

# **Measuring Stress, Well-Being & Connectedness across Two Generations with Mobile Technologies: A Feasibility Study**

## **Final Report**

June 20, 2017

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**Funding:** This project was funded by a pilot study funded under by NIA P30 grant P30AG034424 to the Duke Center for Population Health and Aging (CPHA).

## Section A. Overview of the Study and Aims

**Specific Aims:** This 2-year pilot project had the following specific aims: *Pilot a field-based trial to evaluate the use of mobile technologies to monitor stress, wellbeing, and social connectedness among older parents and their adult children.* To address this aim, we:

1. evaluated the feasibility of using mobile technologies to collect ecological momentary assessments (EMA) of daily stressors, interpersonal exchanges and stress-related markers among older parents and their adult children.
2. field tested commercially available wearable devices that continuously captured resting heart rate, movement, and sleep duration and quality among older parents and their adult children.

This represents a slight modification of the study's original aims. In particular, in the original study we were going to assess the feasibility of conducting the study simultaneously on *three* generations – an adolescent child (the “child”), their “parent” and their “grandparent” – during the same 7-day period. Instead, we simplified our design and sampled dyads of adult women (the “mothers” of adolescents participating in our ongoing study) and their mothers who were the “grandmothers” of the adolescent child. To further focus our limited resources, we drew a sample of mother-grandmother dyads from a lower-income population (details below), as we anticipated that dyads from this population may present less access to and familiarity with the mobile technologies we used in this study. We think determining our ability to implement this study with the latter group would be useful information for the likelihood of successfully implementing our protocols on other populations.

In this small pilot study, we sought to assess the feasibility of recruiting dyads of adult daughters and their mothers to participate in a real-time study that assessed their connectedness, with each other and with others, measures of subjective well-being and their health and stress levels using mobile technologies. The protocols for data collection were EMA three times-a-day administered via the mobile app, MetricWire, installed on the cell phones of each member of the dyad and by data collected from mobile tracking devices, Jawbone UP3, that were to be worn throughout the day and while the subjects were sleeping. Data collection via both of these protocols occurred for a contiguous 7-day period.

Although a number of ongoing studies use mobile technologies and wearable devices, no prior research to our knowledge targets multiple generations. In addressing the specific aims, we pre-selected socio-economically disadvantaged older individuals and their adult children as potential participants. All recruitment efforts, including setting up the technologies that the participants used, were made remotely. This was done to assess the feasibility of conducting a study like this on a national or regional level with non-clinical populations, where in-person contact with subjects was not a study requirement.

## **Section B. Background and Significance**

Identifying the mechanisms through which social support and connections influence health and wellbeing is crucial to determining the extent to which social connections can buffer the effects of adversity and exposure to stressors at various points throughout the life-course, ranging from early childhood,(1, 2) through adulthood and into old age (3) Indeed, there is a sizeable and growing literature about the relationship between indicators of subjective wellbeing (SWB), individual's health status and behaviors and social connectedness.(4)-(5). Much of the past literature has focused on the negative health and developmental consequences of extreme or 'catastrophic' life events such as maltreatment, extreme neglect or the loss of a close family member (6-9) and, more recently, on how reactions to these exposures may vary as a function one's genetic makeup (10) and access to social support. However, we are now learning that exposure to daily stressors, or the 'drip, drip, drip of daily life,' may have effects that are just as strong, if not stronger than more frequently studied stressful life events.(11-13)

At the same time, new tools are emerging to capture, in real time, interpersonal exchanges, health and wellbeing in daily life, including mobile-phone based assessments and streaming data from wireless sensors that monitor individuals' physiology and environment. These new tools present exciting new options for estimating the reciprocal and immediate effects of social connectedness on key aspects of health and wellbeing within families and across generations. Unfortunately, these technologies have evolved at a pace that has made it challenging for most social and behavioral scientists to integrate them into field-based studies focused on these questions. In this study we will field test EMA protocols, wireless and wearable sensors, as well as recruitment and retention methods within a set of older parents, their adult children and grandchildren. Tools and findings generated from this study will be used to build the capacity among our investigators for fielding EMA protocols via mobile devices in ongoing longitudinal studies of health and development.

## **Section C. Research Design**

### **C1. Sample Selection & Recruitment**

Parents of our adolescent study participants from the Research on Adaptive Interests, Skills, and Environments Study (RAISE) [#D0396] were contacted by phone and invited to participate in a 7 day EMA study in which they were asked to respond to 3 daily surveys on a mobile device, as well as wear a Jawbone UP3 © that will monitor their sleep and activity levels.

Via phone and e-mail, the parents of the adolescent study participants (hereafter referred to as the mothers) were contacted and then asked to see if their mothers (hereafter referred to as the grandmothers) would be interested to participate. If one member of the pair (mother and grandmother) decided not to participate, they were still asked to complete the EMA and wear a Jawbone UP3 ©.

Through this sample selection procedure, we were able to recruit 26 mothers and 22 grandmothers who were able to complete the baseline portion of the EMA among 86 mothers in the sampling pool. These mothers from the RAISE study all had a (our target enrollment was 25-dyads). The diagram in Figure 1, shown below, illustrates steps of our recruitment process.

The initial contact was made by either phone or e-mail, beginning on February 13, 2017, and we concluded our recruitment efforts by the end of April in the same year. Over this period, we made attempts to contact the 86 pre-selected parents of the RAISE adolescent participants who were eligible for the National Student Lunch Program. Our target was to enroll 25 dyads, consisting of mothers from this contacted pool and their mothers (or the grandmothers of the RAISE adolescents.) After several attempts that spanned over a few weeks, we were not able to reach 24 mothers. Among the remaining 62 mothers that we were able to establish contact with, 6 mothers declined to participate. Additional 19 mothers were determined as ineligible based on the following four inclusion criteria: the grandmother is alive at the time of contact; the mother contacts the grandmother at least once a month; the mother is willing to contact the grandmother to see if she are willing to participate in this study; and, both the mother and grandmother have smartphones. Despite their eligible status, we were not able to recruit 9 mothers because the grandmothers refused to participate.

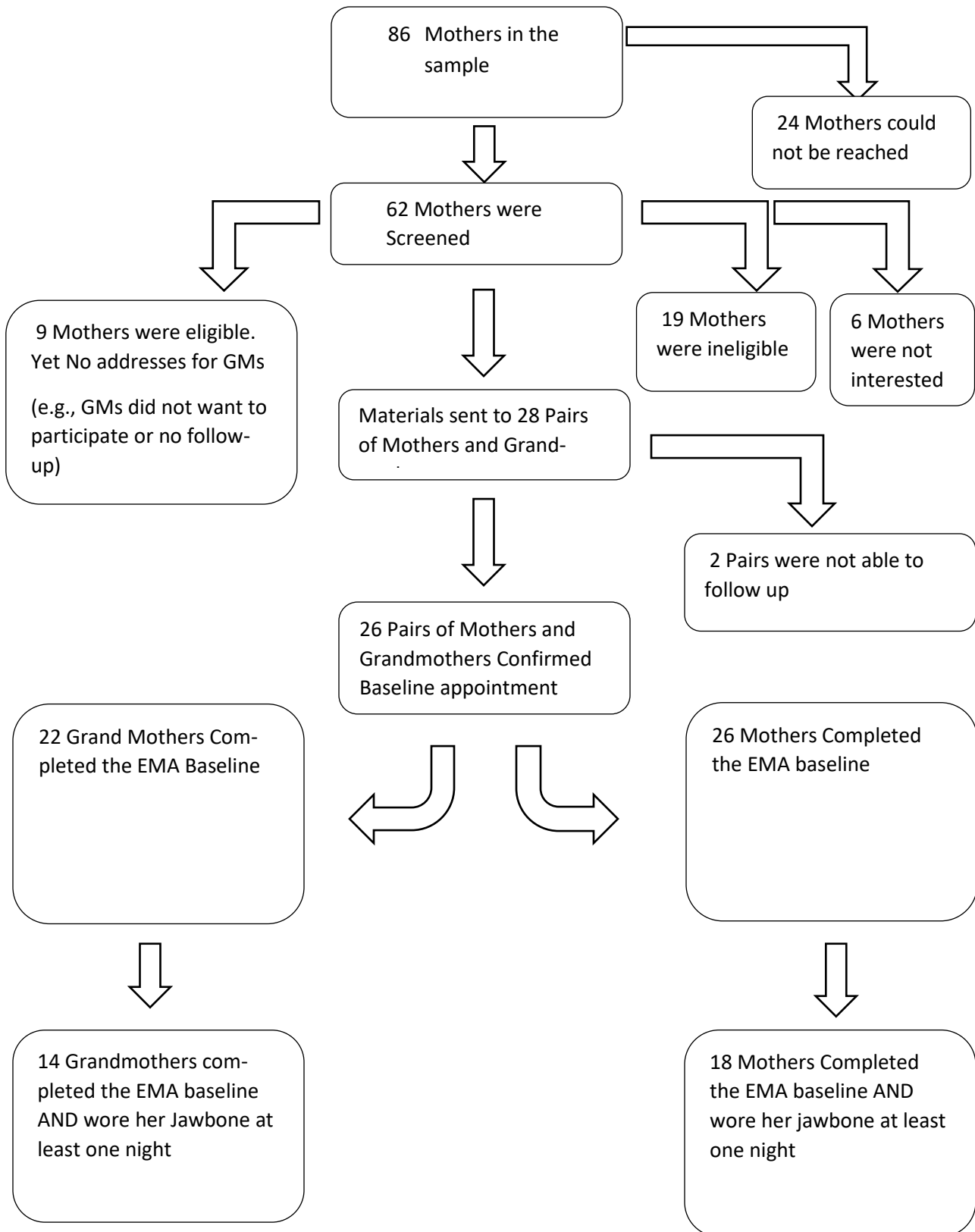
After this screening procedure, we sent the study materials to 28 pairs of mothers and grandmothers who provided valid address. We arranged a virtual meeting with them to complete the baseline section of the EMA and also to ascertain a Jawbone UP3 © was set up properly. We did not hear back from 2 out of the 28 pairs to whom the materials were sent. Data show no indication that these pairs ever participated in the EMA. By the end of the study, we confirmed the baseline completion of the EMA for 26 mothers and 22 grandmothers. We are able to monitor sleep for 18 mothers and 14 grandmothers for at least one night. All mothers and grandmothers who wore their Jawbone at night completed the baseline portion of the EMA. Detailed compliance/completion statistics for these mothers and grandmothers are described in the following section.

## **C2. Modes of Data Collection**

Our primary aim was to test the feasibility of using mobile technologies to collect EMA data, including daily stressors, with mobile phones and of using commercially available wearable to continuously monitor heart rate, movement, and sleep duration and quality.

We conducted EMA assessments 3 times a day for 7 days and then elicited participant feedback regarding the usability of our mobile-phone based survey application. We also ask the participants to wear a Jawbone UP3 © throughout the 7 day period. We have used this protocol with adolescents in previous studies. However, we have not yet evaluated the receptiveness of middle and older-aged adults to these assessment methods. As a way to assess the feasibility of using these technologies in a national-scale study, the wearable devices were directly sent to the participants' home address. Our recruitment staff then remotely assisted them to properly set up a Jawbone UP3 © and EMA app MetricWire on their own phone.

**Figure 1. Recruitment Tree Diagram**



### **C3. Protocols for Collection of Data**

Participants were asked to participate in a 7 day EMA study were they will be prompted to respond to 3 daily surveys on a mobile device, as well as wear a Jawbone UP3 © that monitored their heart rate, sleep and activity levels.

Each EMA survey was designed to last approximately 2-4 minutes, gathering information on emotion, working memory, social connectedness and exposure to daily hassles. A brief test of working memory will be performed each morning using adapted measures from the NIH Toolbox along with repeated assessments wellbeing throughout the day, adapted from the National Study of Daily Experiences.

All study procedures will conform to our previously developed security protocols for ensuring the confidentiality and security of data collected via mobile devices (approved under IRB protocol B0757).

### **Section D. Findings on Compliance with EMA and Jawbone Protocols**

The compliance rates for the participants in our pilot study are summarized in Table 1, tabulated by the mothers and grandmothers. Among the mothers and grandmothers in the 28 dyads to whom the materials were sent, the baseline completion rates for the EMA surveys was 93% for the mothers and 79% for the grandmothers. Compliance rates for the Jawbone were lower; 75% of the mothers and 66.7% of the grandmothers wore her Jawbone at least one night during their 7-day study period.

Interestingly, the grandmothers achieved higher compliance rates for the EMA surveys than their mothers. For example, nearly 73% of the grandmothers completed at least 80% of the daily EMA instruments, compared to 50% for the mothers. Compliance rates among the grandmothers are not higher for the Jawbone surveys, regardless of baseline completion.

Among the 75% of mothers who wore her Jawbone, the average number of nights we were able to monitor their sleep (“sleep days”) was 5.89 (out of a possible 7). The average number of “sleep days” was 5.14 for the grandmothers. The field notes detailed in the following section sheds further light on Jawbone usage throughout the week.

There were 13 pairs of mothers and grandmothers who *both* completed the EMA baseline *and* wore their Jawbone for at least one night. That is, among the 28 mother-granddaughter pairs to whom we sent materials (Jawbone device, instructions for activating it and MetricWire app, etc.) for our pilot, we were able to collect data from the EMA surveys and wearable devices simultaneously from 13 older mothers and their adult daughters.

The compliance rates for these 13 pairs with “complete” data are presented in Table 2. The average number of “sleep days” was identical for mothers and grandmothers. The

average completion rate of the EMA instruments is higher for grandmothers than mothers, similar to what we found for all participations (see Table 1). Finally, about 42% of the 13 pairs completed at least 85% of the EMA instruments.

While a large number of studies using mobile apps in health assessments and interventions, (14-17) we are not aware of ones that involve dyads. Furthermore, we found even fewer studies that use mobile devices that collect EMA-like data and measures from tracking devices. (14) In a recent review of the peer-reviewed studies of health behavior interventions that utilized mobile apps, “compliance” rates for use of smartphone apps throughout the entire intervention period ranged from 29% to 100% with a mean of 79.6%. (17) While these studies are not directly comparable to our pilot, our compliance rates, either those for mothers and grandmothers separately or for dyads with complete compliance, look quite favorable compared to the existing literature on the use of mobile apps for studying health-related behavior.

**Table 1. Compliance Statistics for Jawbone and EMA instruments Among the 28 Mothers and Grandmothers who received the survey materials**

	<u>Grandmothers</u>	<u>Mothers</u>
<b>Jawbone</b>		
Rate of Participants with Sleep Days > 0	0.67	0.75
Average Number of Sleep Days	5.14	5.89
<b>EMA</b>		
Baseline Completion Rate <sup>a</sup>	0.79	0.93
Average Survey Completion Rate <sup>b</sup>	0.81	0.72
Completed at least 80% of Instruments <sup>c</sup>	0.73	0.50

Notes:

<sup>a</sup>The number of baseline completed cases = 28.

<sup>b</sup>The average completion rate of daily instruments among those who completed the baseline

<sup>c</sup>Those who completed at least 80% of daily instruments / Those who completed the baseline.

**Table 2. Compliance Statistics for the 13 Mother-Grandmother pairs that both completed the EMA baseline and wore their Jawbone at least one night**

	<u>Grandmothers</u>	<u>Mothers</u>
<b>Jawbone</b>		
Average Number of Sleep Days	5.62	5.62
<b>EMA</b>		
Average Survey Completion Rate <sup>a</sup>	0.86	0.77
Both Completed at least 70% of the EMA <sup>b</sup>		0.69
Both Completed at least 80% of the EMA <sup>b</sup>		0.54
Both Completed at least 85% of the EMA <sup>b</sup>		0.46

Notes:

<sup>a</sup>The average completion rate of daily instruments among those who completed the baseline.

<sup>b</sup>The pairs who completed at least 70%/80%/85% of daily instruments / 13

## Section E. Field Notes on Recruitment and Implementation

### E1. When to call

We had the most success calling on weekends (late morning to late afternoon). The next time frame that worked best was after 5pm on weeknights, followed by weekdays (morning to afternoon). On the weekends, we had a few mothers answer our calls even when their children were in the middle of games (basketball and baseball) and one even answered during her daughter's dance recital. They all asked if we could call back later the same day – which we did. Our experience was that mothers were generally less willing to break from their weekday (family and work) routines to answer our calls, but were more willing to do so when it came to their more 'flexible' weekend routine.

In addition, we recommend leaving a brief message (initially) for those who do not answer, although many did not return our calls. When we made follow up calls our primary recruiter checked his notes to make sure he was not calling during the same time frame as the initial call. He tended not to leave a message if he made the follow up call relatively close to the initial call. As part of our 'light touch' approach to recruitment, we decided that after two calls it was best to avoid calling again for at least a few weeks. We did not want to risk losing potential participants by being (or seeming) too aggressive. It seems like our strategy paid off as we managed to recruit a number of mothers even after a long time had passed from the initial calls (in a few cases even up to 6-8 weeks later). Therefore, we do not recommend excluding anyone from the recruitment list even after multiple calls and no return calls. Some mothers told us they received our message/s and were planning to call us back – but forgot – and were happy we called back again. We believe it pays off to be persistent, as long as the recruiter is cautious and respectful.

### E2. The Initial Contact

We found that the initial moment of contact with a potential participant is the most crucial component of the recruitment process. It either opens or shuts the door on the opportunity to continue the dialog, which is necessary to allow the potential participant to properly evaluate whether or not to join the study. A poor introduction can lead to a sudden hang-up or to the potential participant 'zoning-out' the recruiter, which almost always concludes with an abrupt end to the phone call. We found that using the following practices when initiating the attempt to recruit a subject into the study improve the likelihood of success:

- a. **Keep it concise.** The initial design of our introduction gave too much information and within our first few phone calls the potential participant either could not follow what was being said and/or stopped listening. Fortunately, we were able to recover during those calls by apologizing, slowing down, and reiterating the main points. We quickly realized we needed to change our approach to the introduction.



- b. **Be nice.** The following point may seem obvious, however we feel it cannot be emphasized enough. Recruiters should always use their 'nice' voice --- yet making sure to be genuine. By doing so, potential participants will be much less likely to end the conversation prematurely and will allow the recruiter to effectively present the proposal. Also, speaking slowly, clearly, and with confidence is essential. Following this approach will help with building trust as well.
- c. **Build trust.** Building trust is one of the most important elements of the entire recruitment and field work process, and it begins with the initial call. We believed that if we could not earn the trust of the mothers right away then they would not agree to participate. With this study, building initial trust was not too difficult considering the mothers already knew us from the RAISE study. Also, people in this area of North Carolina are going to be more inclined to trust the Duke University name. Therefore, we did not need to find other ways to assure them that they could trust us. Our approach was to speak to them cordially (but politely) and to make sure we mentioned Duke and the RAISE study right away, with the goal of creating a feeling of **familiarity**. Nonetheless, there were a few occasions where we had to reassure potential participants they could trust us. On these occasions we emphasized that we have to follow very strict protocols as part of Duke University and that, as researchers who have dedicated our lives to helping people, we take the protection of their personal information (and making sure they receive their payment) very seriously. In addition, we let them know that if they decided to participate in the study we would make sure everything went smoothly and we would always be available to help them if a problem should arise or even if they just had a quick question. In general, recruiters should frequently reassure the participants that they are there to help and let them know that they should '(please) feel free to call them if they need anything.'
- d. **Use succinct but informative (about the study) script.** The following was (roughly) our opening introduction to the mothers:

"Hello, this is [Recruiter's first name] from Duke University and I'm calling to follow up with you about the RAISE study as well as to let you know that we are about to conduct a new *adult* study. I wanted to see if *you* might be interested in participating in this study. It's a 7-day study that takes only about 10-15 minutes of your time per day."

Almost everyone wanted to hear more about the study after the introduction. Only a few mothers were not interested at this point (with a few more who were not interested once they heard more about the study).

We emphasized the words 'adult' and 'you' because many mothers automatically assumed the new study was for their child. Emphasizing these words helped alleviate this problem, however going forward it would be more useful to emphasize key words such as 'Duke', 'pays', and 'free.'

### **E3. Promoting the EMA and Wearable Components of Study**

Obtaining a potential participant's agreement to join a study with wearable and EMA components was not as difficult as we expected. Most likely this was due to them already being familiar with these components from the RAISE study. On the few occasions they expressed concern over the potential complexity of the study components we simply reassured them that the process was 'quite straightforward' and 'not very difficult', and that it was a matter of downloading two apps to their smartphones and following the instructions we provided in their packet. Furthermore, we emphasized that we would be there to 'guide them through the whole process.' In addition, we emphasized all the 'cool things' the Jawbone has to offer and that a lot of people really enjoy using their Jawbones and think they are fun.

As a side note, we avoided saying the components were 'easy' to setup and use because we knew some of them would inevitably have difficulties at some point in the process and we did not want them to feel badly about it – which could have resulted in participants avoiding us and possibly abandoning the project. It is always important that recruiters act sensitively toward participants' feelings and to choose their words carefully. This is why it is important not to rush through their conversations and to take the time to help the participants feel confident about their decision to join the study.

When it came to the 'grandmothers' it was more difficult convincing them that the components would be user-friendly and that they may find it enjoyable. This was according to many of the potential participants (the 'mothers') who were in charge of recruiting their mothers (the 'grandmothers'). However, overall, the mothers were successful in recruiting their mothers, i.e., the grandmothers. In only a few cases the grandmothers did not follow through with the EMA or baseline session.

### **E4. Technical Difficulties Experienced in the Field**

The only technical difficulties that arose came from the Jawbones. However, problems only occurred with the older devices (two different models were used over the course of the study due to the timing of our orders - no one who received a new Jawbone had any issues with the device). Most of the problems occurred as a result of the Jawbones not being properly charged. Once they were charged the participants were able to get them to sync with their smartphones. A few participants had some difficulties getting their Jawbones to charge after syncing them with their smartphones, with some believing the problem was with the charger. In essentially every case, we told them to leave their Jawbones to charge overnight, which seemed to help in most cases. For the few participants who believed it was the charger that was not working properly, we did our best to ensure they were connecting the Jawbone and the charger correctly – although it was impossible to verify they were doing it correctly considering this was done via the phone.

Furthermore, we were concerned that problems with the Jawbone component may lead some participants to believe that withdrawing from the study was their only option.

Therefore, to prevent this from occurring we reassured them that any problem with the Jawbone ‘was not their fault’ and we would not withhold payment because of it, and that it was *important* that they proceed with the daily surveys.

## **E5. Lessons for Scaling up the Study and Sample**

Overall, the remote recruiting approach was successful. As already noted, our recruitment was aided by the fact that a member of these families (the adolescent) had already participated in a related study; advantages that we would not necessarily have if we implement this study on a larger scale.

As we discussed above, the quality of the initial contact with a potential participant is vital. We had a 100% success rate getting through our entire introduction once the potential participant answered our call. Perhaps much of it had to do with the potential payment we were offering, however there are a lot phone and email scams that may make people skeptical of calls from strangers offering these types of rewards. Mentioning ‘Duke University’, therefore, most likely had the strongest effect on gaining that initial trust and keeping people from hanging up the phone. In addition, perhaps a practical way to bring a ‘local’ feel to our recruitment would be to acquire local area codes for our phones/phone numbers, which was done in the current study.

Finally, we noted some problems with the wearables we used in this study. Recall that we made use of Jawbone devices used in a previous study in order to stay within our pilot’s budget. These problems may have contributed to our lower compliance with respect to monitoring sleep, especially amongst grandmothers. Looking forward, we want to try to make use of the new tools that are emerging to capture, in real time, interpersonal exchanges, health and wellbeing in daily life, including mobile-phone based assessments and streaming data from wireless sensors that monitor individuals’ physiology and environment. The field of human sensing is rapidly emerging and changing. Both active and passive sensors can be integrated into the home environment, using sensors that are wearable, sensors that analyze movement that are embedded in the home infrastructure, and sensors that analyze metabolic byproducts integrated into sink drains and toilets.

These new tools present exciting new options for estimating the reciprocal and immediate effects of social connectedness on key aspects of health and wellbeing within families and across generations. At the same time, these technologies have evolved at a pace that has made it challenging for most social and behavioral scientists to integrate them into field-based studies focused on these questions. In this study we will field test EMA protocols, wireless and wearable sensors, as well as recruitment and retention methods within a set of older parents, their adult children and grandchildren. Going forward, we plan to use the findings generated from this study to build the capacity among our investigators for fielding EMA protocols via mobile devices in ongoing longitudinal studies of health and development.

## **Section F. Plans for dissemination and proposal development**

We plan to prepare an article on the findings of this feasibility study for submission for publication in a journal, such as the *JMIR Research Protocols* and *JMIR Mhealth Uhealth*. The former journal recently published a pilot study somewhat related to ours that compared survey data on self-reported health with biometric data collected with the use of wearable technology. (14) We think our findings suggest that it is feasible to use mobile technologies and wearables on adult family member dyads to study the relationship between family member connectedness and the mitigation or exacerbation of daily stressors. We were able to recruit and enroll a group of more economically disadvantaged dyads of adult women and their mothers and to get them established on a mobile app for securing responses to short EMA queries and to activating wearables without having any face-to-face contacts and with remote interactions with subjects during the study period.

We plan to develop a proposal to fund such a study of adult child-parent dyads either from an on-going study of one generation or the other or a two-generational study, such as the Add Health and Add Health Parent Study. We also are exploring the use of the data for participation in a collaborative network to respond to the recent NIH RFA-OD-17-004, "Intensive Longitudinal Analysis of Health Behaviors: Leveraging New Technologies to Understand Health Behaviors (U01)."

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