**Examining Daily Activity Space
in Rural and Non-Rural Settings: A Feasibility Study**

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** 11/19/2021: Tables need to be updated with versions that Sarah/Joe produced. They are in an Excel File, "Feasibility Report Selected Tables". Look for the latest version.

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Background and Motivation for Assessment

The aim of this study was to assess the feasibility of collecting data on individuals' "activity space" – i.e., the space they move through during the course of a day – and measures of their overall well-being. The concept of activity space is rooted in geographic research and refers to the spatial patterns of routine activity, wherein regular events occur with distinctive rhythms, tempos, and timings (Cagney et al., 2020; Golledge & Stimson 1997). It is a spatiotemporal construct that captures the set of places individuals encounter as a result of their routine activities in everyday life (Browning & Soller 2014, Cagney et al. 2013). Tasks, obligations, social engagement, and tastes may draw people out of, and potentially far from, their residential context. Activity spaces therefore include—but are typically not limited to—individuals' residential areas. Activity spaces also vary across individuals in geographic span as well as in the structural, physical, and social features contained within them.

Activity space approaches recognize that relevant social spaces often emerge through the dynamics of individuals' movement between and among neighborhood areas. The spatial turn in late-twentieth-century social scientific research led to a focus on the assessment of neighborhood effects on individual outcomes. Social disorganization theory has been a guiding framework for this literature, elaborating a process through which compositional and collective characteristics of a neighborhood, including concentrated poverty, residential instability, and racial/ethnic heterogeneity, weaken social connections among neighbors and reduce community involvement (Sampson 2012, Sampson & Groves 1989, Sampson et al. 1997). Given these theoretical underpinnings, research on activity space has primarily focused on urban context. Extending these concepts and methods to rural spaces allows both for fundamental comparative work across urban and rural areas and unprecedented documentation of the form and span of activity space in rural context.

In this assessment, we sought to draw on these fundamental tenets but extend activity space concepts and methods in several important ways.

First, unlike previous studies that have been conducted in urban settings, we sought to determine the feasibility of conducting the study in rural and non-rural settings. By including participants in both settings within the same study, we were able to assess whether a study with comparable protocols for data collection was feasible across settings. In particular, we employed exactly the same survey instrument for participants residing in both settings to ask about what activities they were engaged in and their effects throughout the day during the same period of time. Furthermore, we used the same protocols and software to monitor activity-related movement. Both the survey instruments and software for monitoring movement throughout the day were designed to be comparable to those employed in the NIA-funded study, *Activity Space, Social Interaction and Health Trajectories in Later Life*, being conducted in urban neighborhoods of Chicago, Illinois. The PI of the Chicago-based study is Dr. Kathleen Cagney, one of the investigators of this study. These design features of the current study, i.e., the use of instruments and movement protocols employed in an urban setting and administered on participants residing in both rural and non-rural settings, allowed us to assess the feasibility of extending the study to non-urban contexts.

Second, this study was also designed to assess a fully remote implementation of the survey and survey protocols in both rural and non-rural settings. That is, this study was conducted with a minimum of interviewer-respondent interactions, i.e., recruitment, consenting and the study itself

were all handled remotely, i.e., without in-person care, with few exceptions.[1] Rather, almost all interactions were handled with telephone conversations and/or text messages. This approach was necessitated, in part, because the field work for this assessment was conducted during the COVID-19 pandemic, which required minimizing all in-person contact between respondents and field staff.

Third, unlike the *Activity Space, Social Interaction and Health Trajectories in Later Life* in which participants were supplied with study-specific phones, the participants in this study were encouraged to use their personal mobile devices. As a result, this required installation for all the platforms used for conducting the surveys and location tracking (MetricWire) to be done on alternative smart phones (iPhones running iOS or Android phones using Android OS). To conduct this assessment, we employed samples of participants from two ongoing studies being conducted in the State of North Carolina. One sample was drawn from participants of a longitudinal study, Research on Adaptive Interests, Skills, and Environments (RAISE), conducted by the Center for the Study of Adolescent Risk and Resilience (C-StARR) at Duke University. This study began in 2015 and consists of families across North Carolina. Designed to assess the development of self-regulation across adolescence, with a particular focus on the consequences of self-regulation deficits, participants of this study consist of parent and child dyads. For the current study, parents from this study were contacted and ranged in age from early 30s to late 50s. Two of the PIs for Project RAISE, Drs. Rick Hoyle (Duke) and William Copeland (U. of Vermont) also are investigators of this study. We drew a second sample from participants in the longitudinal, community-representative Great Smoky Mountains Study (GSMS). The latter ongoing study consists of participants that reside in the western region of North Carolina. Originally designed to study mental health and substance abuse of adolescents, including Native American Indians who are members of the Eastern Band of the Cherokee Nation, the study began in 1996, thus the participants are now in their mid-30s and early 40s. This decision to draw samples from these two studies dramatically reduced the costs of conducting this study, allowing us to work with participants of ongoing studies that had existing operations and field staff who could conduct our study. We also could draw from a set of participants who had ongoing relationships with the study and field staff; this meant that they were more likely to be open to, and accommodate, this new form of data collection.

For data collection and recording of spatial movements, we employed the platform used in the earlier Chicago study, MetricWire, a mobile phone enabled survey platform. For seven consecutive days, participants completed three short daily surveys (morning, afternoon, and evening) while the MetricWire app collected their second-by-second geo-coordinates. On the eighth day, participants completed an end-of-study survey to summarize their experiences during the past week. Participants were compensated $5 for each daily survey completed, $10 for the final survey, and a $20 bonus if they completed 15 or more daily surveys for a total possible compensation of $135.

This report includes a detailed account of the successes, challenges, and recommendations that emerged from this assessment of implementing comparable protocols to measure participants' activity spaces in rural and non-rural settings using participants' own mobile devices. This report also includes a number of metrics that highlight specific details related to this study design.

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[1] In a few instances, subject payments were provided in-person to participants from the GSMS component of the study.
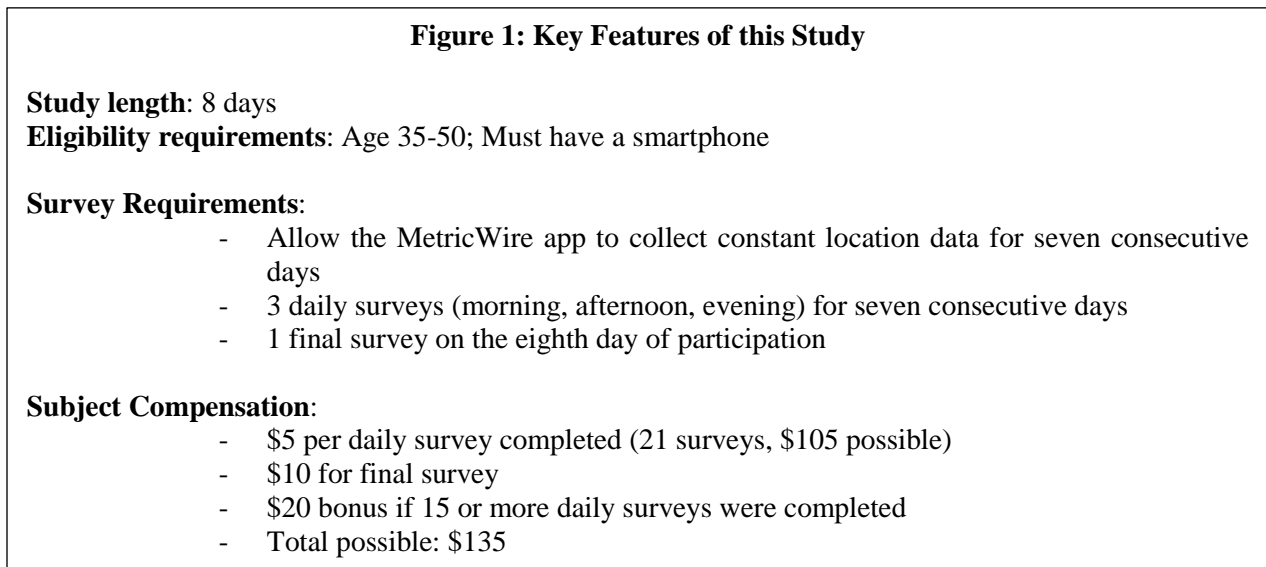
Study Activities

Study Design

As noted above, the design of the study had several key features. It used the same protocols from the *Activity Space, Social Interaction and Health Trajectories in Later Life* in both rural and non-rural settings, was administered remotely, and allowed participants to use their own smart phone rather than study-supplied ones. The overarching aim was to assess the feasibility of this data collection approach in more remote areas – spaces which may pose both technological and logistical challenges – so that other investigators may more easily and effectively implement such an approach moving forward.

The research team developed the study design, survey items, budget, and general recruitment plan over the course of 18 weeks. The team outlined the survey structure, budget structure, and meta-data collection needs, relying heavily on protocols from the prior Chicago-based study. Once the study design was finalized, the survey items were delivered to a research technician for programming and testing. The MetricWire dashboard requires approximately one minute per item for programming. The final set of surveys included a total of 354 items, which required approximately 6 hours of programming. Challenges related to survey programming in MetricWire are discussed in Challenges section (p. 10). To accurately assess feasibility metrics for this study, members of the research team created tracking tools for data collection (e.g., daily surveys completed, date of consent, etc.) and meta-data (e.g., how often issues arose, how long it took to recruit participants, etc.). The template for these tools is included in the Supplemental Materials available upon request.

Figure 1 provides a summary of the key features of this study.

Figure 1: Key Features of this Study

Study length: 8 days
Eligibility requirements: Age 35-50; Must have a smartphone

Survey Requirements:
- Allow the MetricWire app to collect constant location data for seven consecutive days
- 3 daily surveys (morning, afternoon, evening) for seven consecutive days
- 1 final survey on the eighth day of participation

Subject Compensation:
- $5 per daily survey completed (21 surveys, $105 possible)
- $10 for final survey
- $20 bonus if 15 or more daily surveys were completed
- Total possible: $135

Getting IRB Approval

The two larger samples from which participants were drawn have been studied by the RAISE and GSMS teams across many years, requiring multiple reviews by the Duke Institutional Review Board (IRB). Prior requests for IRB approval of new data collection had been reviewed by the

medical IRB for the GSMS sample and the "campus" IRB for the RAISE sample. Although the feasibility study protocol was the same for the two samples, the team decided to apply separately to the IRB that had reviewed prior protocols for each sample. Key considerations for the feasibility study were (1) how this study related to the overall goals of each project (2) how contact information would be managed in order to protect privacy, (3) how reports of illegal behaviors (e.g., use of illicit drugs) would be protected, (4) how geo-location information would be used without disclosing participants' identity, and (5) the security of data initially stored on MetricWire servers and the transfer of data from MetricWire to the cloud-based service used by Duke for data storage. Critical to each of these considerations was the deidentification of data by the data collection team prior to transferring it to the data analysts. The most time consuming aspect of the review for both IRBs concerned approval following a risk assessment of the MetricWire app. MetricWire developers were required to provide detailed information about features of the app and their handling of data with respect to privacy and security. The study was able to move forward only after review and approval by the Duke Office of Information Technology, which was required before grant funds could be used to purchase a license. The time period from initial submission to final approval was two months for the campus IRB and 2 and a half months for the medical IRB.

Testing of Survey Instruments

The survey instrument was thoroughly tested for a period of three months prior to the study launch. First, the primary research technician who programmed the survey in MetricWire tested the survey for approximately one month to check that the MetricWire app was delivering the surveys as intended and scheduled. Next, members of the research team and outside volunteers tested the daily surveys using their personal devices. This pilot testing was conducted in two phases. In the first phase, three members of the research team loaded the software on their mobile phones and completed the daily surveys for 3 days without using an official study protocol. A small number of adjustments were made to the protocols based on the experiences from this initial group. In the second phase, seven additional research affiliates volunteered to participate in a full 7-day pilot using a complete study protocol (i.e., participants were provided official recruitment materials, sent all daily surveys, and asked to share location data). Across the two phases, a total of ten individuals ($N = 10$) participated in testing the protocols.

During this testing period, there was one day during which many testers received two surveys erroneously. The research technician reached out to the MetricWire support staff and learned about a server-side issue that caused some surveys to be sent twice. The issue was quickly resolved. Following this internal pilot, a feedback survey was sent to all participants. Eight testers responded with thoughts on how recruitment and the surveys might be improved. Once the pilot ended, the primary research technician downloaded a sample of the survey and location data to check that the data files were outputting properly. A final meeting was set to discuss the pilot and resolve final issues prior to launch.

Recruitment of Study Participants

As previously noted, participants were recruited from two well-established recruitment pools. The first pool included participants who had previously participated in the longitudinal study, conducted by the C-StARR at Duke. The second pool included participants that were members of the long-running GSMS project. Both samples included respondents who reside in rural areas of North

Carolina as well as some who reside in urban and suburban areas of the state. The main eligibility criteria required participants to be (1) between the ages of 35 and 50 and (2) have a smartphone.

To prepare for **recruitment from the RAISE sample**, a member of the C-StARR research team created a spreadsheet with the home addresses of eligible participants and the corresponding Rural-Urban Continuum Codes (RUCC) based on those addresses. Once the RUCCs were identified, participants were split into urban and rural groups based on these codes (urban 1-3; rural: 7-9) for recruitment. The utility of using the RUCC for rural-urban distinction is discussed in the Challenges section (p. 10). The initial plan was to recruit 20 participants from the urban group and 20 participants from the rural group; however, based on high response rates and positive feedback from participants, recruitment continued beyond this initial target of 40 and expanded to include participants living in suburban areas (RUCC values of 4-6).

RAISE participants with different RUCCs were evenly assorted into 13 batches. The study consent form was programmed in Qualtrics by the primary research technician with the assistance of two other staff members and was then used to recruit and enroll all RAISE participants. The number of participants in each batch ranged from 2 (pilot batch) to 43. Participants from RAISE were initially recruited via an email sent through Qualtrics at the start of the week. For the first two batches, participants who did not immediately respond received a direct email reminder from a student recruiter 1-2 days after receiving their Qualtrics invitation. Starting with the third batch, participants received reminder emails through Qualtrics as this yielded a similar result to the direct emailing, but was more time-efficient (1st reminder: 1-2 days after initial email; 2nd reminder: 6-7 days after initial contact; 3rd reminder: 10-14 days after initial contact). The full recruiting flow is included in the Supplemental Materials (p. 23).

A total of 377 members of the RAISE sample were contacted and 188 (49.9%) consented to be in this study, i.e., they completed the consent form after receiving it. However, it was determined that only 170 of the 188 RAISE sample members were eligible for this study (90.4% of those that consented); 15 were over the age of 50 and 2 were under the age of 35 and 1 did not have a smart phone. Of that 170 that consented and were eligible, 162 RAISE sample members ended up participating in this study or 95.3% of those who consented and were eligible. So a total 162 ($N =$ **162**) of the RAISE sample members participated in this study. See **Table 2** for details of the recruitment breakdown for the participants in this study from RAISE. Also see **Table 1** for the distribution of the RAISE study participants by RUCC values.

A total of 43 members of the RAISE sample resided in **rural areas** (RUCC codes 6-9) and 333 resided in **non-rural areas** (RUCC code 1-5) were contacted to participate in this study. 27 from rural areas consented to participate (48.3%) and 161 from non-rural areas consented (62.8%). Of those that consented to participate, XX (YY%) of those residing in rural areas were determined to be eligible and XX (YY%) of those from non-rural areas were eligible. members that participated in this study, 23 participants resided in and 139 participants resided in. Of those that consented and were eligible, a total of 23 (85.2%) residing in rural areas and 139 (86.3%) residing in non-rural areas participated in this study. See **Table 3a** for details of the recruitment breakout of RAISE participants by their rural and non-rural status.

The **GSMS** is a mixed urban-rural sample, but this study exclusively recruited participants that

were **American Indians living in rural areas**. The **recruitment goal** was to recruit 20 participants from the GSMS sample. Eligible participants resided in mountainous nonmetropolitan counties that fall within RUCC codes of 6-9. Recruitment for this study was conducted via direct contact by the primary GSMS recruiter. The primary recruiter sent both an email and a text to participants to provide information on the study and to gauge participant interest. Consenting was completed by phone with the recruiter reading the consent to the participant. For participants who were interested in participating, verbal consent was obtained by the primary recruiter. A copy of the signed consent was sent to the participant by email or mail. If participants did not respond after the first contact attempt, they received a second call and/or text. Recruitment progressed quickly and smoothly during the first five weeks of recruitment and then slowly declined in pace following week five as fewer participants were interested in participating. The target goal of 20 participants was met (20 of 49 participants approached or 40.8%). Thus the **GSMS sample size was $N = 20$**, **all of which**, by design, **resided in rural are**as.

The combined RAISE and GSMS samples for this study resulted in an **overall sample size of $N = 182$** for this study (see **Table 2**), of which **43 resided in rural areas** and **139 resided in non-rural areas** (see **Table 3b**).

Tables 2-7 provide some additional statistics for various aspects of the enrollment process for the target samples and respondents from each of the two samples, RAISE and GSMS.

Enrollment

Once a participant consented, the primary research technician sent an email with enrollment information within 24 hours. If participants completed the consent form before 4pm, they received enrollment information within a few hours and were invited to begin the following day. If participants completed the consent form after 4pm, they were contacted the following morning for enrollment two days after their consent date. This time frame proved most effective as it typically gave participants enough time to set up the app on their mobile devices before their start date. After participants received the enrollment information email, they were sent an invitation from MetricWire to download the app and join the study. This invitation email was typically sent within 5-10 minutes of the informational email so that participants could quickly and easily get set up. Samples of the enrollment information email and the MetricWire invitation email are included in the Supplemental Materials (pp. 33-34, 23).

Monitoring

The primary research technician monitored participant enrollment, completion of daily surveys, and location sensors. After a participant was sent an enrollment email, their MetricWire account was monitored that afternoon and then early the following morning (between 7-9am) to check on their enrollment status. If a participant did not download the app and enroll in the study by 9am the morning of their start date, they received a direct text and/or email reminder to get their study set up. Based on the participant's response, the account was adjusted as needed to get participants started on time. This adjustment process will be discussed further in the Troubleshooting section below. Once a participant enrolled in the study through the MetricWire app, the primary research technician monitored their completion of daily surveys and responded to any troubleshooting issues that arose. Daily survey completion, troubleshooting contact, and payment amounts were

tracked in Excel files in Duke's cloud-share application (Box) (see Supplemental Materials folder). Occasionally, weekend monitoring was necessary to keep participants on track and ensure they were paid on time; however, to avoid this, the majority of recruitment and enrollment contact was initiated at the start of the week (Monday-Wednesday).

Tables 8-10 provide daily completion and compliance rates for the RAISE, GSMS and combined samples and **Table 11** displays the average number of daily surveys, broken out by mornings, afternoons and evenings, for the subjects in these samples.

Troubleshooting

RAISE participants were principally contacted by the primary research technician when issues arose, however, there was an additional staff member who would also occasionally communicate with participants regarding enrollment issues. GSMS participants were contacted by the main recruiter on the GSMS team. The primary C-StARR research technician would alert the primary GSMS recruiter to any issues and then the main GSMS recruiter would communicate this information to the GSMS participants. There were two main routes through which troubleshooting issues were identified:

(1) *The MetricWire dashboard.* The dashboard alerted the technician if a participant: a.) Stopped uploading location for 24 hours or b.) Missed a day of surveys (All 3 daily surveys in a 24-hour period). The dashboard was not set up to alert the technician if participants didn't enroll on time, so this was monitored directly by the technician.

(2) *Direct Participant Contact*. The second approach for identifying issues was from direct participant contact. This included any time a participant emailed/texted/called a recruiter to ask a question or raise a concern about the app and/or study.

Table 12 provides a summary of the frequency that participants had issues for the two samples and the combined sample, while **Table 13** summarizes the frequency of the various issues that required troubleshooting. **Table 14** displays the distribution of participant preferences for the alternative types of contact for the RAISE sample and **Table 15** provides the distribution of the modes of contact that were used to reach study participants for the RAISE, GSMS and combined samples.

Study Completion

Upon successful completion of the study, participants received a message from the MetricWire app instructing them to un-enroll from the study, sign out, and then delete the MetricWire app. Not all participants un-enrolled from the study before deleting the app and so payments were issued once the window for the participant's final survey ended (8pm on Day 8). **Table 16** provides a broad summary of the study timeline, including design and development, programming and testing, data collection, data retrieval and analysis. **Table 17** provides a more detailed timeline with week-to-week descriptions of the study activities.

Compensation Schedule

Table 18 summarizes the payments participants could receive for completing the daily surveys

and the final survey. Note that participants who completed 15 or more of the daily surveys received a bonus of $20. **Table 19** summarizes the distribution of participant payment types, i.e., in cash, check or gift cards, across each sample.

Successes

Despite challenges (detailed below), overall, we found that the ability to implement comparable protocols for measuring individuals' activity spaces in both rural and non-rural settings with participants own mobile devices was an overall success. We summarize these successes across the various activities of the study.

MetricWire

Participants found the MetricWire app to be easy to navigate and had little issue completing the surveys. Participants were able to download the app on their personal device, making it convenient and accessible. The MetricWire survey system itself is well-suited to run EMA studies and functioned better than alternative systems (e.g., Qualtrics) for this purpose. The app was also able to retrieve large amounts of location data without requiring much effort from participants beyond the initial setup.

The MetricWire dashboard offered several features that minimized the manual effort required from the research team. For example, the dashboard raised alerts when participants: (1) missed a day of surveys; (2) did not upload location data for 24 hours; and (3) unenrolled from the study. The study alert system provided researchers with the ability to set a variety of conditions for receiving alerts. This system reduced the amount of manual data checking required and minimized any potential user error. The MetricWire dashboard also provided our team with the ability to schedule survey reminders and create unique messages for these notifications. The ability to preschedule such reminders reduced the burden on the recruiters for this study.

MetricWire – Sensors

MetricWire was particularly suited to our needs in this study because of its ability to closely track participant location data via passive geo-location sensing. Participants simply needed to turn on a setting on their smartphone to allow the MetricWire app to access their GPS systems and then the rest was automated. This feature was a benefit to our team because it allowed us to easily implement the study protocols remotely with participants and ultimately resulted in an impressive amount of location data for each participant.

MetricWire – App Notifications

The MetricWire dashboard offered our team the ability to preschedule survey triggers and survey reminders according to our desired schedule. Specifically, we were able to schedule survey triggers to be sent at random within a specific time interval and then schedule survey reminders on a consistent schedule following the initial random trigger. This flexibility was critical and beneficial for our study.

MetricWire – Data Retrieval

Retrieving data from the MetricWire dashboard posed several challenges that are discussed below; however, there were two notable benefits of using MetricWire for this purpose. First, the MetricWire dashboard included numerous options for uniquely tailoring data files prior to exporting them. This ability to format the files as needed prior to data retrieval was advantageous for our team because it reduced the amount of manual data cleaning required. Second, MetricWire support staff provided our team with R scripts that were designed to allow researchers to quickly and easily pull data from the MetricWire dashboard. This script was essential for retrieval of the location data files and significantly decreased the time spent retrieving the files.

Recruitment

Participants were generally enthusiastic about enrolling in this study. In their feedback, participants commented on the ease of the MetricWire app, the generous compensation, and the constant availability of support from the recruiters. Participants also felt that the enrollment instructions for the study and downloading the MetricWire app were clear and easy-to-follow. Providing user guides and detailed instructions during enrollment reduced the number of participant questions and is highly recommended for future studies.

COVID-19 Pandemic

This study was conducted during the COVID-19 pandemic, when many individuals were required to adhere to governmental restrictions related to travel and mobility. The study launched on March 2nd, 2021 and ended on June 11, 2021. The several months during which the study ran were characterized by a variety of changes surrounding pandemic-related restrictions in place across North Carolina. The study began shortly after Governor Roy Cooper announced Executive Order No. 195, effective March 23, 2021, which lifted the nightly curfew and allowed for the opening of the indoor areas of bars and amusement parks; however, several capacity restrictions remained in effect (Exec. Order No. 195, 2021). Several Executive Orders followed that continued to ease restrictions within the state (for a complete list, please visit North Carolina COVID-19 Orders and Directives). For example, Executive Order No. 204, effective March 26, 2021, increased capacities for mass gatherings and eliminated the cap on the number of individuals allowed to gather time in certain indoor spaces, such as bars (Exec. Order No. 204, 2021). Executive Order No. 215, effective May 14 , 2021, most notably reduced restrictions as it ordered that face masks were no longer required in most settings and lifted capacity restriction and social distancing requirements in most settings (Exec. Order No. 215, 2021).

It is important that the changing nature of restrictions within the state of North Carolina be considered when interpreting the results of this study. These restrictions limit the conclusions that can be drawn from these data; however, the success of the feasibility evaluation is nonetheless impressive. Recruitment reached higher numbers than expected and participants were highly compliant. The ongoing global pandemic required that this study be conducted remotely and that collaborators work remotely. Despite this modality, the study progressed smoothly and successfully. Given the experience of our team under such adverse circumstances, we can confidently argue that this study can be conducted remotely, opening the possibilities for future implementation in remote locations that are otherwise more difficult to access.

Administrative

This study was not only a success in terms of the high participant yield and compliance rates, but also because of the team's ability to closely monitor every step of the process. The metrics included in this report were all calculated using the tracking tools created for the study. The tracking system used in this study allowed for easy collaboration between groups and kept participant information both secure and protected. Without tracking tools, errors in compensation and study enrollment would be likely. Finally, the informational guides and emails created for this study proved to be essential tools in reducing the burden on recruiters. Creating user guides for studies like this is a crucial step in ensuring successful data collection.

Enrollment

In order to set up the MetricWire app, participants were asked to follow a set of steps outlined in the informative guides recruiters shared with them. These guides provided instruction on how to download and set up the MetricWire app. The user guides that were created for this purpose were well-received by participants and appreciably reduced the amount of study-related questions. The MetricWire app itself is also laid out in a neat and organized manner that made it easy for users of any technical level to enroll in the study.

Setting up the MetricWire App and location settings

Participants were required to set up their smartphone settings to allow the MetricWire app to access both their location data and notification settings. Though it was occasionally challenging to ensure that the settings were correctly adjusted, most participants had no issue setting up their devices for this purpose. As noted above, the MetricWire app is a user-friendly system and is likely to be accessible to a wide range of participants.

Prior to study launch, our team had concerns about whether participants would be hesitant to share their location data, however, this concern quickly dissipated following the first few enrollments. Participants had few issues with this requirement and generally felt comfortable sharing their location data for the entirety of the study. It is possible that the long-term relationships already built with these samples aided us in this manner. That said, it is our hope that even in an unfamiliar sample such trust could be built via clarity and transparency during study recruitment and reminders that their data are protected and not identifiable at the individual level.

Device differences

Participants were asked to use their own smartphones for this study, so we had no control over the use of iOS versus Android devices. Though this posed some data challenges that are discussed below, this was advantageous because it eliminated a device-related inclusion criterion and allowed us to assess the utility of these two devices in a study of this nature. Overall, both devices worked well for this study.

Challenges

While we found that the overall implementation of comparable protocols for measuring activity

spaces in both rural and non-rural settings was successful, we did encounter a number of challenges. We summarize them for the various components of the study.

MetricWire – Dashboard

The research team chose MetricWire as the survey platform for this study because of its ability to closely track geolocation and its fitness for a daily EMA study and because it was used in past waves of the GSMS, RAISE, and the NIA Activity Space studies. However, there were several challenges with the survey system on the researcher side. The first set of issues related to MetricWire's survey programming capabilities. At the time of the study (2020-2021), MetricWire did not include the option to create matrix-type survey questions. Because of this, the research team had to alter the initial survey design to work within the system parameters. In addition, when programming items into MetricWire, each item needed to be individually named, coded, and then saved before moving to the next item. The inability to name groups of items (e.g., name a set of items in a scale) and the lack of an autosaving feature added additional time to survey programming.

The MetricWire dashboard also posed a few challenges when monitoring participant activity over the course of the study. Because participants could vary in the length of their study (e.g., if a participant missed a day of surveys, their study would be extend to be a total of 9 days instead of 8 days), all participants had to be enrolled in their own "study" on the MetricWire dashboard. This meant that every time a participant consented, the master study would have to be copied, edited to reflect the correct dates for participation, and updated to turn on the necessary tracking features (e.g., turn on study alerts for any issues that might arise). The primary research technician would then need to copy and paste the participant's name and email address to invite them to join the study. This took about 5-6 minutes per participant to complete and required careful attention to detail.

At times, the MetricWire dashboard would freeze for up to 20 minutes for issues that were never fully understood despite attempts to reach out to the MetricWire support staff. This delay would disrupt study activities and occurred sporadically. The dashboard would also occasionally not properly save changes made to participant accounts. This once occurred when scheduling participant surveys and led to surveys being sent out at the wrong time. Luckily, the issue was caught and resolved quickly, but it was an issue that again seemed to occur randomly.

MetricWire – Sensors

During the testing phase of this study, the research team attempted to turn on several of the available sensors (e.g., geolocation, pedometer, and accelerometer). The use of multiple sensors and the length of the surveys (~90 items/survey) caused the app to crash when completing the surveys. The MetricWire support staff suggested choosing only one sensor to resolve this issue so the team chose to only use the location sensor. For studies requiring multiple sensors, this may pose a challenge.

MetricWire – App Notifications

During active data collection, a few complaints were received regarding participants not receiving notifications. Sometimes these issues were related to participant error (i.e., participants missed the

notification before the survey expired); however, others seemed to be app-related. When this issue would arise, the primary research technician instructed participants to log out of their account and then sign back in and this often resolved the issue. Again, this issue seemed to occur randomly so it is possible future groups may encounter this issue again.

MetricWire – Data Retrieval

Retrieving data from the MetricWire dashboard proved to be unusually time-consuming and arduous compared to other survey platforms like Qualtrics. The primary research technician first attempted to download the location files directly from the MetricWire dashboard, however, this attempt failed as it took several days for the files to be delivered because of their size (~100MB). The location data files were then retrieved using an R script that worked initially, but then stopped working partway through data retrieval. The issue that led to the R script not working was related to a server-side issue that was resolved in a few weeks, but nevertheless delayed data retrieval. Using the R script, it took about 4-5 minutes to pull the location data for each participant and then upload these data to a secure server (about 15 hours for 182 participants).

Retrieving the daily survey files proved to be even more difficult as this was done manually. MetricWire's default output format did not match the format needed for analysis so each file needed to be customized within the dashboard before being exported. In addition, multiple files could not be downloaded at once because this created a long delay in the retrieval of the files. It took about 5-6 minutes to download the survey data for each participant (about 18 hours for 182 participants) and this resulted in collections of survey files that would later need to be manually merged and reorganized.

Recruitment

The recruitment stage for the RAISE sample posed a unique challenge in that the research team needed to sort through participant addresses to determine each participant's RUCC value. However, on preliminary examination of the final survey data, it was clear that the RUCC designations did not always match the participant's self-reported rural-suburban-urban designation. This meant that the categories created prior to study recruitment did not align with participants' view of the area in which they live. **Table 20** compares the RUCC designations of sample participants displayed in **Table 1** against the participants' self-described area ratings. There are marked differences between the two classifications, with notably fewer participants self-designating as residing in rural areas and urban areas, and many more self-designating as living in suburban settings, than based on the RUCC code classifications of their residential locations.

Enrollment

Study enrollment posed several recruitment challenges. Because a participant's study account was created with specific participation dates, it was important that participants enroll in the study in the MetricWire app before their official start date. If a participant was not enrolled by the time of their scheduled start date, a reminder was sent to that participant and, in some instances, a new start date was established.

Setting up the MetricWire App and location settings

Participation criteria also required that participants set up their smartphone settings in a specific way to allow the MetricWire app to collect their location data. Ensuring that participants completed this step correctly proved to be challenging because the recruiter could not check a participant's device and needed to rely on just verbal communication, but also proved to be challenging because of inadequacies on the MetricWire dashboard. Manually checking a participant's location sensor can be done in one of two ways on the MetricWire dashboard: (1) by looking at a map view of a participant's movement; and (2) by downloading the participant's current location file from the dashboard (this was prior to receiving the R script for downloading location data). The first option was not a feasible choice as it would be invasive and was not permitted by the IRB. The second option was too time-intensive to be feasible (location files would take hours to days to download depending on their size).

The final option was to let the MetricWire dashboard automate monitoring of a participant's location data. If the system detected that a participant had not uploaded location data within 24 hours, then the dashboard would alert the technician and the technician would contact the participant. This was the system used in this study and though it generally worked, it was flawed. If a participant uploaded only a single point of location data within 24 hours, no alert would be sent. Participation in the study required that participants allow the research team to continually track their location data over the course of the study, so this lack of continuous data flow became problematic. Although this specific issue was not frequently encountered, it is a potential challenge of the automated monitoring system.

Device differences in Measuring Movement

Upon retrieval of the location data files, there was a clear difference between the data of iOS users and Android users. Participants with an iOS device uploaded about 10x more location data than Android users. The MetricWire support staff informed the research team that Android devices only upload location data points a few times an hour in an effort to mitigate battery drain; whereas, on iOS devices, location data are pulled every second regardless of battery drain. There are also differences in the setup required for each device, so two sets of instructions and user manuals had to be created to support both device types.

Management of the Data Collected on Movements

Another challenge was the retrieval and management of the data collected on participants' movements over their 7-day study period. In order to retrieve the location data files, an R script was run for each participant to retrieve an Excel file with all data points from the participant's mobile device over the course of their 7-day study period. It took 3-5 minutes to run the script each time, which totaled to about 15 hours for 182 participants. Once the files were retrieved, they were uploaded to Box and the local files were deleted. The size of the files ranged from about 112 MB (~500,000 rows of data – iOS devices) to under 1 MB (~2000 rows of data – Android devices). There was also variability within iOS and Android devices.

Staff Time and Effort

The staffing required for this study is significant. In particular, both recruitment and participant

management required nearly constant monitoring from both the primary research technician and study recruiters. It was critical that participants were monitored closely to ensure that the Metric-Wire app was functioning correctly and that participants were engaging with the app as needed (i.e., completing daily surveys and uploading location data). The primary research technician and recruiters also had to be diligent and attentive to any participant issues that arose. It was necessary to respond quickly to such issues in order to minimize data loss and potential participant frustration. Because of this, the staff members involved in active data collection were on-call for participants nearly 24/7, leading to some weekend and evening work.

Recommendations

Based the findings of this assessment, we offer a number of recommendations to aid in the design and implementation of future studies of individuals' activity spaces in different geographic settings and mobile devices.

Staffing

To begin, we would like to acknowledge that the staffing burden for the current study was significantly reduced because of the use of existing study populations and existing recruiting staff. The recruitment leaders for both GSMS and RAISE were highly familiar with the study participants and had already built a great degree of trust. Because of this, it is possible that the high rate of participation (and compliance) was in direct relation to the recruitment of well-known participants. We anticipate that recruitment would require more time and effort for samples drawn from unfamiliar populations and recommend revising and enhancing the recruiting strategies outlined here to ensure success.

Overall, for a study with a target sample of 100-200 participants, we recommend employing a minimum of three staff members to manage testing, data collection, and data retrieval. We suggest that these staff members fill the following roles:

1. Primary MetricWire technician (in charge of programming, testing, and monitoring MetricWire)

2. Primary recruiter (in charge of recruiting participants and responding to participant concerns)

3. Recruiter/backup MetricWire technician (fulfill both roles as needed)

The testing phase of the study is not time-sensitive and could be prolonged or shortened depending on the availability of the staff and the primary research questions. As such, this phase of the study could be completed by one or more staff members and could last several weeks to several months depending on the timeline outlined by the research team. The estimated amount of hours to feasibly and carefully test the study protocol before launching is about 80 hours. The daily tasks required during active data collection (enrolling participants, monitoring daily survey completions/location sensors, and troubleshooting issues) are time-sensitive and would require about 2-4 hours each day from all three staff members. Enrolling participants and monitoring their participation can easily be completed within standard office hours; however, troubleshooting may require evening and weekend time. Participants may not always be able to respond during business hours so it is at the discretion of the team to decide whether to offer evening and weekend support. Round-the-clock

support was offered in the current study and is highly recommended as it yielded a positive response from participants.

Finally, we also would like to note that it is essential to ensure that data management and analysis experts are recruited prior to launch to ensure that the data can be properly handled and analyzed. In particular, for studies that include the collection of location data using the MetricWire app, it is necessary for there to be a staff member available to analyze geocoded data.

MetricWire

We suggest dedicating several weeks to testing the study on MetricWire before launching. This extensive testing period was crucial to the success of the feasibility study. During this testing period, we recommended conducting one or more internal pilots and then at least one external pilot. It is also recommended that surveys be kept short (under 100 items) and that only one sensor be used at a time to avoid app delays or crashes. For studies in which sensor data will be collected, we also suggest, if possible, restricting participants to a single device type (Android or iOS). Android and iOS devices differ significantly in the amount of location data they can retrieve and this variability is likely to pose a challenge in data analysis. Alternatively, the sampling rate for iOS devices could be reduced to correspond to that of Android devices.

When considering other emerging technologies for a study of this nature, we recommend choosing platforms that allow for the simultaneous distribution of EMA surveys and retrieval of passive sensor data. MetricWire worked well for this study because it allowed all research operations to be centralized within one survey system. We also recommend selecting a platform that is user-friendly so that it is possible to implement the survey protocols remotely. Finally, we highly recommend careful assessment of the data retrieval options provided by the survey company in order to make appropriate prior staffing arrangements for data download, cleaning, and analysis. We note that the technologies in this area are rapidly change so assessing the options at the outset of studies in this area is advisable.

Enrollment

We recommended providing clear instructions to participants and sharing additional materials with them (e.g., user guides) to avoid any obscurity in app setup and study completion. In this study, we provided a detailed email (see Supplemental Materials p. 24) and user guides (see Supplemental Materials folder). Though not used in this study, it may be beneficial to create a webpage with these instructions and potentially video tutorials to guide participants through app setup. Participants will vary in their need for support, so it is important to be as thorough as possible. In this study, there were three recruiters available to answer participants' questions and respond to participants' concerns. The staff's availability to participants was crucial in mitigating attrition.

Compensation

We recommend compensating participants via the same structure proposed in this study. We also suggest offering multiple routes of payment (e.g., cash, check, gift card) to participants if possible.

Data retrieval

We suggest retrieving data files shortly after participants complete their study. In this study, all data retrieval was completed once active data collection had finished. This process took several weeks and delayed the overall study timeline. As such, we recommended working through data retrieval concurrent to data collection if possible.

Data cleaning/analysis

As described earlier, the daily survey data files had to be downloaded individually from the MetricWire dashboard. Following data retrieval, the research team had to then manually merge and reorganize the daily survey data files in order to conduct analyses. This was both time-consuming and onerous. We recommend that other teams carefully assess the exporting options of a survey platform prior to study launch and that retrieval begin during data collection if possible.

Study Infrastructure Needed to Conduct Such Studies

We recommend having a minimum of three staff members working on a study of the same magnitude as the one described herein during active data collection. One staff member should program the study in MetricWire and conduct thorough testing with both an internal and external pilot. This staff member will be the resident expert on the study and will monitor the dashboard over the course of data collection. The two other staff members will primarily work as recruiters in that they will: (1) contact participants to obtain consent; (2) answer participant questions; and (3) respond to issues related to the study. These two staff members will work closely with the MetricWire dashboard manager to monitor participants over the course of the study and to continually update the study tracking tools.

And, to repeat, we suggest having a staff member working on retrieving data files for completed participants as data collection is still ongoing. This is optional, but, if desired, could be completed by either the MetricWire dashboard manager or by a fourth staff member. The time required for these activities is typically between 2-3 hours each day (for 10-15 active participants). If staff members have greater availability to devote to the study, the number of participants enrolled concurrently could be increased. Compensation is another major consideration for a study of this nature. It is important that participants are adequately compensated for their time and so it is critical to consider the budget available before determining the target number of participants. Finally, depending on the sensor data retrieved from the MetricWire dashboard, it is important to ensure that there are staff available with this ability to analyze geocoded data as this cannot be done through the MetricWire dashboard.

Concluding Comments

This pilot study was able to effectively evaluate the feasibility of collecting activity space data across a range of geographic locations. These findings have important implications for comparative work, and for research in remote areas where other forms of data collection might not be logistically or monetarily possible. The challenges identified are addressable, and likely technological advancements will make data acquisition and retrieval more effective in the near future. The pilot suggests great promise in activity space approaches, and the integration of such

work with other forms of data collection.

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Table 1: *RUCC breakdown & # of participants in each category in final RAISE sample*

RUCC	Description	Final N
1	Counties in metro areas of 1 million population or more	45
2	Counties in metro areas of 250,000 to 1 million population	71
3	Counties in metro areas of fewer than 250,000 population	1
4	Urban population of 20,000 or more, adjacent to a metro area	19
5	Urban population of 20,000 or more, not adjacent to a metro area	3
6	Urban population of 2,500 to 19,999, adjacent to a metro area	19
7	Urban population of 2,500 to 19,999, not adjacent to a metro area	1
8	Completely rural or less than 2,500 urban population, adjacent to a metro area	3
9	Completely rural or less than 2,500 urban population, not adjacent to a metro	0

Table 2: *Recruitment breakdown for RAISE, GSMS, and combined samples*

	RAISE	GSMS	Combined
Total # contacted	377	49	426
Total # consented	188	20	208
Of consented, total # eligible[1]	170	20	190
Average # of contacts to get consent	1.33	1.5	1.35
Total # that participated (*N*)	162	20	182

[1]Breakdown of participants that were ineligible: Age > 50: 15; Age < 35: 2; No smartphone: 1

Table 3a: *Recruitment breakdown for RAISE sample – broken down by RUCC designations*

	Non-Rural	Rural
Total # contacted	333	43
Total # consented	161	27
Of consented, total # eligible	XX	XX
Average # of contacts to get consent	1.27	1.59
Total # that participated (*N*)	139	23

Non-Rural: RUCC 1-5; Rural: RUCC 6-9

Table 3b: *Recruitment breakdown for Combined sample – broken down by RUCC designations*

	Non-Rural	Rural
Total # contacted	333	92
Total # consented	161	47
Of consented, total # eligible	XX	XX
Average # of contacts to get consent	1.27	
Total # that participated (*N*)	139	43

Table 4: *Recruitment – Contact frequency for RAISE – broken down by RUCC designations*

	All RAISE	Non-Rural	Rural
Max # of contacts	7	7	6
Min # of contacts	1	1	1
Total # of contacts	688	591	96
Avg # of contacts per participant (all P's)	1.83	1.77	2.23
Avg # of contacts per P that didn't consent	2.31	2.24	3.31

Table 5: *Recruitment – Contact types for RAISE – broken down by RUCC designations*

	All RAISE	Non-Rural	Rural
Qualtrics email	448	401	47
Qualtrics text	180	151	29
Recruiter email	45	27	18
Recruiter text	11	9	2
Recruiter phone call	4	4	0

Table 6: *Recruitment – Opt-outs & incompletes for RAISE, GSMS, and combined samples*

	RAISE	GSMS	Combined
Total # opt-outs (declined before/during consent)	4	2	6
Total # opt-outs (after consenting/mid-study)	2	1	3
Total # incompletes (consented, but never finished study)	6	3	9

Reasons for opting out included: time constraints, a recent death in the family, not comfortable with location tracking.

Table 7: *Recruitment – Opt-outs & incompletes for RAISE – broken down by RUCC*

	Non-Rural	Rural
Total # opt-outs (declined before/during consent)	4	0
Total # opt-outs (after consenting/mid-study)	2	0
Total # incompletes (consented, but never finished study)	4	2

Table 8: *Survey monitoring – Daily survey completion rates for RAISE*

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Avg # of surveys completed	2.52	2.54	2.54	2.57	2.58	2.57	2.56
Avg compliance (%)	83.95	84.57	84.77	85.60	86.01	85.60	85.39

Table 9: *Survey monitoring – Daily survey completion rates for GSMS*

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Avg # of surveys completed	2.70	2.45	2.60	2.50	2.60	2.70	2.45
Avg compliance (%)	90.00	81.67	86.67	83.33	86.67	90.00	81.67

Table 10: *Survey monitoring – Daily survey completion rates for combined*

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Avg # of surveys completed	2.54	2.53	2.55	2.56	2.58	2.58	2.55
Avg compliance (%)	84.62	84.25	84.98	85.35	86.08	86.08	84.98

Table 11: *Survey monitoring – Avg # of total daily surveys completed by time of day*

	RAISE	GSMS	Combined
Morning (Total possible: 7; Survey expired after 90 min)	5.78	5.80	5.79
Afternoon (Total possible: 7; Survey expired after 90 min)	5.73	5.70	5.73
Evening (Total possible: 7; Survey expired after 3 hr)	6.38	6.55	6.40

Table 12: *Troubleshooting – Frequency of participants issues for RAISE, GSMS, and combined samples*

	RAISE	GSMS	Combined
# of P's that had issues (including opt-outs & incompletes)	92	20	112
# of P's that had issues (excluding opt-outs & incompletes)	85	16	101
% of P's that had issues (excluding opt-outs & incompletes)	52.47	80.00	55.50
Avg # of issues per participant	1.95	2.25	2.01
Total # of issues	179	45	224

Table 13: *Troubleshooting – Issue types for RAISE, GSMS, and combined samples*

Types of Issues	RAISE	GSMS	Combined
Not enrolled at start of study[1]	56	12	68
Location data not uploading[2]	35	19	54
Missed a day of surveys[3]	21	6	27
Other[4]	67	8	75

[1]Participant would be sent a text and/or email (based on preference indicated in consent form) with a reminder to enroll in the study to begin participating. Additional instructions were also provided on what they needed to do to get enrolled.
[2]Participant would be sent a text and/or email with instructions on how to check their location settings and update them as needed for the study.
[3]Participant would be sent a text and/or email to see if they would like to extend their study by one day.
[4]Participant had a question/issue that didn't fall into above categories.

Table 14: *Troubleshooting – Contact preference marked in consent form (only collected for RAISE sample)*

	RAISE
Email	64
Text	98
Phone call	0

Table 15: *Troubleshooting – Contact types for RAISE, GSMS, and combined samples*

	RAISE	GSMS	Combined
Email	52	2	54
Text	111	38	149
Phone call	1	0	1
No contact[1]	15	5	20

[1]The troubleshooting issue either didn't require direct contact (i.e., issue could be resolved directly on the MetricWire dashboard) or many contacts had already been made without success so no further contact was made.

Table 16: *Timeline for study*

Study Stages	Time for Current Study	Estimated Time
Design & development	6 weeks	6-8 weeks
Programming & testing	12 weeks	8-14 weeks
Data collection ($N = 182$)	14 weeks	12-18 weeks
Data retrieval & cleaning	14 weeks	8-16 weeks
Assessment write-up	16 weeks	12-18 weeks

Table 17: *Timeline for study activities*

Week of Study	Dates	Phase of Study
Week 1	11/16-11/23/2020	Survey items shared with research technician
Week 2	11/23-11/30/2020	Survey items programmed into MetricWire
Week 3	11/30-12/7/2020	Study codebook created and survey edited
Week 4	12/7-12/14/2020	Internal pilot conducted ($N = 3$)
Week 5	12/14-12/21/2020	Survey updated per recommendations from pilot and app issues resolved with MetricWire staff
Week 6	12/21-12/28/2020	Additional testing conducted by technician
Week 7	1/4-1/11/2021	Communication with MetricWire staff about app issues
Week 8	1/11-1/18/2021	Participant and study materials prepped (e.g., user guides created, tracking tools created, etc.)
Week 9	1/18-1/25/2021	Study prepared for larger external pilot
Week 10	1/25-2/1/2021	External pilot team invited to participate in full 7-day study including the final report on day 8
Week 11	2/1-2/8-2021	External pilot conducted ($N = 10$)
Week 12	2/8-2/15/2021	External pilot asked for suggestions and study/survey updated per recommendations
Week 13	2/15-2/22/2021	Pilot participants recruited (from study samples)
Week 14	2/22-3/1/2021	Pilot participants completed study ($N = 4$)
Weeks 15-29	3/1-6/14/2021	Data collection for both samples ($N = 182$)
Week 30	6/14-6/21/2021	Recruitment reports drafted by study recruiters
Week 31	6/21-6/28/2021	Location data retrieved from MetricWire dashboard
Weeks 32-40	6/28-8/28/2021	Feasibility report drafted; EMA data retrieval
Weeks 41-45	8/28-10/4/2021	Feasibility report edited; EMA data cleaned
Week 46	10/4-10/11/2021	Feasibility report finalized; initial data analysis

Table 18: *Compensation breakdown for all participants*

Participant Activity	Payment
Daily surveys (21 possible)	$5 per survey ($105 possible)
Daily survey bonus (if 15 or more were completed)	$20
Final survey	$10
Total possible	$135

Table 19: *Compensation type for RAISE, GSMS and combined samples*

	RAISE	*GSMS*	*Combined*
Cash	0	4	4
Check	0	6	6
Amazon gift card	127	10	137
Target gift card	16	0	16
Food lion gift card	19	0	19

Table 20: *Comparing RUCC assignments to self-described area ratings*[1]

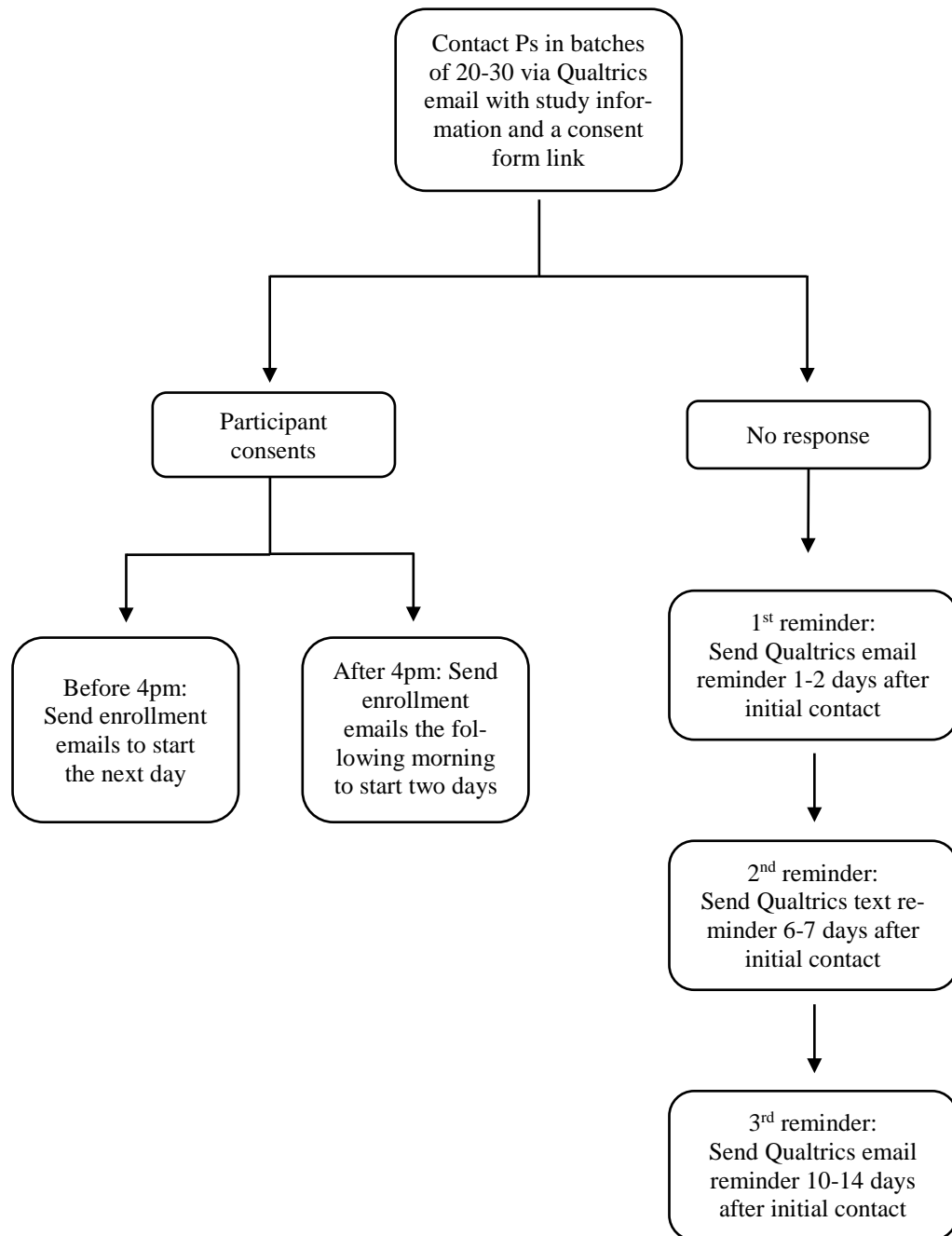| *RUCC	*Rural*	----------	*Suburban*	-----------	*Urban*	Missing
1	3	5	26	4	6	1
2	15	12	31	5	8	-
3	0	1	0	0	0	-
4	13	3	2	0	1	-
5	2	1	0	0	0	-
6	15	2	1	0	0	1
7	1	0	0	0	0	-
8	3	0	0	0	0	-
9	-	-	-	-	-	-

[1]Participant's response to item: "How would **you** describe the area where you live?"
(Response scale: 1 Rural -2- 3 Suburban -4- 5 Urban)
*RUCC in descending order from **1 Urban → 9 Rural**

Supplemental Materials

Recruiting flow

```
                    ┌─────────────────────┐
                    │  Contact Ps in batches │
                    │  of 20-30 via Qualtrics │
                    │  email with study infor-│
                    │  mation and a consent   │
                    │  form link              │
                    └─────────────────────┘
```

Contact Ps in batches of 20-30 via Qualtrics email with study information and a consent form link

Participant consents

No response

Before 4pm: Send enrollment emails to start the next day

After 4pm: Send enrollment emails the following morning to start two days

1st reminder: Send Qualtrics email reminder 1-2 days after initial contact

2nd reminder: Send Qualtrics text reminder 6-7 days after initial contact

3rd reminder: Send Qualtrics email reminder 10-14 days after initial contact

Invitation email (sent via Qualtrics to eligible participants)

Greetings _____,

You may be eligible to participate in a new paid study for **parents**, titled "Measuring Activity Space in Rural and Urban Contexts." Previously you completed a study with us titled "Research on Adaptive Interests, Skills, and Environments" and agreed to be contacted for future studies. We hope to get your help again with this new project where we will use a smartphone app to evaluate the challenges to obtaining location data in rural contexts with limited cell coverage.

What is the study about?

The study is designed to assess "activity space," which measures how people move or travel during the course of their daily activities and their relationship with those different settings. We are looking for participants from both rural and urban locations so that we can compare differences across these two types of settings.

What does the study involve?

The study lasts 8 days and will involve a series of 3 short surveys (<5 minutes) each day for 7 days and then 1 final survey on the 8th day. You will need to have a smartphone that you can have with you throughout the study and use to respond to notifications from an app you will install to participate. Surveys ask questions on the places you go, who you are with, characteristics of those places, substance craving and use, and your mood. This study will also involve geolocation during those 7 days to track your typical patterns of movement in your daily life (e.g., total distanced traveled, trips taken, communities visited).

What is the compensation?

Participants can receive _up to $135_, in the form of a gift card to a selection of online retailers, for participating in the entire study. Payment will be provided at the end of your participation based on the following criteria:

- **$5** for each daily survey you complete (A total of 21 daily surveys will be sent)
- **$20** bonus if you complete 15/21 daily surveys
- **$10** for completing an end-of-study questionnaire

If you are interested in being in this study, you can click on the link below to get more details, provide consent, and begin participation.

[Survey Link]

If you have additional questions regarding the study, we can be reached by phone or text at _____ or by email to _____.

Consent form (for all RAISE participants recruited through Qualtrics)

<div align="center">

Informed Consent for Participant in Research
Measuring Activity Space in Rural and Urban Contexts

</div>

Key information:

- This form asks you to be in our research study looking at the connections between locations and people's activities in their everyday lives.
- You will need a smartphone to participate in this study.
- We will ask you to install the MetricWire app on your phone.
- This app will track your location throughout the course of the study.
- We will ask you to complete a series of 21 short surveys (3 surveys per day for 7 days) through the app.
- We will ask you questions about your mood, who you are with, and your substance use.
- We will ask you to complete an end-of-study questionnaire.
- We will link your data from previous studies you have done with us, then remove information from your data that could be used to identify you.
- Participation in this study is voluntary.

Study overview: We are researchers from Duke University asking you to be in a research study examining how people move or travel during the course of their daily activities and their experiences in those different settings. To be in this study, you will be asked to install the MetricWire app on your smartphone. You previously completed up to four RAISE studies with us, including several online surveys. We may link your data from this study to your data from the other completed studies.

If you agree to be in this study, we would ask you to install the MetricWire app on your phone and use it to report your activity 3 times each day for 7 days. Each report should take no more than 5 minutes to complete, for a maximum of 15 minutes per day. You will answer questions about where you go, who you are with, characteristics of the places you go, your mood, and your substance use. The app will also collect location data while you have it installed on your phone. This data will be encrypted (stored in way that is unreadable by anyone who does not have the "keys") on a secure server. At the end of 7 days, the app will direct you to an end-of-study questionnaire that should take no more than 15 minutes to complete.

Data: The MetricWire app will collect information about your location, your step count, and your phone use throughout the study, as well as your responses to the daily report and end-of-study questions. We will only use location information to address our research questions. After this information has been processed by a member of the research team not involved in data analysis, your data will not be connected with your contact or other identifying information, and will not be shared outside of the research team.

Voluntary participation: Participating in this study is completely up to you. Even if you decide to participate, you can change your mind and stop your participation in our study. If at any time after the app is installed you decide to stop being in the study, we ask you to contact us so we can make sure that the app is completely uninstalled from your phone. At that time, you can let us know whether it is okay for us to keep the data we already have, or whether you want us to destroy it.

Risks: Some of our questions ask about your mood (e.g., stress) and your substance use. We hope these questions will not make you feel uncomfortable or upset you. You can always skip answering questions or stop participating at any time.

MetricWire app: Information collected by mobile applications or "apps" is subject to their privacy policy (https://metricwire.com/privacy-policy/) and terms of use (https://metricwire.com/terms-and-conditions/), which you should read carefully. It is recommended that you run a current operating system (OS) on your device, review the privacy/security settings often, and restrict any unnecessary access. These applications may run in the background of your device. Mobile apps may have unanticipated impact on the operations

of your device (e.g., battery drainage). At the conclusion of the study, we will provide you instructions on how to remove the mobile app from your device. As with all technology, we ask you to wait until you are in a safe environment, use good judgment and follow prevailing laws. Do not perform study-related activities while you are driving.

Confidentiality

Who has access to the data: We will not share your data with anyone outside of the research team. MetricWire and the Duke research team will have access to the data collected during the course of the study. MetricWire will never have access to your data from previous studies or to the contact information we use to recruit you to be in our studies. Information captured by the app will be retained by the company (MetricWire) that developed and maintains the app for three years after the last research report. The information will be encrypted (locked) and stored on highly secure servers. The Duke research team will maintain access to your data on a locked, password-protected server.

How your data will be protected: All data collected as part of this project will be labeled with a code number. Only members of our research team will have access to this data linking this code number to you and your personal information.

Although data collection of this type may raise privacy concerns, because of the sensitivity of mobile phone data, the MetricWire team has a highly skilled team of programmers and data scientists whose job it is to ensure the privacy of your data. Only staff associated with this research project will have access to your data.

- A set of unique IDs will connect your mobile phone data to data collected from previous studies you have completed with us.
- Your data will initially be processed by a single team member whose only role is to prepare the data for researchers on the team who will analyze it. Only that person will have access to your name and contact information, which will be kept in password-protected folder on a secure server at Duke. All other members of the research team will work data from which identifying information has been removed.
- All of your mobile phone data and survey responses will be encrypted (locked) after being uploaded to secure servers for storage and processing. The upload process uses secure methods as well, so your data is protected in transfer.
- We are using secure methods to transfer, store, and access data to limit the possibility of the data being lost or accessed by people outside the research team.
- We recommend that you add a passcode to open your phone if you do not already use one. This will help prevent the data on your phone from being stolen.

To further help us protect your privacy, we have a Certificate of Confidentiality from the United States Department of Health and Human Services (DHHS). With this Certificate, we cannot be forced (for example, by court order or subpoena) to disclose information that may identify you in any federal, state, local, civil, criminal, legislative, administrative, or other proceedings. The researchers will use the Certificate to resist any demands for information that would identify you, except to prevent serious harm to you or others.

How data will be shared: Data collected from you during this study may eventually be shared with other

researchers for future scientific research purposes only; however, these data will not contain any identifying information that would allow others to link the data to you. When the results of this research are published or discussed at conferences, absolutely no information will be included that would reveal your identity.

Payment: You can receive up to $135 in gift cards for being in this study. You can choose from Amazon, Target, GrubHub, or Food Lion.

- You will receive $5 for each activity report you provide. If you provide all 21 reports, you will receive $105 for activity reporting.
- At the end of 7 days, you will be eligible for a $20 bonus if you have provided at least 15 of the 21 reports.
- You will receive $10 for completing an end-of-study questionnaire.
- You will receive compensation by email at the end of the 7-day study period.

Rights of Research Participants: You may withdraw your consent at any time and stop your participation. If you have any questions or concerns, you may contact Dr. Rick Hoyle at Duke University, 919.695.3567. If you have any questions about your rights as a research participant, please contact the chair of the Human Subjects Committee at Duke University at campusirb@duke.edu or 919.684.3030 with reference to Protocol ID#2021-049. You may ask for a copy of this form to keep.

Consent to Link Data: By selecting "Yes" I am indicating that I agree to allow the research team to link the data collected in this study to the responses I provided in previous RAISE/C-StARR studies I have participated in.

Do you consent to having your data in this study linked with previous RAISE/C-StARR studies you have participated in?

- o Yes
- o No

Consent to Track Location: By selecting "Yes" I am indicating that I agree to allow the MetricWire app to track my location for 7 days. This information will be de-identified when analyzed, so at no point will a member of the research team be actively looking at your location.

Do you consent to allowing the MetricWire app to track your location for 7 days?

- o Yes
- o No

Consent: By selecting "Yes" I am indicating that I agree to participate in the study. I have been read and understand the information provided in this form. I have been offered a copy of this form to keep.

Do you wish to participate in the **Daily Activity** study?

- o Yes
- o No

Consent form (for all GSMS participants)

Duke University Health System

Consent to Participate in a Research Study
Pilot Study for EMA Survey and Geolocation in Rural Communities
Doctor Directing Research: William Copeland, Ph.D.
Phone: 919-943-6248

CONCISE SUMMARY

The purpose of this study is to have participants from the Great Smoky Mountains Study (**GSMS**) complete a series of 21 short surveys (5 to 10 minute per survey) over 7-days (3 surveys per day) on the places you go, who you are with, characteristics of those places, and your mood. The study will also involve geolocation tracking during those 7 days to track your typical patterns of movement in your daily life (e.g., total distanced traveled, trips taken, communities visited).

This study should take between 15 to 30 minutes per day for 7 days. The risks of participation are minimal and mainly involve the potential risk for loss of confidentiality. There are no physical risks.

If you are interested in learning more about this study, please continue to read below.

INTRODUCTION

You are being asked to participate in this study to evaluate the implementation of a brief daily survey study in a rural population of middle aged adults. One aim of the study is to evaluate the challenges to obtaining geolocation data in rural contexts with limited cell coverage. The surveys are designed to assess "activity space" which measures how people move or travel during the course of their daily activities and their relationship with those different settings. Research studies are voluntary and include only people who choose to take part.

Please read this consent form carefully and take your time making your decision. As the researcher or research staff discusses this consent form with you, please ask him/her to explain any words or information that you do not clearly understand. We encourage you to talk with your family and friends before you decide to take part in this research study. The nature of the study, risks, inconveniences, discomforts, and other important information about the study are listed below.

A grant from the National Institutes of Health (NIH) sponsors this study. Dr. William Copeland is the lead researcher for this portion of the study and is available to answer any questions that you may have. Portions of the research team's salaries will be paid by this grant.

Subject Initials

WHY IS THIS STUDY BEING DONE?
The purpose of this study is to evaluate the implementation of a brief daily survey in a rural population of middle-aged adults. One aim of the study is to evaluate the challenges to obtaining geolocation data in rural contexts with limited cell coverage.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?
We would like 20 people to complete this study.

WHAT IS INVOLVED IN THE STUDY?
If you agree to be in this study, you will be asked to sign and date this consent. You will receive a signed and dated copy of this consent. You will be asked to:

1) Complete a series of 21 short surveys (5-10 minute) over 7-days (3 per day) on the places they you go, who you are with, characteristics of those places, and your mood.
2) Allow geolocation during the survey study to track patterns of movements of your daily life.

We will assist you in downloading and logging into the Metric Wire app that will be used for the survey study. We will also provide instruction on enabling geolocation.

For the daily surveys, we help you set up your phone to receive the daily surveys or provide you a phone to use to complete the surveys. You will receive the surveys 3 times each day in the evening for 7 days.

As always, your participation is voluntary and you may refuse to participate at any time without any penalty. However, if you decide to stop participating in the study, we encourage you to talk to Dr. Copeland first.

HOW LONG WILL I BE IN THIS STUDY?
These daily surveys will take about 15 to 30 minutes to complete each day for 7 days.

WHAT ARE THE RISKS OF THE STUDY?
There are no physical risks associated with this study. Some people may experience some discomfort when answering questions about personal or emotional subjects. You may refuse to answer any of the questions and you may take a break at any time during the study. You may stop your participation in this study at any time without penalty or loss of any benefits to which you are entitled. There is the potential risk of loss of confidentiality. The research team will make every effort keep your information confidential as we have done for all participants for the past twenty years; however, this cannot be guaranteed.

Subject Initials _____

Risks specific to mobile apps

Survey information that you provide will be collected using the Metric Wire app which will be installed on your phone. Information collected by mobile applications or 'apps' is subject to their terms of use, which you should read carefully. Many apps make claims that they are very secure, compliant with federal privacy regulations, and used and tested by other academic centers. However, any mobile app that is downloaded carries potential security risks, and Duke cannot guarantee that these mobile apps are free of risk.

It is recommended that you run a current operating system (OS) on your device, review the privacy/security settings often, and restrict any unnecessary access. These applications may run in the background of your device. Mobile apps may have unanticipated impact on the operations of your device (e.g., battery drainage). If you do not have an unlimited data/text plan, you may incur additional charges. At the conclusion of the study, we will provide you instructions on how to remove the mobile apps from your device.

As with all technology, we ask you to wait until you are in a safe environment, use good judgment and follow prevailing laws. Do not perform study-related activities while you are driving.

If you are loaned a Duke phone for use during this study and you use it for non-study related reasons, this could add your personal information onto the device and potentially result in it being sent to unauthorized persons. The device will be preset with security settings. Please do not alter these during the course of the study. When you return the device at the end of the study, the device will be cleaned to remove any of your personal information. If the device is lost or stolen during the course of the study, please contact the study team immediately

WHAT ARE THE BENEFITS TO TAKING PART IN THE STUDY?

If you agree to take part in this study, there is no direct benefit to you. We hope that in the future the information learned from this study will benefit other people and society in general.

WILL MY INFORMATION BE KEPT CONFIDENTIAL?

Participation in research involves some loss of privacy. We will do our best to make sure that information about you is kept confidential as we always have, but we cannot guarantee total confidentiality. Your personal information may be viewed by individuals involved in this research and may be seen by people including those collaborating, funding, and regulating the study. We will share only the minimum necessary information in order to conduct the research. Your personal information may also be given out if required by law.

As part of the study, results of your study-related procedures may be reported to the National Institutes of Health and its affiliates. In addition, your records may be reviewed in order to meet federal or state regulations. Reviewers may include representatives and affiliates of the National Institutes of Health and the Duke University Health System Institutional Review Board, and others as appropriate. If any of these groups review your research record, they may also need to review your entire medical record.

DUHS IRB
IRB NUMBER: Pro00090215
IRB REFERENCE DATE: 02/05/2021
IRB EXPIRATION DATE: 04/19/2021   Subject Initials _____

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The Department of Health and Human Services has issued a **Certificate of Confidentiality** to further protect your privacy. With this Certificate, the investigators may not disclose research information that may identify you in any Federal, State, or local civil, criminal, administrative, legislative, or other proceedings, unless you have consented for this use. Research information protected by this Certificate cannot be disclosed to anyone else who is not connected with the research unless:

1) There is a law that requires disclosure (such as to report child abuse or communicable diseases but not for legal proceedings);
2) You have consented to the disclosure, including for your medical treatment; or
3) The research information is used for other scientific research, as allowed by federal regulations protecting research subjects.

Disclosure is required, however, for audit or program evaluation requested by the National Institutes of Health.

You should understand that a Confidentiality Certificate does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. If you want your research information released to an insurer, medical care provider, or any other person not connected with the research, you must provide consent to allow the researchers to release it. This means that you and your family must also actively protect your own privacy.

Finally, you should understand that the investigator is not prevented from taking steps, including reporting to authorities, to prevent serious harm to yourself or others.

The study results will be retained in your research record for at least six (6) years after the study is completed. At that time the research information not already removed will be destroyed.

While the information and data resulting from this study may be presented at scientific meetings or published in a scientific journal, your identity will not be revealed.

WHAT ARE THE COSTS?

There will be no cost to you for taking part in the study.

WHAT ABOUT COMPENSATION?
We will pay you $5 per survey (21 short surveys) for a total of $105, a $20 incentive for full participation (15 or more surveys), and $10 for the final survey for a total of $135.

WHAT ABOUT MY RIGHTS TO DECLINE PARTICIPATION OR WITHDRAW FROM THE STUDY?
You may choose not to be in the study, or, if you agree to be in the study, you may withdraw from the study at any time. If you withdraw from the study, no new data about you will be collected for study purposes other than data needed to keep track of your withdrawal.

Subject Initials _____

Your decision not to participate or to withdraw from the study will not involve any penalty or loss of benefits to which you are entitled, and will not affect your access to health care at Duke. If you do decide to withdraw, we ask that you contact Dr. William Copeland in writing and him know that you are withdrawing from the study. His mailing address is 214A Sanford Building Box 90245, Durham, NC 27708.

WHOM DO I CALL IF I HAVE QUESTIONS OR PROBLEMS?
For questions about the study or a research-related injury, or if you have problems, concerns, questions or suggestions about the research, contact Dr. William Copeland at **919-943-6248** during regular business hours or after hours and on weekends and holidays.

For questions about your rights as a research participant, or to discuss problems, concerns or suggestions related to the research, or to obtain information or offer input about the research, contact the Duke University Health System Institutional Review Board (IRB) Office at **919-668-5111**.

STATEMENT OF CONSENT
"The purpose of this study, procedures to be followed, risks and benefits have been explained to me. I have been allowed to ask questions, and my questions have been answered to my satisfaction. I have been told whom to contact if I have questions, to discuss problems, concerns, or suggestions related to the research, or to obtain information or offer input about the research. I have read this consent form and agree to be in this study, with the understanding that I may withdraw at any time. I have been told that I will be given a signed and dated copy of this consent form."

_____   _____   _____
Signature of Participant   Date   Time

_____   _____   _____
Signature of Person Obtaining Consent   Date   Time

DUHS IRB
IRB NUMBER: Pro00090215
IRB REFERENCE DATE: 02/05/2021
IRB EXPIRATION DATE: 04/19/2021   Subject Initials

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Enrollment email (sent to participants that consented)

Hi _____,

This is _____. Thank you for your interest in participating in our new study: Daily Activity! Below you will see an overview of the study for you to have as a reference. Please read through this information carefully.

If possible, please enroll in the MetricWire app by 11pm tonight. Downloading the app and enrolling in the study should only take about 3-5 minutes. If you are unable to do so by this time, please let me know and I'd be happy to rework your study timeline. You will begin receiving your surveys tomorrow morning. As of now, I have set your study timeline as follows:

Start Date:
End Date:

--

Getting Enrolled

You will receive a separate email with a link to the MetricWire app. The sender's name will be "_____" and when you open the email, you will see a banner at the top that says "MetricWire." Select the button for your device (iOS or Android) and then **register using the email address where you received the invitation**. Once you register, you will need to join the available study "Daily Activity." These steps are outlined in the user guides attached in this email as well, so please have that open as you enroll.

Device Settings:

iOS Users
1. After installing the app, go to your phone "Settings"
2. Scroll down until you find "MetricWire" and tap it to open
3. Tap "Location"
4. Tap "Always"

Android Users
1. When installing the app, you will be asked if you would like to allow MetricWire to access your location – tap "Allow"
2. Once enrolled in the study, go to your phone "Settings"
3. Tap "Battery"
4. Tap "Power saving exclusions"
5. Scroll down to find "MetricWire" and toggle it to exclude MetricWire from power saving

Survey Distribution:

You will receive 3 surveys each day for one week (7 days): a morning report, an afternoon report,

and an evening report. There is also a final survey on the 8th day. Below you will see the survey schedule:

1. **Morning report**
   a. Sent at a random time between **8-10am** each day
   b. Available for **90 minutes** after you receive the notification
   c. Reminders sent 20 and 40 minutes after your first notification
2. **Afternoon report**
   a. Sent at a random time between **2-4pm** each day
   b. Available for **90 minutes** after you receive the notification
   c. Reminders sent 20 and 40 minutes after your first notification
3. **Evening report**
   a. Sent at a random time between **7-9pm** each day
   b. Available for **3 hours** after you receive the notification
   c. Reminders sent 20, 40, and 100 minutes after your first notification
4**. End-of-Study report**
   a. Sent to you at **8am** on the **8th day** of your participation
   b. Available for **4 hours**
   c. Reminders sent each hour until noon (9am, 10am, 11am)

User Guides

You will find two user guides attached to this email – one for iOS (iPhone) users and the other for Android users. Please download the appropriate guide for your device and review the information carefully.

If you do not receive an email from MetricWire (sender's name: "_____") within 2-3 hours of receiving this email, please reply to this email. You may also reply to this email or text _____ with any additional questions you have.

Thank you for your participation!

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Enrollment reminder (for participants not enrolled on start date)

Text
Hi _____! This is _____ with _____. Thank you for agreeing to participate in our new study: Daily Activity! I see that you haven't yet enrolled in the study. You will need to download the MetricWire app and enroll in the study to start participating today. You should have received an email yesterday from the sender _____ with a link to the app store. If you need to change your start date, just let me know. Please let me know if you have any trouble with this - thanks!

Email

Hi _____,

Thank you for agreeing to participate in our new study: Daily Activity! I'm following up as I see that you haven't yet enrolled in our study through the MetricWire app. As a reminder, you will need to download the MetricWire app and enroll in the study to start participating today. If you would like to change your start date or if you have further questions about your participation, please let me know.

Thanks!
_____

Location sensor instructions (iOS)

Text (iOS)

Hi _____! This is _____ with _____. Thank you for participating in our new study: Daily Activity! It looks like your location data hasn't come through since _____, so I wanted to check to make sure that your settings were set up properly. Whenever you have time, please follow these steps to check your location sensor: (1) Go to your phone "Settings" (2) Scroll down and tap "MetricWire" (3) Tap "Location" (4) Tap "Always" If these are on correctly already, then please sign out of the app and back in to reset it. Let me know if you have any trouble with this - thanks!

Email (iOS)

Hi _____,

Thank you for participating in the Daily Activity Study! I am reaching out because it looks like your location data hasn't uploaded since _____. Whenever you have a moment, please follow these steps to check that your settings are on correctly:

1. Go to your phone "Settings"
2. Scroll down until you find "MetricWire" and tap it to open
3. Tap "Location"
4. Tap "Always"

If your settings are already set to this, then please sign out of the app and back in. This will help to reset the app and get the data uploading again.

Let me know if you have any questions or trouble with this -

Thanks!
_____

Location sensor instructions (Android)

Text (Android)

Hi _____! This is _____ with _____. Thank you for participating in our new study: Daily Activity! It looks like your location data hasn't come through since _____, so I wanted to check to make sure that your settings were set up properly. Whenever you have time, please follow these steps to check your location sensor: (1) Go to your phone settings (2) Tap "Apps & notifications" (3) Tap "App info" (4) Find "MetricWire" and open it (5) Tap "Permissions" (6) Make sure your location is turned on. If these are on correctly already, then please sign out of the app and back in to reset it. Let me know if you have any trouble with this - thanks!

Email (iOS)

Hi _____,

Thank you for participating in the Daily Activity Study! I am reaching out because it looks like your location data hasn't uploaded since _____. Whenever you have a moment, please follow these steps to check that your settings are on correctly:

1. Go to your phone "Settings"
2. Tap "Apps & notifications"
3. Tap "App info"
4. Find "MetricWire" and open it
5. Tap "Permissions"
6. Make sure your location is turned on

If your settings are already set to this, then please sign out of the app and back in. This will help to reset the app and get the data uploading again.

Let me know if you have any questions or trouble with this -

Thanks!
_____

Missed a day of surveys

Text

Hi _____! This is _____ with _____. I wanted to reach out as I see that you missed all surveys on _____. If you'd like, I could extend your study by one day so that you have more chances to complete surveys. As of now, you have missed ____ surveys. You are allowed to miss as many as needed, I just wanted to check in. As a reminder, you receive 3 surveys each day to complete - a morning, afternoon, and evening survey. Let me know if you'd like to extend your study or if you have any questions - thanks!

Email

Hi _____,

Thank you for agreeing to participate in our new study: Daily Activity! I wanted to reach out as I see that you missed all surveys on _____. If you'd like, I could extend your study by one day so that you have more chances to complete surveys. As of now, you have missed ____ surveys. You are allowed to miss as many as needed, I just wanted to check in. As a reminder, you receive 3 surveys each day to complete - a morning, afternoon, and evening survey. Let me know if you'd like to extend your study or if you have any questions.

Thanks!
_____

Final survey reminder (sent if final survey is not submitted by 12pm on Day 8)

Text

Hi _____! This is _____ with _____. This is just a quick reminder to make sure you complete your final report before 8pm tonight. You will receive an additional $10 for completing it! Let me know if you have any questions - thanks!

Email

Hi _____,

This is just a quick reminder to make sure you complete your final report before 8pm tonight. You will receive an additional $10 for completing it! Let me know if you have any questions.

Thanks!
_____

Additional materials available on Box

1. PDF user guides for the MetricWire app for both iOS and Android devices

2. Troubleshooting tracking sheet

3. Recruitment tracking sheet

4. Daily survey & compensation tracking sheet