchers have biases and blind spots that can affect research results, and researchers working cross-culturally or

with diverse or unfamiliar populations may be especially likely to make incorrect assumptions.

Even studies that purport to measure quality of time often do so based on the researcher's own preconceptions of quality—for example, that interrupted leisure time or leisure in the presence of a child is of lower quality (Floro & Pichetpongsa, 2010; Mattingly & Bianchi, 2003; Bittman & Wacjman, 2000). This may be true, but the converse—that uninterrupted leisure or leisure without children present is of higher quality—does not automatically follow. How people experience time may differ by individual or by other characteristics such as culture. For example, for adolescent girls in rural Guatemala (Hallman et al., 2006), isolation can be a problem and spending more time with others may be considered desirable, whereas in India, adolescent girls are highly monitored and rarely get to spend time alone, so being alone is desirable (Gibby, 2018).

If we are interested in the wellbeing of individuals and populations, we need to be able to measure wellbeing from their perspectives, not an arbitrarily designated researcher perspective. Most attempts to measure multidimensional aspects of time so far address adults in high-income countries. But why would we expect the experience of American or British or Australian adults to be the same as that of youth from Africa or Asia or Latin America? Or that of the youth from urban areas to be the same as for youth from rural areas? Or that of immigrants in a given country to be the same as the native born? Feminist economists and sociologists recognized the need to expand definitions of work to include unpaid work. Development economists advocated for paid work to include informal market work. In much the same way, we need members of the populations that we seek to learn about to contribute to qualitative measures that reflect the diversity of their experience and not just the experience of adults from high-income countries.

There are a range of subjective aspects of time that one might study. From a gender perspective and child/adolescent development perspective, I chose to focus on the concepts of control of time and subjective well-being on an activity basis, as well as overall feelings of time pressure.

3.1.2 Subjective Well-being

Many studies of subjective well-being measure enduring concepts such as life satisfaction. I chose instead to measure what has alternatively been referred to instantaneous utility or hedonic affect—which, for simplicity, I describe here as "mood" —as associated with specific activity episodes.

Although other researchers conducted time use studies measuring subjective well-being before them (Juster & Stafford, 1985), much of the study of affect related to time use in recent years has been based on the work of Krueger and Kahneman. (See e.g. Krueger et al. 2009; Kahneman and Krueger, 2006; Kahneman et al., 2004; Seymour, Malapit & Quisumbing, 2017; Seymour & Floro, 2016; Hendriks, Ludwigs & Veenhoven, 2016; Knabe et al., 2010.) Their Day Reconstruction Method (DRM) measures six feelings: happiness, sadness, tiredness, pain, stress and interest. They combine these ratings to calculate what they call a "misery index." The U-index quantifies the extent to which negative emotions outweigh positive. Studies have found that the U-index for specific activities is not necessarily consistent with life satisfaction, as people rate individual activities and their life in general based on different expectations. For example, unemployed people may engage in many activities they enjoy throughout the day because they have free time, but still have lower life satisfaction than if they were employed (Knabe et al., 2010). As my interest is in how a person felt in the moment of

doing an activity, I find Krueger and Kahneman's approach of measuring activity-related affect more compelling than measuring overall life satisfaction.

3.1.3 Control of Time

An important gender difference among adults is that women often have less control over what they do and when (see e.g. Glorieux, 2018; Folbre, 2009; Mattingly & Bianchi, 2003; Bittman & Wacjman, 2000). For example, children must be fed every day, multiple times, not just when it is convenient. Stereotypical "male" activities such as home repairs or gardening can be scheduled for a weekend. Research in Ireland (Hunt et al., 2014), Canada (Hilbrecht, Zuzanek & Mannell, 2008) and Belgium (Glorieux, Stevens & Vandeweyer, 2005) found similar patterns among adolescents, but to date there is limited research on age trajectories of autonomy in time use in LMICs.

Goodin et al. (2008) use this concept of choice of what to do when as a proxy for freedom. They describe how people who spend a large proportion of their day doing necessary things (as opposed to discretionary) are usually materially and psychologically worse off (or less "free") than those who spend more time on what they classify as discretionary. This argument has value, but it is limited by the way they operationalize choice. The authors assign activities as necessary or discretionary using standard definitions. They call this an "objective" assessment of control of time, but it cannot account for personal preferences, or contextual factors that can make a given activity different: working at a job you love or hate; driving to work in bumper to bumper traffic or walking; walking in the sun or walking on the rain.

And people may still choose to do unpleasant tasks whether or not they want to. There is a difference between choosing to do something because you enjoy it and doing something you may dislike because you think it needs to be done, or because you fear the

judgement or censure of others. A child may do an unpleasant activity because they are compelled or ordered to, because they are being altruistic, or because it will somehow gain them something they want. In the first case, someone else chose how they would spend their time while in the second and third, the child chose for themselves, but their motivation was different: one is for their own gain and one is for the gain of others. Helping others is associated with improvement in life satisfaction (Robinson & Gershuny, 2015), so we might expect it to be associated with improved affect as well.

Worldwide, girls do more housework than boys (Larson & Verma, 1999). Is this by choice? For example, do girls do this work willingly, with altruistic motives? Using a nationally-representative survey (with stylized questions), Villanueva and Aragão (2018) find that while 80% of Brazilian girls aged 13–18 reported doing any housework during the one-week reference period, only 20% of boys did. This raises several questions: Why are girls doing more work (assuming they are telling the truth)? Is it because they are told to whereas boys are not? Do girls feel more responsible? Do they like cleaner homes? How might age relate to various motivations?

A relevant theory for understanding motivation is self-determination theory, or SDT (Ryan & Deci, 2000). It is often used to classify individuals with regard to a single type of behavior, whether that behavior is positive (e.g. sports) or negative (e.g. substance use, leisure boredom). SDT is particularly relevant for youth. As Baldwin and Caldwell state:

> Understanding and measuring levels of motivation for free time activity among youth is particularly important because of the developmental demands associated with autonomy development and the processes of individuation and differentiation that characterize the period of adolescence. The uncomplicated reasons of "I have to, want to, or nothing else to do" evolve into more complex

> and contextual reasons of "I feel obligated," or "If I do this, then I might get [some reward] in the future." (p. 129)

With regard to the housework example, SDT leads us to expect that gender differences among younger children are largely imposed on them by adults, whereas among older adolescents, differences are more the result of girls making a choice that boys do not, whether to help or avoid disappointing others, or because it somehow benefits them.

In the 1980s and 1990s, Glorieux and Elchardus did several time diary studies with Belgian adults on what they describe as the "meaning of time." They use the term "meaning" to describe both what motivates the person and how they evaluate the activity: "If I do this well, it will give me pleasure" or "If I do this well, people will praise my garden" or "If I do this well, my child will be cared for and happy" (Glorieux & Elchardus, 1999). Using several different analytical approaches, they developed a scheme of seven meanings:

1. Time spent out of a sense of duty (internalized values)
2. Time spent to please others and maintain relationships (social alliance)
3. Time spent as an obligation enforceable by others
4. Instrumental time, used as a means to an end
5. Time for physiological gratification or to maintain or improve my body
6. Time for personal gratification
7. "meaningless time," spent to "pass" or "kill" time (Glorieux 2018, slide 11)

Because they wanted to ask respondents about all episodes, they abbreviated these into a "light" set of questions, grouping the first four into "social time" and keeping items 5–7 separate.

3.1.4 Time Pressure

Time pressure is a concept that is relevant to everyone, but the more extreme "time poverty" disproportionately affects women and the poor. Studies of adolescents have found that time pressure increases with age and being female (Hunt et al., 2014; Hilbrecht, Zuzanek & Mannell, 2008; Glorieux, Stevens & Vandeweyer, 2005). On the other hand, poor children (who make up a large portion of my sample) may experience the opposite of time pressure: leisure boredom or lack of opportunities for recreation as well as lack of development opportunities (Baxter, 2011; Gordon & Caltabiano, 1996).

3.1.5 Contribution of This Study

I expand upon other time diary studies measuring multidimensional aspects of time by explicitly asking respondents about their subjective wellbeing and motivation for doing an activity for all activity episodes, and by using age-appropriate, culturally relevant tools developed through an interactive process with the study population.

Studies that measure subjective experience or quality of time are not very common, and many rely on either the experience sampling method (ESM, also called ecological momentary assessment, or EMA) or ask about a subsample of activities in a time diary—often three. The Wellbeing Modules of the 2010, 2012 and 2013 American Time Use Surveys did this, for example, as did the Princeton Affect and Time Survey (PATS) (Krueger, 2009). Nearly all time diary studies with activity-specific affect ratings are based on the Day Reconstruction Method.

Some researchers have adapted the DRM approach for low-income countries. For example, Seymour and Floro (2016) used modified questions among couples in Bangladesh. Most LMICs studies asked multiple questions about affect but about a limited number of episodes. One of the main drawbacks of the DRM is that it typically

takes over an hour to conduct an interview. Researchers with the World Health Organization applied a modified DRM in China, Ghana, India, Mexico, Russia, and South Africa. One of their main modifications is to only ask about a portion of the day—morning, afternoon, or evening—to compensate for the time needed to ask six affect questions about each activity episode (Ayuso-Mateos et al., 2013; Miret et al., 2012).

What I do is closer to the 2010 INSEE study in France (Fleche & Smith, 2017), in that I ask one question about affect, but about all episodes. Only by collecting information about each episode can we understand subjective wellbeing as related to the sequence of activities (is a leisure activity less enjoyable after an interruption than before? is it more enjoyable if it is preceded by less-pleasant activities, or by work?), duration (is a longer time spent doing an activity associated with lower affect, what has been referred to as the "hedonic treadmill effect"?), or other unique features of 24-hour time data.

Krueger (2009) used cluster analysis of the affect ratings in the PATS to group activities into categories such as "unpleasant personal maintenance" and "work-like activities," inferring peoples' reasons for doing things by how they felt. Rather than infer, I ask respondents why they did each activity. Glorieux and Elchardus's studies from Belgium (1999) are the only other time diary studies that I know of that systematically ask about motivation (or "meaning").

3.2 Methods

The study was approved by the Princeton University Institutional Review Board (Protocol 10620) and the Universidade Federal de Minas Gerais Comitê de Ética em Pesquisa (Research Ethics Committee; CAA 95214318.6.0000.5149, Parecer Consubstanciando de Nº 2.929.372).

A PhD demographer who had experience working with public schools served as study coordinator. The interviewers were students and one graduate of UFMG. Most were economics or demography graduate students. They participated in two two-hour training sessions prior to data collection. I was present for almost all fieldwork.

Data collection took place from September to December 2018.

3.2.1 Setting and Recruitment

Brazil is the largest country in Latin America and one of the most urbanized. It is a middle-income country with a multi-racial population. Though it is unique in many respects, it has much in common with other low- and middle-income countries, such as a lack of infrastructure, high levels of economic inequality and strong gender norms. It can also serve as an example with regard to processes such as urbanization and adoption of sedentary lifestyles, which have important implications for time use.

Belo Horizonte (BH), the third-largest metropolitan region in Brazil, has a population of over 5 million across 34 municipalities. In the 2010 census it was approximately 40% white, 10% black and 48% mixed race (IBGE, 2010). Students were selected from four public schools in the Belo Horizonte Metropolitan Region. Two were in the municipality of Belo Horizonte and two in Ribeirão das Neves. Although Ribeirão das Neves borders the municipality of Belo Horizonte, the daily life of its young people takes place largely on the periphery. It is on average much poorer than BH, but comparable to the catchment area of the BH neighborhood school. Infrastructure, such as transportation and public services, is poorer.

We purposively selected the schools as they had previously participated in UFMG research and they were willing to continue to do so. Both of the Ribeirão das Neves and one of the BH schools were neighborhood schools in low-income areas. In contrast, the

second BH school was a magnet school with lottery-based admissions. The student body included all socioeconomic levels but had a much higher proportion of higher socioeconomic status (SES) children than most public schools. The quality of education was considered to be more on the level of private schools, and parents had higher education levels on average than parents from most public schools. Students also commuted from much farther distances, many spending an hour in a car or school bus, compared to a 10–15 minute walk at the other schools.

We gave school administrators the sample size and asked them to divide equally by grade and gender. We invited at least 25% more than target sample size to allow for lack of interest once they learned about the study, and failure to get consent. School administrators said the biggest obstacle would be children forgetting to bring back signed parental consent forms, rather than parents refusing consent.

The study coordinator explained the procedure to interested children and gave them consent forms to bring home. Teachers collected signed consent forms over the following week or so. When we returned for the interviews, those who had signed parental consent were led through the assent form by a member of the research team, either individually or in a group, before the interview began. A few who brought in a consent form decided not to participate on the day and did not go through the assent process, mostly because they did not want to miss class activities. As we returned to the school multiple days, we were able to reschedule those who wanted to participate but had a conflict or were absent on the designated day.

3.2.2 Procedures

We collected data through interviewer-administered 24-hour recall surveys. Each respondent was supposed to do one interview about a weekday and one about a

Saturday. Respondents provided written assent before the first interview and verbal assent before the second. Interviews took place in the school library during school hours. Each participant-interviewer pair sat at a table by themselves, away from other participants.

For the weekday interview, participants listed all their activities from 4AM the previous day to 4AM that day, as is standard for time diary studies, in 15-minute increments. The interviewer first asked what time the participant woke up and what time they ate meals. Such "anchor points" help reduce the cognitive burden on participants because these activities are often done at regular times. Interviewers then proceeded to record all of the respondent's activities in sequence, asking about the start time, end time, and length. When respondents had difficulty estimating times, the interviewers prompted them with the above anchor points or others, such as school hours or TV programs shown at regular times.

One of the strengths of the diary-type recall survey is that the narrative flow is natural and mirrors the way people talk about their experiences. Therefore, interviewers first took participants through what they did, concentrating on getting the timing and activities correct. The interviewer then returned to the morning and asked who the respondent was with, if anyone, during each activity, and where (what type of place) the activity occurred. They then asked why the respondent did the activity and how they felt.

At one of the interviews, respondents also filled out a questionnaire containing background information about themselves and their families.

3.2.3 Measures

The two key questions that this chapter is based on were asked of each activity episode:

1. Why did you do [the activity]?

2. How did you feel while you were [doing the activity]?

I call the response to the first question "motivation" and the second question "mood." The term "motivation" may also describe a deeper or unconscious force, but this survey was only capable of measuring self-reported perceived motivation—that is, the reason the respondent thinks they did a particular activity at a particular time. Glorieux and Elchardus (1999) use the term "meaning" to describe a similar concept. Other possible terms would be "reason" or "purpose," but I consider those to be too general. Instead, I describe the response to why as the perceived motivation, or simply motivation.

3.2.3.1 Mood

Kahneman and Krueger's U-index, derived from separate questions about six emotions (happy, sad, interested, tired, stress, pain) is sufficiently onerous that most studies ask the full battery of questions about only three randomly-sampled episodes per diary day. As Gershuny (2011) states,

> The burdensome nature of the multiple affect fields in the U-measure, together with the poor fit of the "three random event" approach to the HETUS "own words" self report design, and the much wider analytic possibilities offered by the single "enjoyment" scale currently being collected by the INSEE in France, suggest strongly that the latter approach be adopted. (p.44)

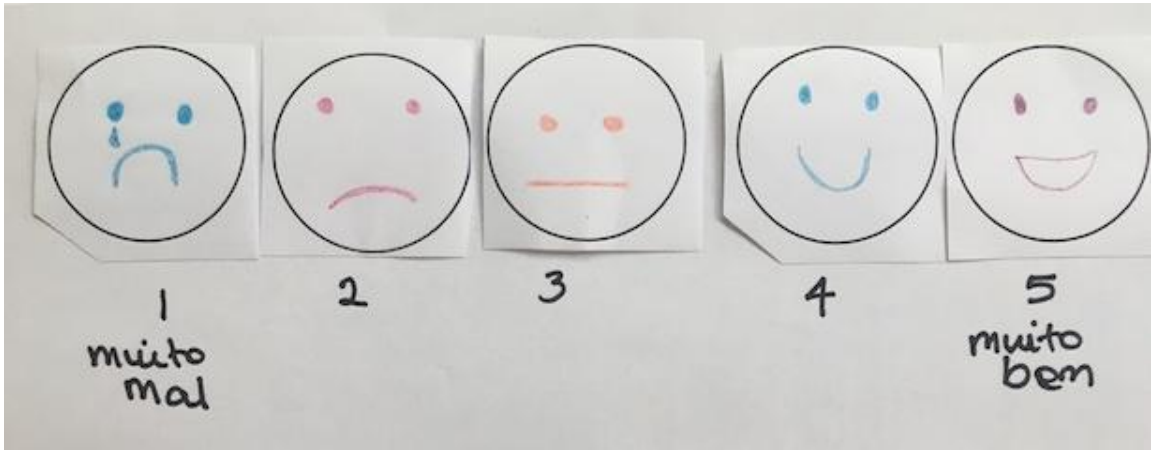
We also asked about mood for all activity episodes, for two interviews. We were limited in the amount of contact time we had with respondents, and were concerned they would provide poor quality responses if they considered the questions redundant (for example, asking how happy and how sad about the same activity). We therefore decided to use a single measure. Our five-point scale went from feeling very bad (1) to very good (5).

Children are used to expressing themselves with emojis, so we decided to use an emoji scale with a face to match each level. There are existing emojis but we wanted our scale to be tailored to our population's conceptions of moods, so we developed the scale with our pretest participants, eight boys and girls aged 12 to 16.

We gave each pretest participant five cards with a blank circle, and a colored pencil. We instructed them to independently draw five faces, ranging from the best to the worst mood. We then pooled all of the faces in the middle. Together, the participants created a master scale of the best five faces. We made sure everyone was participating and asked them about alternatives to those they had chosen to be sure they had considered all the options and the process was not being dominated by one or two opinions. Thinking back on my own teenage years, I would depict the worst mood as rage rather than sadness, but when I asked whether they wanted to include one of the angry-looking faces in the pool, they said they did not, and that the crying face could be angry or sad or upset.

We printed and laminated the scale, and the participants could either point to a face or refer to the number that matched how they felt during the activity episode.

Figure 13. Mood Scale



We decided to use hand-drawn faces rather than standard digital emojis to allow the participants to choose expressions that reflected their own experience. A challenge of using existing/validated scales in cross-cultural research is that explanations of levels or items do not always translate the same way. Children of different ages may have differing verbal ability, or differing self-awareness or ability to translate abstract feelings into relative values on a numerical scale, but they can compare two side by side expressions and choose the one that best matches their feelings. The facial expressions gave a clear indication of the difference between, for example, a 4 or a 5, thus standardizing the responses according to the range of likely emotions of the peer group of the participants.

Some time use studies have used more levels for subjective well-being ratings, up to a range of 0 to 10, for example (Cantril, 1969, cited in Robinson & Gershuny, 2015). I felt that this would give the results a false sense of precision, at least with our population. The DRM uses a seven-point scale of 0–6. The INSEE study also used seven points, ranging from -3 to 3 (Fleche & Smith, 2017). One of the most rigorously validated[9] face scales developed for children is to rate pain in medical settings (Tomlinson et al. 2010). Although they tested many ranges, they chose six. Our pretest group was able to agree on four faces easily and had some trouble choosing the level 2 face, suggesting that they would have had difficulty with any more subtle differences than the five faces we used.

3.2.3.2 Perceived Motivation

Developing response options for the question about why the participant did the activity was more complicated. Based on the literature on time use and on adolescent health and

[9] As it was measuring a physical symptom, this scale could be validated using biomarkers, something that is not possible for a scale measuring affect.

well-being, and on correspondence with several established time use researchers, I first brainstormed a list with several research assistants.

In the pre-test, each participant listed three activities they had done that week, without repetition, giving us approximately 24 activities. They then said why they had done each thing. We discussed whether others did things for those reasons, to gauge how the reasons resonated with them. We told them any remaining reasons from our previous list and asked them to think of any additional reasons we had not mentioned. I consolidated the ideas into the response options listed in Table 12, below. For this chapter, we further grouped them into these categories:

1. Enjoyment (I like it)
2. Instrumental (to get something else)
3. Social expectations (it is expected of me, but I have some choice)
4. Ordered by someone (no choice)
5. Nothing better to do (amotivation)
6. Necessity

Although we developed the categories through a qualitative, iterative process, they align with the dimensions from the Free Time Motivation Scale for Adolescents developed by Baldwin and Caldwell (2003) using self-determination theory (SDT), and with Glorieux and Echardus's seven dimensions of the social meaning of time, based on empirical work with Belgian adults (1999). See Table 16 (Appendix) for a comparison.

Locally-relevant examples help respondents understand how their experience fits into abstract categories (Seymour, Malapit & Quisumbing, 2017). We created concrete examples for each response option, based in part on the pretest discussion. The research assistants reviewed the vignettes and made some modifications. The final script read:

People have different motivations for doing the things they do.

Ana likes math and history very much. She wakes up early to go to school every day. She goes to school because ***she likes it.***

Gabriel would rather swim than study. His parents say he can only swim if he goes to afterschool classes to improve his grades. Gabriel goes to afterschool classes even though he doesn't like it, in order ***to get something he wants.***

All of Carolina's friends play volleyball. She doesn't really like volleyball, but her friends always invite her and she is afraid if she refuses, they'll talk badly about her. She plays volleyball ***because other people think she should.***

Fernando has a little brother that always needs help washing and getting dressed. Fernando is very busy with his own things and would prefer not to take care of his brother, but he knows his mother works too much and is tired. Fernando takes care of his brother ***to be responsible and help others.***

Susana detests going to school. Her mother says she has to go to school every day because if not, the family will lose their government benefits. She goes to school because ***someone orders her to.***

Eduardo lives with his siblings and grandfather. Every night they watch telenovelas. Eduardo doesn't like watching telenovelas but he does it because ***he has nothing better to do.***

Cecilia works in a store on the weekends. She would prefer to go out with her friends but she ***needs money.***

Why did you do _____?

The interviewer read the entire script once, and then for each subsequent activity, only asked the respondent why.

A local cartoonist, Henrique Osvaldo Aloisio de Andrade of PontAfiada (pontafiada.carbonmade.com), illustrated the vignettes, as shown in Figure 14. The illustrations again demonstrated the importance of having locally-adapted tools. I was not certain that some of the pictures conveyed the reasons, but when we showed them to children without explaining anything about them, they were able to correctly describe what was depicted.

The respondent held the laminated A4 sized card throughout the interview. It served as a reminder of the concepts, while still allowing the respondent to use their own words to describe what had motivated them. It also gave them something to look at during the interview, preventing them from becoming completely distracted.

Figure 14. Motivation Showcard



3.2.3.3 Time Pressure

While we asked about mood and motivation for each activity, we only asked about time pressure in general, at the end of the survey, with the question: How often do you feel stressed or pressured because you don't have enough time in your day? Response options were: Never, Seldom, Sometimes, Often ,and Always. We also asked what the respondent would do (up to two activities) if they had one additional hour in their day to do anything, and whether they would be able to reorganize their schedules if they wanted to do that activity this week.

Table 12. Key Variables

Dimension	Response options	Measurement level
Where	• Own home • Indoors (others' home, public place indoors), • Outdoors (public place outdoors, active transport) • School or work • Transit (passive transport, waiting for transport) • Other	Activity Single response
With whom	Alone, Adult family members, Child family members, Friends, Others	Activity Multiple responses possible
Motivation	1. I like it 2. To get something else 3. Peer pressure / social expectations 4. To help someone, be responsible (altruistic) 5. Someone ordered me to / made me 6. I had nothing better to do 7. I need money 8. It's a (physiological) necessity 9. Other	Activity Multiple responses possible
Mood	1 very bad – 5 very good	Activity Single response
Time pressure	Never, Seldom, Sometimes, Often, Always	Day Single response
Control of schedule	Yes (could rearrange tasks) or no	Day Single response

3.2.4 Analysis and Presentation of Results

Interviewers recorded activities in the respondents' own words. For each episode, they generally recorded one activity. If they recorded multiple activities, we chose the primary activity during coding, or sometimes divided time if it appeared things were done in sequence. For example, if a respondent spent a half-hour school lunch break eating and playing with friends, we assigned 15 minutes each to eating and playing.

Most interviewers entered their own data, and one research assistant reviewed the database against each paper questionnaire and corrected any errors. One member of the research team and I each coded the activities. The research assistant also made notes explaining ambiguous phrasing for me, such as, "When Brazilians say _____, they usually mean _____" We used a list of codes adapted from the 2016 update of the United Nations International Classification of Activities for Time-Use Statistics (ICATUS) to make it comparable with other time use studies but relevant to Brazilian adolescents. For example, we combined all childcare into one code, but separated playing games outside from playing games indoors from playing videogames. We began with a training dataset of about 40 interviews which we both coded. We then discussed and agreed on issues we were not sure of, adding a few codes. I compared our coding to identify any inconsistencies. I ultimately decided on the correct classification, but I reviewed her notes and we discussed most cases to be sure I understood the activity being described.

Once all activities were coded, I transformed the data into an episode-level file, where the unit of analysis is an activity episode. Each time the respondent changes activity, a new episode is begun. An individual who eats three meals a day would have three separate eating episodes. Each episode has the following attributes: activity, duration, start time, copresence, location, motivation, mood. Episodes can also be associated with attributes of the actor (e.g. age, gender, race, school, or other personal characteristics) or the day (day of week or responses to time pressure questions).

As discussed earlier, time use researchers group activities into a much smaller number of categories or domains for most analysis. These domains vary depending on the research questions, but typically distinguish between paid work, unpaid work or school, personal care, and leisure. Following Ås (1978), these groups are often described as contracted

time, committed time, necessary time, and free time. Studies of adults tend to emphasize differences in types of work, while differences in free time may be grouped simply as (inter)active versus passive (e.g. anything but watching TV vs. watching TV). As children and adolescents do not usually work full-time, research questions often require different domains, for example distinguishing among recreation and social activities. In this chapter, I adapt the classification system Ferrar, Olds and Walters use in their 2012 review of adolescent time use cluster research, grouping activities into 9 "macrodomains" and 30 "microdomains."[10]

Table 13. Activity Domains

Macrodomains	Microdomains
Work	Paid work, preparing/cleaning up after meals, indoor chores, care, outdoor chores, animals
Education	Classroom, school routine (e.g. breaks at school), homework, courses or study outside school
Community	Community events, religious activity
Personal	Eat, hygiene, health, rest
Physical activity	Active play, organized sports, active transport
Hobbies	Hobbies, music, read
Screentime	video games, TV, social media/chat, cellphone (various activities)
Social	Social activities with family, social activities with friends, outings
Passive transport	Passive transport

[10] Because of the different characteristics of the Brazilian respondents, the domains are different from Chapter 1 on Guatemala.

3.3 Results

3.3.1 Sample Characteristics

The sample consisted of 240 respondents, of whom 53% were girls. We interviewed children aged 10–11 only about one weekday. Most respondents 12 or older had data from a weekday and a Saturday; 6% had data from only one day and 5% had data from more than one weekday.

I divided participants into three age groups that correspond to the developmental stages of pre-adolescence (10–11), early adolescence (12–14), and middle adolescence (15–17). The younger age group are largely in primary school (Ensino Fundamental level 1) and the middle age group in middle school (Ensino Fundamental level 2). The older age group contains students from middle school and high school (Ensino Medio).

The large majority of participants lived with their mother and 68% lived with their father. One-third lived in single-parent households. Most single-parent households were female-headed.

Table 14. Sample Characteristics

	% of sample
Age group	
10–11 yrs.	23
12–14 yrs.	44
15–17 yrs.	32
Gender	
Boys	45
Girls	55
Race	
Multiracial	48
White	23
Black	16
Other	15
Family structure	
Live with mother	92
Live with father	68

3.3.2 Time Pressure

We asked respondents how often they felt stress or pressure because they do not have enough time in their day. Many, especially the younger children, were confused about why this might cause them stress. Less than 10% of the youngest age group said they felt stressed about time "often" or "very often." The proportion increased among each age group, rising to 37% among the 15–17 year age group. Many more older girls than boys felt stressed about time "often" or "very often"—44% of girls compared to 28% of boys (see Figure 15). In a chi-square test among the 15-17 year age group only, this difference was statistically significant ($X^2(1)= 4.3621$, p=.037).

When asked if they would be able to organize their tasks that week to make an additional hour to something they wanted, the large majority (74-86%) thought they could. There was no clear pattern by age or gender.

Bivariate correlations between time pressure, age, and gender are shown in Table 15. Higher frequency of feeling stressed about time was associated with lower feeling of control of their schedule.

Figure 15. Frequency of Feeling Stressed or Pressured because of Lack of Time

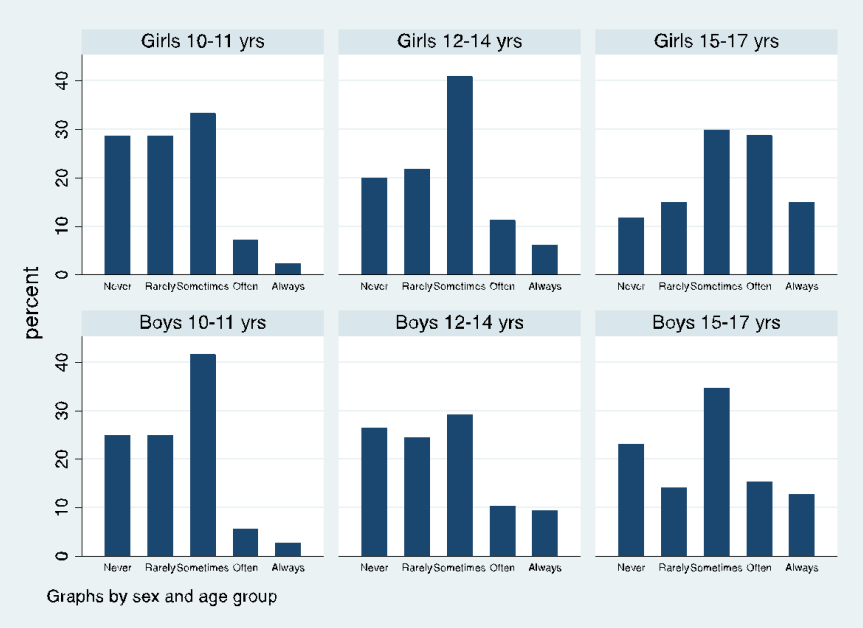


Table 15. Correlations between Person-level Characteristics and Time Pressure

	Frequency of stress (1=never, 5=always)	Could reorganize own time	Age in years
Could reorganize own time	-0.1255*		
Age in years	0.2597*	-0.0692	
Female	0.072	-0.0253	0.0079

3.3.3 Episode Characteristics

The remainder of this chapter is based on the activity episode as the unit of analysis. The episodes are not weighted by duration. Results in this section do not represent the proportion of time but the proportion of distinct activities.

There were 6,906 episodes after excluding sleep. The mean number of episodes per person-day is 18.9. A typical number of episodes per day in surveys such as the ATUS is 20.

Figures 16 and 17 show mood and motivation as a proportion of activity episodes, by sex and age groups. Children reported being happy most of the time. Overall, respondents reported having the best mood for 38% of episodes. They gave an additional 41% of episodes a score of 4, only slightly less happy. The proportion of episodes receiving the highest rating dropped with age. The difference was statistically significant but small. Between age 10 and 16, mean mood dropped only 0.15, from 4.2 to 4.05.

Motivation was dominated by two replies: the respondent did the activity because they liked it (40% of episodes overall) or because they considered it necessary (34% overall). Although the category of necessity was intended to include only physiological necessities like eating, sleeping and personal hygiene, activities that were not physiologically necessary made up approximately 20% of activities that respondents said were "necessary." Half of these were transportation, usually returning from an activity. In that transportation is necessary to do something else (or get home from doing something else), these activities might have more correctly been classified as "instrumental." The rest of the "necessary" activities were largely school or school-related, or chores, but a small number (less than 5% of those reported as necessary) were community, social, religious or recreational activities.

Differences in motivation by age and sex were small but some were significant. Motivation is an unordered categorical variable. I used a multinomial logistic regression with age and sex as explanatory variables. Compared to the base category of liking the activity, the odds of being ordered to do something decreased by 10% with each year of age ($p<.001$). The relative odds of doing an activity for instrumental reasons was 1.2 per year of age ($p<.001$) and the relative odds for considering an activity necessary was 1.1 per year of age ($p<.001$). The only significant association with gender was doing something because of social expectations: girls had 1.9 times the odds of boys for doing something out because others expected it, compared to doing something because they liked it.

Figure 16. Mood during Episode, by Sex and Age Group

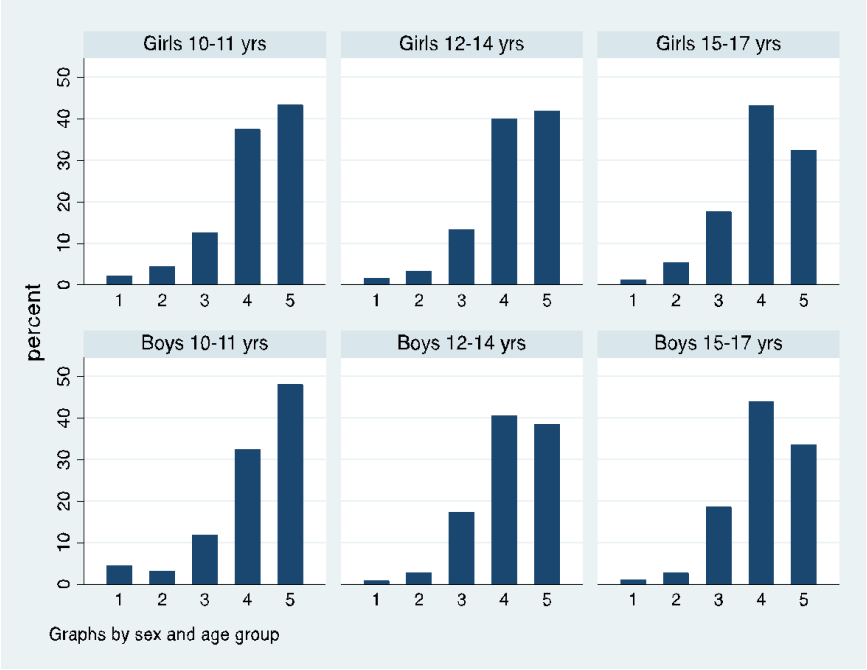
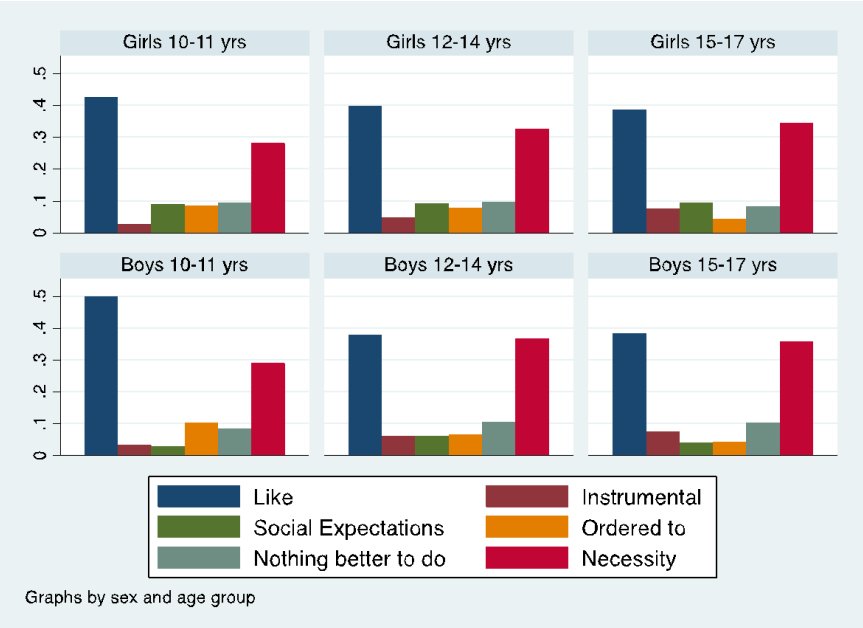
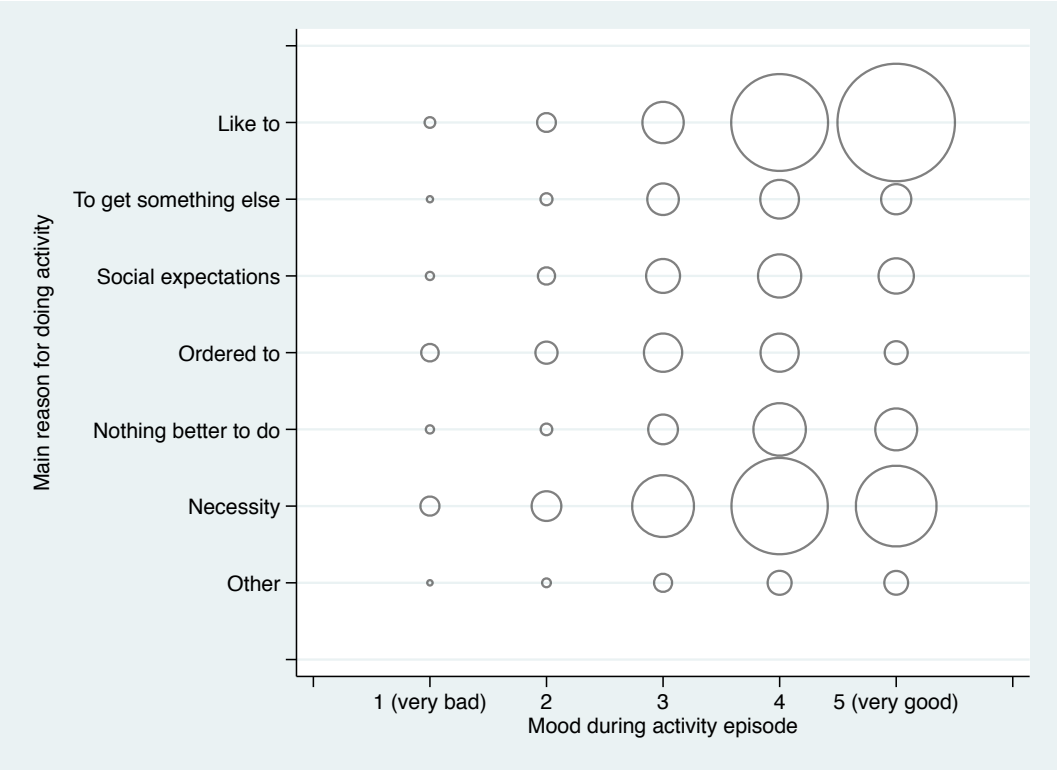


Figure 17. Reason for Doing Activity, by Sex and Age Group (Multiple Responses Possible)



Not surprisingly, mood was associated with motivation: children are happier when they do things because they enjoy them. This association was statistically significant in a chi-square test ($X^2(24)=920.6$, $p<.000$). Figure 18 shows relationship between the two variables, with the frequency of each response pair represented by the size of the bubble.

Figure 18. Mood, by Reason for Doing the Activity



3.3.4 Consistence with Activity Domains

The purpose of this section is to demonstrate that knowing an activity domain—whether the nine macrodomains or the more detailed microdomains presented in Table 13—is not sufficient to know the person's motivation. As Figure 19 shows, motivation varies within nearly all the domains. Fun activities are more likely to be motivated by enjoyment and personal activities by necessity, but there is much more variation for school and work.

Figure 19. Motivation by Activity Macrodomain

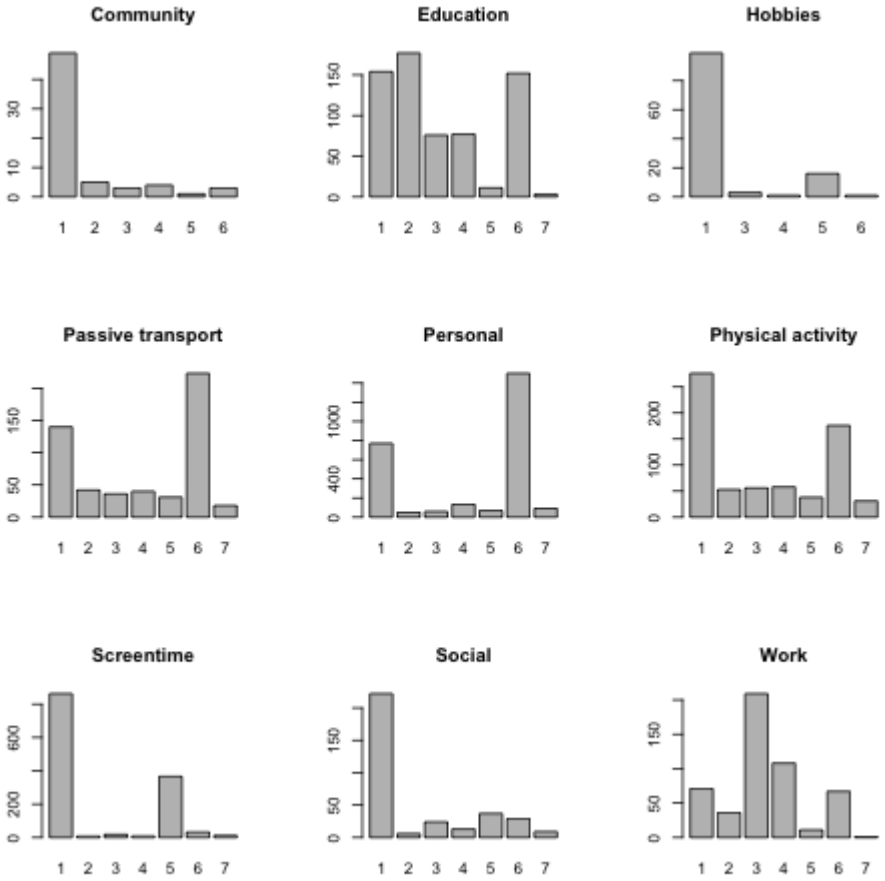
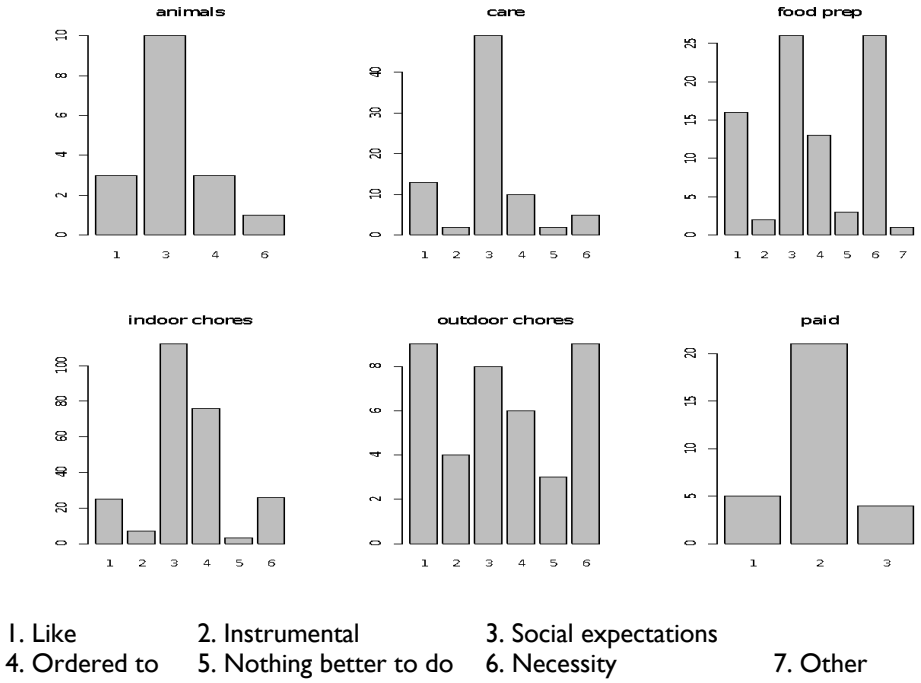


Figure 20 shows that respondents do each type of work (paid work, preparing and cleaning up after meals, other indoor chores such as cleaning, childcare, animal care, and outdoor chores) for a range of reasons. Taking care of animals and siblings are dominated by the expectations of others, but almost all of the possible motivations apply. In almost all cases except paid work, liking a work activity is a more common reason for doing it than to get something else (like privileges or money). The only reason barely

represented is having nothing better to do. (Children can *always* find something better to do than work.)

Figure 20. Motivation by Work Microdomains



Figures 21–23 show motivation by other microdomains. As with work, most motivations are represented in the education microdomains (class time, school routine consisting of breaks and other activities at school, homework/studying, and after school or weekend courses; see Figure 21). In contrast, children do fun activities largely (though not exclusively) because they like to (see Figure 22). The types of activities that make up screentime (see Figure 23) are videogames, TV, interactive texting and social media, and "messing around on my phone." (This last is a code we created because it was such a common response but not part of any standard activity coding system.) Children do the more interactive screen activities of playing videogames and texting/social media because they like to. Often they do the more passive messing around on the phone and

watching TV because they like to, but sometimes also because they have nothing better to do, suggesting that much *but not all* passive screentime is intentional.

Figure 21. Motivation by School Microdomain

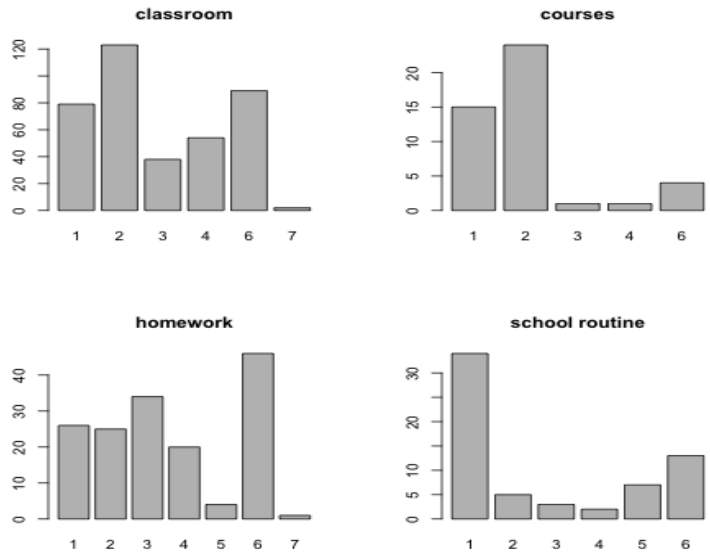
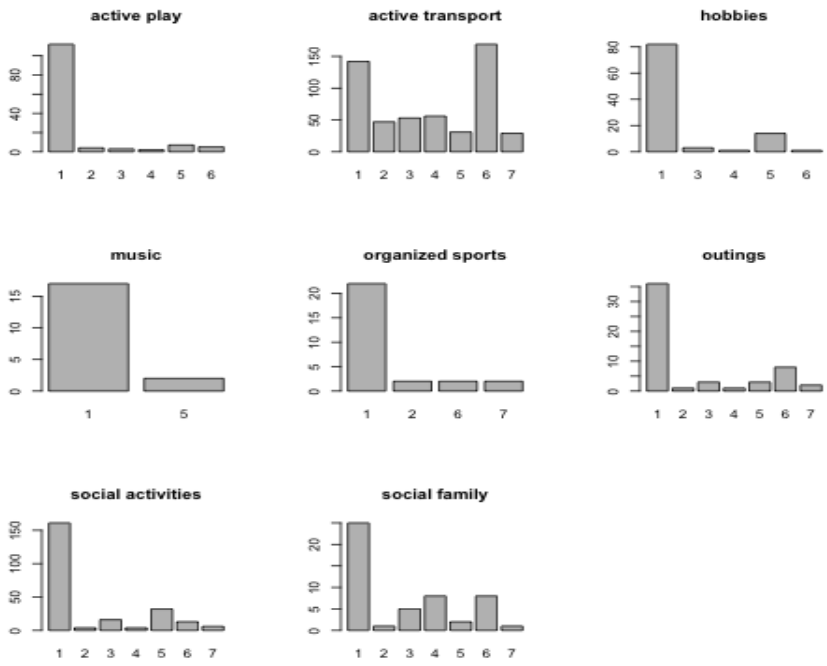
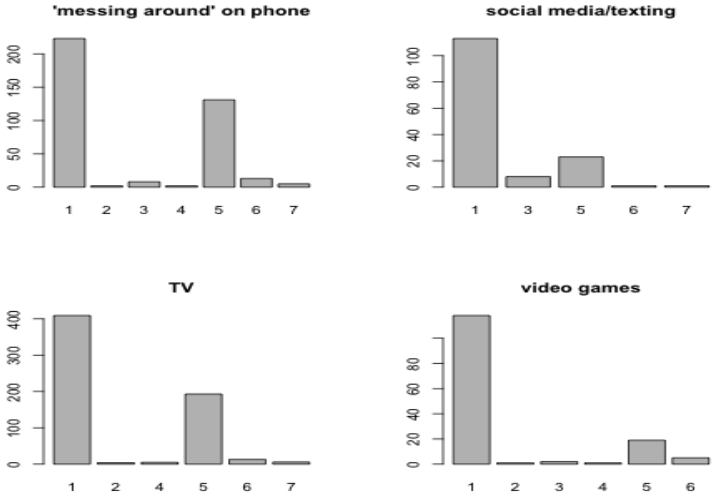


Figure 22. Motivation by Leisure Microdomain



1. Like 2. Instrumental 3. Social expectations
4. Ordered to 5. Nothing better to do 6. Necessity 7. Other

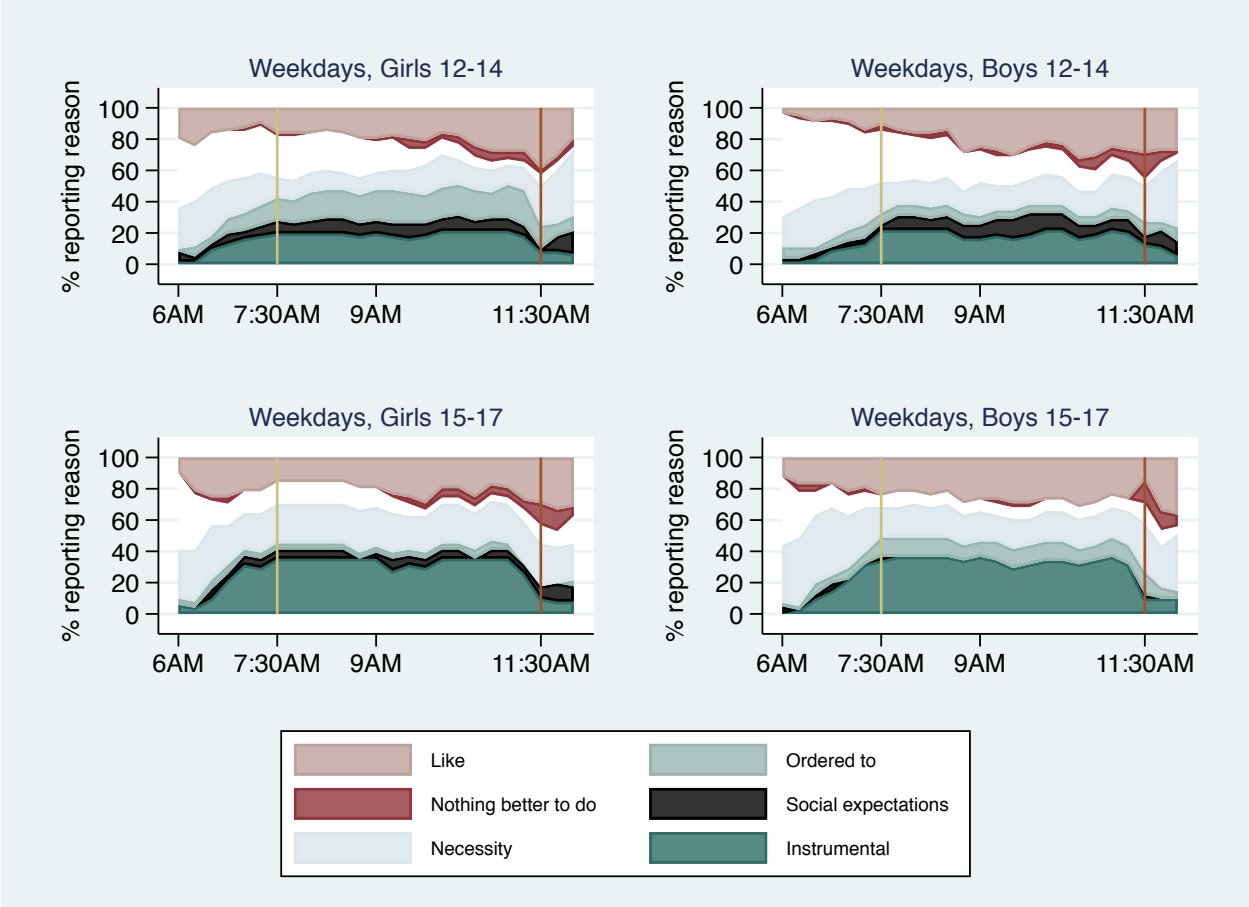
Figure 23. Motivation by Screentime Microdomain



1. Like 2. Instrumental 3. Social expectations
4. Ordered to 5. Nothing better to do 6. Necessity 7. Other

Figure 24 further supports the contention that different reasons may motivate people to do the same activity. This set of graphs shows the motivation reported for activities between 6am and noon on a weekday. During these hours, nearly all 12–17 year olds are getting ready for school, traveling to school or in school. School for middle and high school students ends at 11:30AM at the three local schools, and at 2:30PM in the magnet school. All begin at 7:30AM. Between 7:30 and 11:30AM, they may have multiple activity episodes, such as class, then a break, then class again. (Primary school students are not included because some attend school in the morning hours and some in the afternoon.) The different color bands show the percent of respondents reporting that motivation for the activity they are doing at that time. Within each gender and age group, there are differences, even though they are nearly all doing the same thing. Older respondents report instrumental motivation more than younger respondents. Older boys do not report attending school because of the expectations of others, but they do report being ordered to. Some younger children report being ordered to attend school, but almost no older girls.

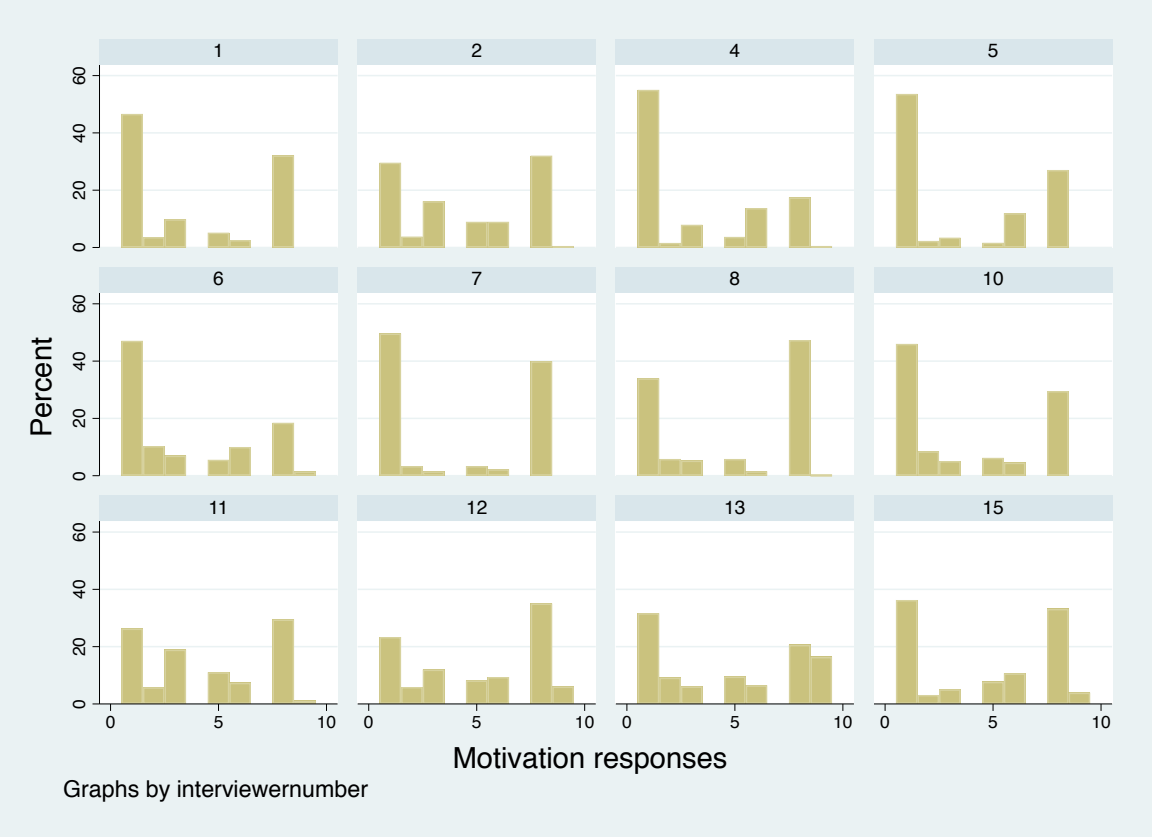
Figure 24. Motivation throughout the Day on Weekdays, by Sex and Age Group



3.3.5 Interviewer Effects

Interviewer effects are an important concern, particularly given the unbalanced responses to the motivation question and high reported moods. We had 16 interviewers, some of whom worked much more than others. Among the 12 most productive interviewers, we can see distinct patterns in responses to the motivation question, as shown in Figure 25. In chi-square tests of independence including all interviewers, I found a statistically significant association between mood and interviewer (X^2 (20)=147, p<.000) and between motivation and interviewer (X^2 (30)=504.5, p<.000).

Figure 25. Distribution of Motivation Responses, by Interviewer



I considered the possibility that some of the differences by interviewer could be due to differences in the age and gender profiles of their respondents. Interviewers worked on different days, with different grades. Sometimes interviewers could choose their respondents or vice versa, if several were free at the same time. In such cases, they might choose someone of the same gender, for example. To test for this, I tested for the joint significance of age, sex and interviewer. I did a likelihood ratio test comparing the multinomial logit model for motivation with age and sex only as independent variables, to the model including age, sex and interviewer as a categorical variable. The statistically significant result (LR X^2 (66) = 829.81, p<.001) suggests that differences in motivation by interviewer are not driven by differences in respondent profile. Similarly, a likelihood ratio test of the linear regression model for mood with and without the interviewer

variable (LR X^2 (11) = 97.07, p<.001) suggests that interviewer had an effect on mood ratings, even after accounting for respondent age and gender profile.

Nevertheless, adding a categorical variable for interviewer to the multivariate analyses did not change the direction or the statistical significance of any of the associations with age, nor the association of social expectations with being female. It did change previously non-statistically significant associations of being male with doing things for instrumental reasons, and for necessity, to statistically significant. Interviewer effects are thus an important concern, but not the sole explanation for age and gender differences in mood or motivation.

3.4 Discussion

In this paper, I have described how my Brazilian colleagues and I created culturally-relevant tools to measure dimensions of time use that are infrequently measured, particularly in LMICs. We asked questions about mood and motivation for each activity, and questions about overall feelings of time pressure.

When reasons for doing an activity are mapped onto standard activity domains—for example, work, school, social—we find that most motivations are represented in most domains. This suggests that within a domain—work, for example—respondents' subjective experience varies. Robinson and Gershuny (2015) report that people feel greater satisfaction when doing an activity for altruistic reasons, and therefore imply that such time is of higher quality. But most often researchers rather than respondents determine what activities fit the criteria for "altruistic." In contrast to typical classification systems for time based on the researcher's opinions of why people to things, we incorporated the perceptions of the person doing the activity. Asking for the respondents' perspectives rather than assuming is essential in cross-cultural research,

where the researcher knows less about the study population. But it would be wrong to assume that even researchers from the same country automatically share the same culture. Indeed, I had more experience working with low-income children than many of my Brazilian research team. PhD researchers routinely study those less privileged than them, and may forget that their own experience is not universal. Explicitly asking for respondents' perspectives protects the researcher from such threats to study validity as confirmation bias, where the researcher more easily recognizes a result they expect while perhaps failing to notice unexpected findings.

Although we did not find dramatic differences by age and sex, girls' activities were somewhat more motivated by the expectations of others than were boys' activities, consistent with adult gender norms. Average mood decreased with age, though it remained generally very good or good. Older adolescents reported feeling more pressured about time than younger children, as has been found in other countries. The absolute level of time pressure in our study, however, was much lower than found in several studies of Canadian adolescents (Hilbrecht, Zuzanek & Mannell, 2008; Zuzanek, 2005); whereas approximately two-thirds of their 15–19 year olds reported moderate to high levels of time pressure, only one-third of our oldest age group did.

During adolescence, children become more independent from their parents and other adults, and develop their own sense of identity. They increasingly pursue their own interests and gain knowledge and life skills through activities and interpersonal relations (Larson & Verma, 1999). They also increasingly take on adult responsibilities, though they may begin to do so at much earlier ages in low- and middle-income countries especially. Self-determination theory offers a framework for this developmental process. Our motivation categories were consistent with self-determination theory (Baldwin & Caldwell, 2003) as well as the "meanings" Glorieux and Elchardus (1999) used in their

work with Belgian adults, but we used locally-developed examples and images to convey them in a consistent and age-appropriate manner. Working with children as young as 10, we could not expect our respondents to apply concepts such as “instrumental purpose” or “intrinsic” or “amotivation” (terms used by Baldwin and Caldwell, and Glorieux and Elchardus) to their own experience in a reliable way. It is possible that even our tools were not sufficient, given the dominance of two categories: enjoyment and necessity. This is not unique to our study. Baldwin and Caldwell describe the difficulty in eliciting motivation from children:

> Why do youth do what they do in their free time? If you ask them, typical answers are “I have to,” “I want to,” or “There is nothing else to do.” These simple answers belie the complexity of motivation. Understanding and measuring motivation in terms of adult behavior is difficult enough, but during adolescence the developmental processes through which youth evolve compound this complexity. (p.129)

Some might argue that it is impossible for children to know why they do what they do. It is true that we cannot uncover the deepest, underlying motivation. Rather, our measure of motivation is perceived motivation, because self-report of perception is really the only feasible way to measure motivation in a quantitative time use study. Nevertheless, measuring even perceived motivation is a big step forward in comparison to most time diary studies.

3.4.1 Limitations

We measure some facts (what activity, when, personal characteristics of respondents) and some perceptions (why did the respondent do something and how did they feel) that

are reported by a respondent and interpreted by the interviewer (or in the case of activities, by a coder). This introduces the potential for several types of bias.

The need for interviewers to interpret respondents' own words to choose the correct category for motivation introduces the potential for confirmation bias. It is possible, for example, that if a child said, "I wanted to" about playing football, the interviewer would code that as "like to," whereas if they said they "wanted to" do homework, the interviewer might probe for *why* they wanted to. This could account for the very high proportions of activities that respondents did because they liked them or because they considered them necessary.

To the extent that children have trouble remembering what they did or how they felt during each activity, there may be recall bias. In summarizing research comparing real-time to remembered subjective well-being, Kahneman and Krueger (2006) report that people tend to remember how they felt during the peaks, the troughs or at the end of activities, but that real-time measures of affect during a particular activity are closely associated with measures of the same activities collected the following day. Based on this, we might expect there to be polarization in mood scores (very happy at the peak or very miserable in the trough), whereas mood scores tended to be quite high. If respondents rated mood based on how they felt at the end of an activity, relative ratings should at least be consistent across the day.

Mood or motivation are self-reported and subject to social desirability bias. This could account for the quite high ratings of mood, but we would have expected more reports of altruistic motivations to be evidence of social desirability.

We purposively selected four public schools and then used quota sampling within schools. Our findings are not representative of even children from Belo Horizonte: our respondents were all current students, mostly living in disadvantaged areas, who

volunteered to participate. I believe, however, that they have enough in common with many groups in low- and middle-income countries to make these exploratory findings useful to time use researchers.

3.5 Conclusions

The analysis presented in this chapter only scratches the surface of what might be learned through multidimensional measures of time. Rather than draw conclusions about the subjective experiences of Brazilian youth, I have attempted to demonstrate that relatively simple adaptations to common time diary tools and protocols can provide information about subjective experiences of time that we are currently missing. Further analysis might compare the proportion of the day that different groups spend doing activities for different reasons, or with different moods. We might analyze the relationship of mood and motivation with respondent characteristics such as SES, school type, access to extracurricular opportunities, or to episode characteristics such as time of day or duration of episode.

Time use research in LMICs has often used simple techniques such as stylized questions to measure what people are doing. This study shows that multidimensional measures of time are challenging, but possible, even in such settings. To understand how people experience time, we must ask them, all the more so the less we have in common with them. Just as we once measured only contracted market labor as “work,” but now include many types such as family work, home production and informal jobs, we need to incorporate the perspectives of populations in measuring subjective experience.

An important strength is that we developed response categories and tools locally, with our study population, so they were relevant to the experience of our respondents. Our use of concrete examples for motivations and mood helped to standardize responses.

More careful training and supervision of interviewers, and regular thorough debriefings is essential to ensure that definitions are correctly and consistently applied.

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Conclusion

In this dissertation, I have written about three aspects of time use by adolescents in one low- and one middle-income country.

While gender disparities are one of the most central themes of time use research, most of our data comes from couples in HICs. Far less comes from children or from rural settings in LMICs. Working with indigenous adolescents in rural Guatemala, I identified large gender disparities in the volume of work and in time with friends during school holidays/harvest season. An important next step is to collect data during the school year, among children who are and children who are not attending school. Though ethnic and gender differences in enrollment have diminished for children aged 8–12, school attendance for Mayan girls begins to diverge from Mayan boys and non-indigenous boys and girls around age 13. Mayan girls begin dropping out of school at this age, while indigenous boys and non-indigenous boys and girls remain in school longer. The main reason families of poor, rural, indigenous girls give for their daughters not attending school is competing household responsibilities. We urgently need to know what girls are doing instead of going to school, in order to develop interventions to reduce early dropout. Such data could be collected at a relatively low cost.

I tested a smartphone diary app and found mobile diaries to be less complete and more error-prone than interviews. Modifications to the tool itself and to the field implementation (e.g. training of users) would certainly affect the coverage and quality of data. This would most likely succeed with a sufficient investment in time and resources for an iterative development and testing process.

The Brazilian data offer the possibility to investigate many research questions without additional fieldwork. How do Brazilian adolescents spend their time, and how does this

differ by age, gender, socioeconomic status, family structure, day of week? How do mood and motivation vary with respondent characteristics, or episode characteristics such as time of day or duration of episode? What can we learn from compositional analysis or sequence analysis of full-day data? We have data on different types of physical activity including organized sports, individual exercise, outdoor play, and active transport. Coupled with data on sedentary activities including screentime and passive transport, this could offer insight into behavior change opportunities in a country facing growing levels of childhood obesity.

While it has its limitations, my dissertation research clearly indicates that with locally-adapted tools, careful training and supervision (including regular debriefing) of the research team, and a certain amount of flexibility, time use researchers can and should aspire to conduct studies in low-resource settings using the same rigorous methods they use in easier settings.

Appendix

Table 16. Motivation Categories

Marin 2019	**Glorieux and Elchardus 1999**	**Self-Determination Theory Baldwin and Caldwell 2003**
Like	Personal gratification	Intrinsic – to have fun, enjoy
To get something else (instrumental)	Instrumental – means to an end	Identified – skills later in life, it is important to me
Peer pressure, other people think I should	Solidarity – to please others and maintain relationships	Introjected – impress friends; want people to like me
To be responsible, help others	Sense of duty	To think I'm good; will feel badly if I don't
Someone ordered me, made me	Obligation enforceable by others	External – it's the rule; won't get in trouble
Nothing better to do	Meaningless time, to kill time	Amotivation – don't care, never thought about it
Necessity	Physiological necessity	

Figure 26. Mean Mood Rating by Activity Microdomain

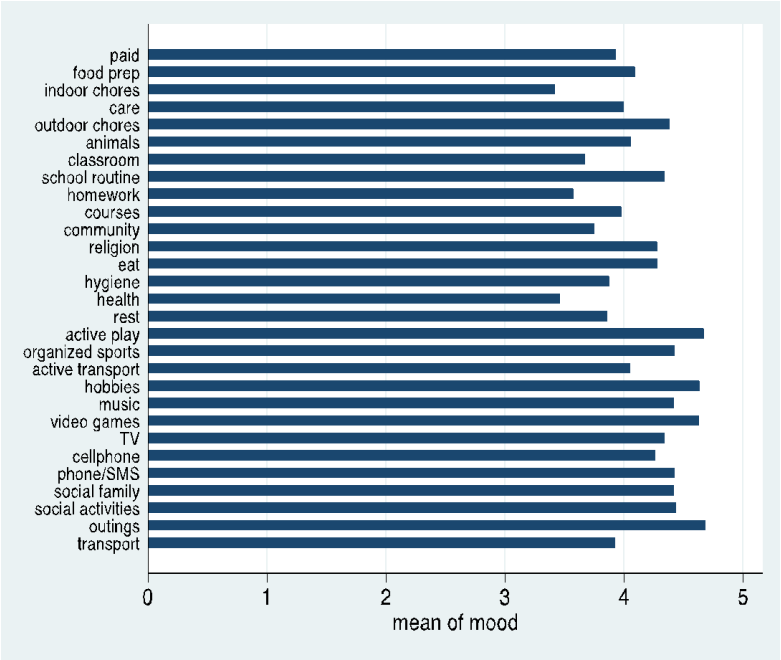

Figure 27. Mean Mood Rating by Activity Macrodomain

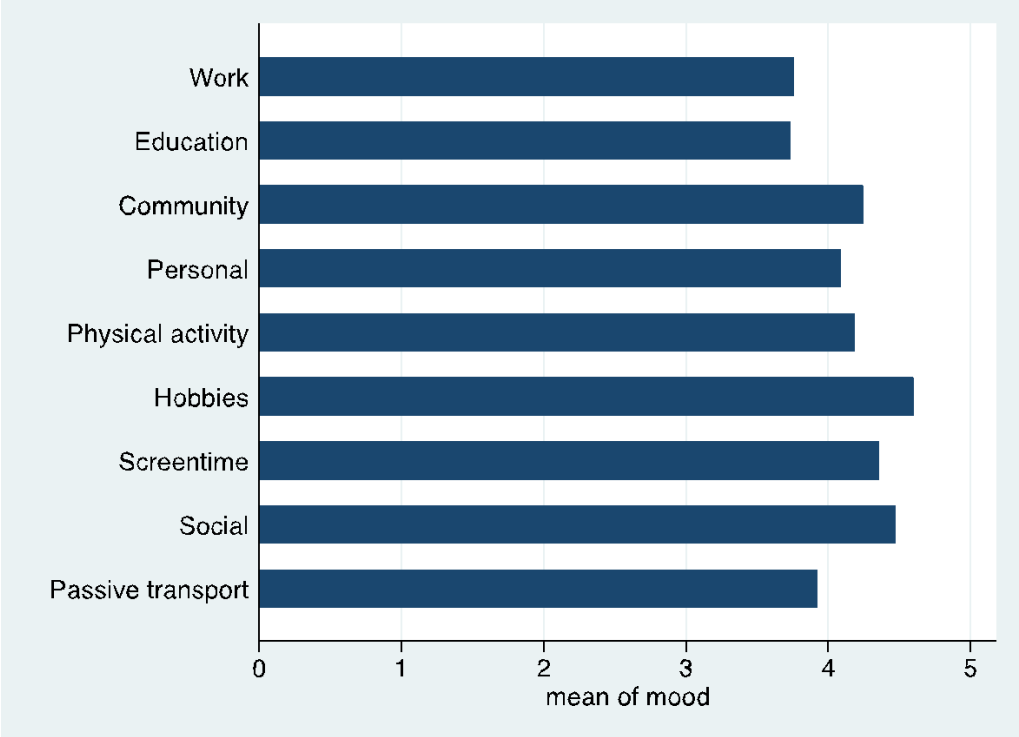

Figure 28. Mean Mood Rating by Sex and Age Group

