# Text-Based Mentoring for New Moms: A Feasibility Study

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**Abstract**

While text-message based interventions that target parents and older students have shown promise for improving a variety of outcomes, evidence on text-based outreach and support for new parents is just emerging.  We explore programmatic data from a text-based mentoring intervention designed to support new mothers and promote healthy child development.  We coded 18,897 text messages from 162 mother-mentor pairs to describe the characteristics of interactions between new mothers and their text-based mentors.  On average, mothers remained engaged with the program for 296 days (out of a full year) and texted with their mentor every 9 days.  Mothers and mentors discussed both child-focused topics (28% of exchanges) and mother-focused topics (8% of exchanges).  Mentors responded to 86% of mothers' problems within 48 hours and offered mothers emotional support (39% of offers) and advice (35% of offers) most frequently.  Based on the demonstrated ability of the program to engage mothers, the content addressed in their interactions with mentors, and the supports offered by mentors, we conclude that text-based mentoring is a promising strategy for providing outreach and support to new mothers.

*Keywords*: parenting intervention; infants and toddlers; maternal mental health; technology; mentoring

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Parents are the most important people in shaping young children's development. Young children's interactions with their parents form the basis for their readiness for school and overall success in life (Bradley, Caldwell, & Rock, 1988; Pianta, Nimetz, & Bennett, 1997). However, the transition to parenthood can be jolting. New mothers may find that the situational challenges and physiological changes brought about by a baby's birth can lead to increased stress and depression (O'Hara & Swain, 1996). These stressors can be consequential for infant development; for example, more stressed parenting is associated with less secure attachment (Coyl, Roggman, & Newland, 2002) as well as negative behavioral and cognitive outcomes for children (Canadian Paediatric Society, 2004; Sroufe, 2005). In addition, while increased parental knowledge is associated with positive child development (Dichtelmiller et al., 1992; Rowe, 2008; Rowe, Denmark, Harden, & Stapleton, 2016), the relatively recent proliferation of online content can present challenges for new parents to navigate and further increase stress levels. These challenges are additionally complicated by the often- contradictory nature of online information on how to care for infants. . Technology-based interventions have emerged as one approach to supporting new parents but the evidence on their feasibility and effectiveness is not yet well developed (Hall & Bierman, 2015).

We add to this nascent literature on technology-based interventions for supporting new mothers using programmatic data from NurturePA, a text-based mentorship program run by a Pittsburgh-based nonprofit. NurturePA trains volunteers to support new mothers using a text-message-based platform, with the goals of reducing maternal stress, increasing maternal knowledge, and promoting positive child development. We coded 18,897 text messages from 162 mother-mentor pairs across the first year of life for focal babies. We examined frequency of

communication, topics of discussion, and supports offered.  We also examined variation in interactions between mothers and text-based mentors by whether the mother had one or more children and by a proxy measure for socioeconomic status (SES).  We find that, across income levels and number of children, mothers engage regularly with their program mentor and discuss child developmental topics alongside their own well-being.  This study contributes to research on technology-assisted interventions targeting parents of very young children, providing a case study of the quantity and type of engagement a text-based mentorship intervention can support.

**Supports and Interventions for New Mothers**

Historically, the United States has provided little publicly funded support for meeting the psychosocial needs of new mothers, with the exception of home visiting programs.  Although efficacious for both mothers and their babies (Fergusson, Grant, Horwood, & Ridder, 2005; Heckman, Holland, Makino, Pinto, & Rosales-Rueda, 2017; Olds et al., 2002; Olds et al., 2004), home visiting has targeted only the most at-risk mothers due to its costs (Nurse Family Partnership, 2014; Schmit, Schott, Pavetti, & Matthews, 2015).  Although most new parents in the U.S. have contact with pediatricians through well-child visits, these visits rarely include much discussion of developmental or parenting topics, even though parents report needing more guidance in these areas (MacPhee, 1984; Schuster, Duan, Regalado, & Klein, 2000).  In addition, adherence rates to American Academy of Pediatrics recommended well-child visit schedules vary based on parental education, family income, and race, with low income, less educated, and minority families being less likely to adhere to recommendations (Abdus & Selden, 2013).  From an adult developmental perspective, the lack of systematic support for new parents represents a missed opportunity.  Relative to most of the life course in adult development, the welcoming of a new child can drive feelings of vulnerability and structural changes in new parents' brains that

make them unusually open to change (Kim et al., 2010; Kim & Watamura, 2015).  Parenting

behaviors may be most malleable in the three to four months immediately following the birth of

a child, compared to later when parenting patterns have already been established and when

structural changes in the postpartum brain have already occurred.

Recently, technology-based approaches to support new parents have drawn attention for

their potential scalability at low cost and because new parents – most of whom are now

millennials who are comfortable with technology – have been increasingly turning to the internet

for guidance and support (Dworkin, Connell, & Doty, 2013).  Seemingly, without additional

intervention, the internet alone could support new parents by increasing their child development

knowledge – a protective factor associated with improved child outcomes (Benasich & Brooks-

Gunn, 1996; Dichtelmiller et al., 1992; Rowe et al., 2016).  Increased parental knowledge has

been shown to improve parenting practices such as rates of child-directed speech (Rowe, 2008),

and parental outcomes such as parental anxiety (Winter, Morawska, & Sanders, 2012).  At the

same time, the volume of information available to new parents may be a source of stress.

Information overload – an overabundance of potentially useful information –  can lead to

feelings of being overwhelmed and losing control over a situation (Bawden & Robinson, 2009;

Iyengar & Lepper, 2000).  Further, for parents to translate information into benefits for children,

the information they access must be accurate.  While parents describe the internet as a

convenient and comfortable way to gather information (Warren, Allen, Okuyemi, Kvasny, &

Hecht, 2010), they also report concerns about the reliability and credibility of the information

they find (Nichols, Nixon, Pudney, & Jurvansuu, 2009).  Although credible research-based

websites for parents do exist (e.g., Zero to Three, Tufts Child and Family WebGuide,

infoaboutkids.org), their usefulness relies on parents being aware of them in a crowded marketplace and accurately judging their reliability.

Technology-based interventions have sprung up to support parents in their baby's early days and to help them filter through this crowded information marketplace. In their review of 48 technology-based interventions that specifically target families with children aged 0-3, Hall and Bierman (2015) found that these interventions have focused primarily on improving parental behaviors, knowledge, and wellbeing. Their technological approaches have been diverse, including websites, text messages, videoconferencing, and online coaching. Research on the efficacy of these interventions is in an early stage. Of the 48 studies Hall and Bierman (2015) examined, 23 addressed program impacts. Across these studies, results were mixed with 12 studies showing some significant improvements in targeted parental and child outcomes and the remaining 11 demonstrating no significant effects (Hall & Bierman, 2015). Importantly, few studies to date have examined *how* parents engaged with technology-based interventions – a key gap that Hall and Bierman identify in their review and that our study helps to address.

Further, only one intervention used text-message communication exclusively, an approach shown to be efficacious with parents of older children (Bergman, 2015; Bergman & Rogers, 2017; Doss, Fahle, Loeb, & York, 2018; Kraft & Dougherty, 2013; Kraft & Rogers, 2014; Smythe-Leistico & Page, 2018) and that is central to our focal intervention. Specifically, the text-only intervention in Hall and Bierman's review (2015), text4baby, sends pre-programmed messages covering health and safety topics to families, three times a week, throughout their child's first year of life. The program is highly scalable; it has reached over 1,100,000 families since its inception in 2010 (text4baby, 2016). Early studies suggest participation in the program is related to improved maternal beliefs of self-efficacy, parental

knowledge of infant health topics, communication with medical providers, and to reduced

postpartum alcohol consumption (Evans et al., 2015; Evans, Wallace, & Snider, 2012; Grabosch,

Gavard, & Mostello, 2014; Martinez & Uekusa, 2013; U.S. Department of Health and Human

Services, 2015).  Importantly, text4baby messages are not tailored to individual families, and

parents cannot ask specific questions through the service – a major difference between text4baby

and our focal program in this study that we return to in the next section.  Further, a service with

fixed messages may be seen as a source of professional guidance whereas a more personalized

intervention may be able to create a feeling of interacting with a knowledgeable peer.  This is an

important consideration because parents are more likely to view family and peers as the most

appropriate source of support for parenting concerns and less likely agree that all parents need

professional help and guidance to assist them in parenting (Edwards & Gillies, 2004).  Thus,

from a theoretical perspective and given existing empirical evidence (Doss et al., 2018; Smythe-

Leistico & Page, 2018), text-based approaches that incorporate a higher level of personalization

and a reciprocal relationship may be particularly effective in influencing specific early parenting

behaviors and parent-child interactions.

**NurturePA Intervention and Theoretical Framework**

NurturePA is an entirely text-based intervention that is both highly personalized and

reciprocal.  Within days of an infant's birth, mothers are paired with trained mentors (training

details provided in the method section) who answer mothers' questions, provide emotional

support, encourage activities that support maternal wellbeing and healthy child development, and

connect mothers to relevant local resources.  Mother/mentor pairs communicate through text

messaging only. Mentors use a web-based platform, not their individual cell phones, to

communicate with mothers.  This platform also provides mentors with pre-loaded conversation

prompts tailored by child's age and a library of curated information and expert recommendations on child care and development that they can easily share with mothers.  The content in the platform draws on a variety of reputable sources including the American Academy of Pediatrics, Zero to Three, and the Centers for Disease Control.  Mentors are assigned up to 10 mothers and are expected to contact them weekly, committing about two hours a week in total across their assigned mothers to conversing and checking in.  Mentors are asked to be available, but not on call, and to do their best to respond to mothers within 24 hours.  Mothers may contact their mentors whenever they like and can stay enrolled in the program until their child's third birthday.

The model is grounded explicitly in behavioral science theory (Mullainathan & Thaler, 2000; Simon, 1955).  Specifically, the model recognizes that task complexity and delayed gratification can act as behavioral barriers to optimal parenting – e.g., that parents may be overwhelmed by the complexity of parenting and the many choices it requires of them (Mullainathan & Thaler, 2000; Simon, 1955), as well as by often-contradictory advice and sources of information.  Mentors address task complexity by providing parents with specific and credible information to help simplify their choice making.  For example, they may answer questions about transitioning to solid foods or safe sleep guidelines.   As many parental investments do not show results in the immediate term, which may result in parents underinvesting in activities or strategies that can ultimately benefit their children (DellaVigna, 2009; Thaler & Sunstein, 2008).  For example, high levels of talking, singing, and reading to babies beginning at birth are beneficial, but can require considerable energy and investment from parents.  As most infants say their first word around one year of age, and experience a vocabulary and talking spurt around 18 months to two years, (Hagan, Shaw, & Duncan, 2007)

the timing gap between investments and observed benefits could lead parents to talk, sing, and read at levels sub-optimal for child development. The NuturePA model addresses this barrier by providing regular encouragement and reminders that there are longer-term benefits of immediate investment in activities, along with suggestions for age-appropriate activities to try.

The model also has a strong theoretical grounding in adult learning theory which posits that adults (1) are most interested in learning when it has immediate relevance to their jobs; (2) learn from reflecting on problems that arise when they try to apply their new knowledge/skills; and (3) want to be actively involved in directing and evaluating their own learning (Knowles, Holton, & Swanson, 2005; Michigan Association of Intermediate School Administrators General Education Leadership Network Early Literacy Task Force, 2016). Mentoring for new mothers largely matches these tenets. Although parenting is not a job in the sense typically addressed in adult learning theory, it is a substantial part of a new mother's daily life, and the information and advice provided by mentors is directly relevant to the work of parenting. Further, as mothers are able to reach out with problems that arise as they apply their developing parenting skills to new experiences, they have the opportunity to reflect on these problems with the support of a mentor who has relevant experience they can share. Finally, mothers are able to control the topics they discuss with their mentors and therefore are engaged in directing their learning they receive from that relationship.

**Research Questions**

We consider three overarching research questions related to the feasibility and potential for text-based based mentoring to support new mothers:

1. What are the characteristics of mothers' engagement with this program? How often and for how long do mothers engage with their mentor? What topics do mothers and

mentors discuss?  How often do mothers raise problems they are experiencing with their

mentors, how often are they offered supports, and what are those supports?

2.  Does engagement and responsiveness vary across mentors?

3.  Does engagement and responsiveness vary across subgroups including:

    a.  First time mothers versus other mothers?

    b.  Mothers in different income terciles?

These questions will allow us to learn about how the NurturePA program functions and how

mothers engage with the program.  In turn, our findings will provide broader insight into the

extent to which low-cost, low-touch efforts such as NurturePA have the potential to

meaningfully improve early childhood and early maternal outcomes.

**Methods**

**Participants and Contexts**

      NuturePA recruits participants in the postpartum wards of three hospitals, two located in

the city of Pittsburgh and the other located just beyond Pittsburgh's city limits in Allegheny

County.  Program staff members have approved access to visit new parents in their hospital

rooms and offer them the service, just as photographers are allowed to visit new parents and

offer photography services.  Mothers who elect to participate in the program are assigned to a

mentor within 24 hours of signing up.  During our study period, the take-up rate of the service

was approximately 60%.  The mothers who opted to not participate in the program included

those who have previously had children who feel they do not need additional support (K.

Brennan, personal communication, May 21, 2018).

      The NurturePA program collects information on participants' race, age, zip code, and

number of children at time of sign up.  As shown in Table 1, participants in our sample had 1.7

children on average and half were first-time mothers.  The average participant's age was 31.1 years-old and 87.6% identified as White.  The remainder of the sample identified as either Black/African-American (87.4%) or as Mixed Race (1%).  Based on the zip codes available for 140 (86.4%) of the sample participants and the demographic characteristics of those zip codes, women in this subsample live in areas characterized, on average, by a somewhat higher median household income ($58,180 in the sample versus $52,390 in the county) and slightly lower poverty rate (11.3% in the sample versus 13.1% in the county) than the county as a whole.[1]

The NurturePA program pairs new mothers with a volunteer mentor trained by the organization.  All mentors attend a three-hour, in-person training during which they are introduced to the program and the logistics of mentoring and receive guidance on how to build relationships with mothers.  Mentors also have the opportunity to role play the text-based mentoring process.  Following this initial training, mentors are given access to seven online training videos (each approximately 15 to 20 minutes in length)  that provide an overview of NurturePA's goals and program design, an explanation of the software mentors use to manage their interactions with mothers, information about a local home-visiting initiative that mentors can recommend to mothers, information about recognizing and responding to perinatal mood and anxiety disorders, and information about supporting breastfeeding, safe sleep, and early language and literacy.  Each training video is hosted by a different individual including a lactation consultant, the director of a nonprofit focused on safe sleep education, a social worker who focuses on mental health, the project coordinator for the Allegheny County Health Department,

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[1] Pittsburgh is the second largest city in Pennsylvania, with a population of approximately 300,000.  .  The county as a whole is 83% White, 14% Black, 3% Asian, and 1% Hispanic (U.S. Census Bureau, 2010a).  .  Pittsburgh is 66% White, 26% Black, 4% Asian, and 2% Hispanic (U.S. Census Bureau, 2010b).  .  The median household income in the county and the city is $52,390 and $40,009 respectively, with 13.1% of Allegheny County residents and 22.8% of Pittsburgh residents living in poverty (U.S. Census Bureau, 2010a, 2010b).  .  Over 12,000 children are born in the county each year (Gally & Kokenda, 2010).

and a representative of the Carnegie Library of Pittsburgh.  Completing the training videos takes approximately two hours.  Mentors also have ongoing opportunities to participate in round table discussions and to attend community presentations, although these activities are not mandatory.

**Data**

Our data comes from transcripts of text conversations between mothers and the mentors with whom they were paired.  To capture mother-mentor relationships that have had sufficient time to develop, we consider the subsample of mothers who began the program on or before March 31, 2015.  We chose this date because the last date available in the dataset is March 31, 2016.  Thus, mothers who joined on or before March 31, 2015 had at least one year – e.g., the first year of their infant's life – to engage with their mentors.  We use data from each mother's first year of involvement so that the data would reflect the same time span – the baby's first year – for every mother-mentor pair.  While the full sub-sample of mothers who meet this criterion is 187, we omitted 25 cases because the mentor never received a response from the mother.  In these cases, we cannot confirm that the mother ever received messages from their mentor (e.g., there may have been data entry mistakes with a mother's phone number).  As such, we examine the 162 cases in which we can be sure the mother was exposed to the intervention.

The programmatic data available for analysis were the transcripts from the text conversations between mentors and the mothers to whom they are assigned.  The transcripts included the date and time each text was sent, the direction of the text message, and the verbatim content of each message.  Across the 162 text transcripts, the messaging system captured approximately 18,897 text messages.

**Data Preparation**

We applied a two-step coding scheme to prepare the collected text-transcript data for analysis.

**Coding scheme.**  Four research team members developed the coding scheme over a period of several months using a small subsample of the NurturePA data (*N*=6).  The coding scheme comprises two main components: a set of exchange coding rules designed to split a transcript into discrete exchanges or conversations (see Appendix A for details) and a set of rules for coding the content of the messages.  Following Weiss (1995), we developed the rules for coding message content first by discussing NurturePA's theory of change with organization staff (see Figure 1).  We then identified what information would need to be coded to examine whether the elements in their theory of change were present in practice.  We also consulted developmental checklists published by organizations like the Centers for Disease Control and Prevention and reviewed the contents of the subsample used to develop the coding scheme (Centers for Disease Control and Prevention, 2016).

We coded each exchange for four features: mother initiation, exchange topic, supports offered, and presence of a maternal problem, following the process diagrammed in Figure 2.  We report the topic codes and subcodes for identifying exchange topics in Table 2.  The codes used to identify the supports offered by mentors are reported in Table 3.  A more detailed explanation of the coding process is presented in Appendix B.

**Coding reliability.**  The master coder exchange coded all 162 transcripts.  While the team did not double exchange code on transcripts when developing the exchange coding process, exact reliability between the master coder and the other research team members was above 90% on 6 transcripts.

A three-person coding team  coded the transcripts for content.  Two were additional team members not involved in developing the coding system who were trained on the coding scheme and tested on a set of transcripts reserved for reliability testing.  Team members began coding when they achieved reliability of 80% or higher on a reliability test.  In all, the master coder content coded 117 transcripts. The second team member content coded 34 transcripts, and the third team member content coded the remaining 11 transcripts.  Of the 34 transcripts content coded by the second team member, the master coder double coded eight transcripts (24%) to assess inter-rater reliability.  Seven (64%) of the 11 transcripts content coded by the third team member were double-coded by the master coder.  For the transcripts that were double-coded, exact reliability was above 80% in all coding categories.

**Correctness coding process.**  Two team members also coded a subsample of transcripts for the correctness of the information being provided by mentors to mentees.  We selected a random sample of 20 transcripts for this process, approximately 12% of the total sample examined in this paper.  When information was provided by a mentor, coders indicated whether or not the information was accurate using the American Academy of Pediatrics Bright Futures Guidelines for Health Supervision of Infants, Children, and Adolescents (Hagan et al., 2007).  In the case that information was not accurate or was inconsistent with AAP guidelines, coders indicated whether or not the incorrect information could be harmful to the wellbeing of the mother or the infant.

**Measures**

We used several self-reported measures to characterize the mothers enrolled in the NurturePA program: race, age, and,  as a proxy for prior maternal experience, the self-reported number of children a mother had (with mothers reporting one child being labeled first-time

mothers). Using self-reported residential zip codes, we also created a proxy for income by identifying the median income in a mother's zip code as reported in the 2010 U.S. Census.

We used the following 11 measures to understand the operations of the NurturePA program: total length of engagement, total number of exchanges, length of exchanges, time between exchanges, frequency of mother initiated exchanges, the frequency with which problems were discussed, topics of exchanges, the number of problems and supports within mother-mentor transcripts, and the types of supports mentors offer both in general and when they are responding specifically to a problem raised by the mother. We describe each and the rationale for each in detail below.

First, as the program aims to support mothers over a period of years and mentors are instructed to check-in with mothers weekly, we sought to understand and characterize both *length* and *frequency* of maternal engagement in our sample. We considered the total length of engagement by calculating the number of days between the first and last message in a mother's transcript. We defined a full year of engagement as having at least one exchange in the twelfth month in the program. We also considered the total number of exchanges, as well as the mean length of exchanges in turns of talk,[2] and the mean time in days between exchanges. In addition, to examine how mothers used the program, we calculated the percent of exchanges that were initiated by mothers and the percent of exchanges they used to discuss a problem they were having with parenting or in their lives more broadly.

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[2] The number of turns is not the same as the number of individual texts in the exchange. In many cases, a mother's question or mentor's response will not fit in a single text and so multiple lines of text are sent and appear in the transcript. . However, to count each line individually would overestimate the amount of interaction between the mother and the mentor. . Thus, in instances where a single response spanned multiple lines of text, all lines were counted as a single turn.

Two goals of the NurturePA intervention are encouraging activities that promote healthy child development and relieving maternal stress and social isolation. As such, we were interested in the topics that mothers were discussing with their mentors. We calculated the frequency with which each topic was discussed, grouping topics into four broader categories of (1) child focused, (2) maternal and family focused, (3) program functioning, and (4) other to calculate how often each category was addressed.

Beyond checking in weekly and attending to child development and maternal stress and wellbeing, mentors were also tasked with responding to any problems the mother was having and with providing emotional support. In some cases, the scope of the mother's problem may fall outside the ability of the mentor to suggest solutions, as in instances when a mother is experiencing post-partum mood disorders or when a baby is sick. In these cases, mentors are still expected to respond to the problem by referring mothers to appropriate resources and professionals who are qualified to address these concerns. To understand whether and how mentors were responding when mothers had problems, we calculated the number of problems mothers had, how often they were offered support for problems, and how often they were offered support in general. We also calculated the number and frequency of offers of each support type, including referrals to outside resources and professionals, both when given specifically in response to problems and when given in general. The same types of support could be coded in each case, for example an informational website offered in response to a particular feeding concern and a website with language building activities offered when the mother has not expressed difficulty supporting language development.

**Analytic Approach**

To answer our first research question – the characteristics of mothers' engagement with NurturePA – we generated descriptive statistics for primary characteristics of mother-mentor exchanges: total length of engagement, total number of exchanges, length of exchanges, time between exchanges, frequency of mother initiated exchanges, and the frequency with which problems were discussed. In addition, we generated descriptive statistics for the topics of exchanges, the number of problems and supports within mother-mentor transcripts, and the types of supports mentors offer both in general and when they are responding specifically to a problem raised by the mother.

Next, to address our second research question – whether engagement and responsiveness vary across mentors – we used multi-level modeling to examine the variation across mentors for these primary characteristics. We fit null models for each of these measures with random intercepts for mentors. This analysis provided intraclass correlation (ICC) values which indicated what proportion of variance, in the outcome of interest, was accounted for by the mentor to which a mother was assigned. Low ICC values indicate that most of the variation occurs between individual mothers, whereas high ICC values indicate that most of the variation occurs between mentors and would suggest that the mentor to which a mother is assigned plays an important role in shaping a mother's experience with NutrePA.

Finally, to address our third research question – how maternal engagement varies with income and prior maternal experience – we added the relevant subgroup characteristic to our regression models. Note that mothers who experienced a change in mentor (*N*=30) were attributed to the mentor with whom they had most of their exchanges in our data.

**Results**

**RQ1 – Characteristics of Mother-Mentor Interactions**

As shown in Table 4, the average length of time between the first exchange and the last exchange in a mother's transcript, an indication of how long she remained engaged with the program, is 296 out of a possible 365 days.  This measure has a large amount of variation ($SD$=100.4 days), and while the minimum length of engagement is six days, half of all mothers stayed engaged for at least 352 days.  This indicates that the majority of mothers remained engaged for close to the entirety of their first year of enrollment while some did not really engage at all.  Overall, 17% of mothers engaged for six months or fewer, with only 3% dropping out within one month, and 61% of mothers remained engaged for at least the full year we focused on for this study.

On average, there were 43 exchanges in a mother's transcript.  However, we again see large variation with a standard deviation of 26 exchanges (range 2 to 119).  When mothers and mentors had exchanges, the average exchange length was 2.5 turns long  with a standard deviation of 1.2 turns (range 1.1 to 7.4).  This indicates that, on average, the mother and mentor participated in the exchange slightly more than once each.  The following is a stylized example[3] from the transcripts of a typical two-turn exchange:

> **Mentor:** Hi Pamela, I hope your summer is going well!  I thought you might be interested to hear about story time at the Carnegie library locations.  It's a great way to get out, meet other moms, and it's an awesome language development opportunity for you and Blake!  They have story times at different locations on different days.  Here's a link to look up times near you: http://www.carnegielibrary.org/events/
>
> **Mother:** Thanks Judy!  This is great.  Blake loves when we read to him so I bet he'd love this.  I've also been feeling like I need to find a way to meet other moms.

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[3] Stylized examples based on actual exchanges are provided because our data agreement with NurturePA prohibits the use of verbatim quotes from the data.

On average, the mean number of days between exchanges was 9.8, with a standard deviation of 4.2 days – slightly longer than the NurturePA benchmark of one exchange per mother-mentor pair per week. Finally, of these exchanges, mothers initiated an average of 3% and overall, 39% of mothers initiated at least one exchange during their engagement with the program. Among mothers who initiated at least one exchange, an average of 6.7% of exchanges were initiated by the mother, indicating that mentors initiated almost all exchanges. The low share of mother-initiated exchanges overall underscores the importance of mentors proactively reaching out to mothers, ensuring that mothers who might not be inclined to initiate a conversation are also receiving support. When mothers did initiate exchanges, motor and language development were discussed less often than in mentor-initiated exchanges but child wellbeing, basic infant care, and sleep safety were discussed more often. This further reinforces the importance of proactive engagement by mentors, especially around topics related to development and strategies to support development.

Mothers also differed in the extent to which they sought assistance from their mentor. Across all message exchanges, 10% addressed a program (*SD*=11.4). However, some mothers raised problems with a much higher degree of frequency. Specifically, nearly 1 in 10 mothers shared problems in one-quarter or more of their exchanges, indicating variability in the degree to which mothers sought help with specific problems. Unsurprisingly, mother-initiated exchanges were substantially more likely (44% vs 8% of exchanges) to address a problem.

As shown in Table 5, mothers and mentors spend the plurality of their exchanges building rapport through check-ins (49%). For example:

**Mentor:** Hey Ebony, how have you and your sweet baby girl been doing?

**Mother:** Hi Jan!  We've been great.  This past weekend the whole family went to the local park to enjoy the weather.  I hope your family has also had a chance to enjoy the sun!

**Mentor:** We sure have, my kids have been loving it!  It's so great that you're able to spend some quality time together as a whole family.  It might be hard to tell while she's so small, but Layla will really appreciate this time as she grows.

Some check-ins also include questions about specific topics which the mother may acknowledge but does not take up in a substantial discussion.  As shown in Appendix Table C.1 for parsimony, among such check-ins, basic care (8%) was the most common topic, followed by feeding, maternal wellbeing, motor development, and language development, all of which made up around 4% of all check-ins.  In addition, stock messages, which may address child or maternal focused topics, but which are not tailored to the mother, account for almost 6% of exchanges.  As shown in Appendix Table C.2, stock messages are most often used to convey affirmations or well-wishes from NurturePA (47%), information about basic care topics (12%), and information about various development topics (21%).

Beyond these rapport-building and informative but untailored interactions, mothers and mentors spend most (28%) of their remaining exchanges discussing child-focused topics such as child needs or wellbeing and child development.  Feeding was the most common child-focused topic discussed, accounting for almost 8% of exchanges on average.  Basic care, child wellbeing, maternal wellbeing, sleep, and motor development all accounted for approximately 4-5% of exchanges each, on average.  Language development accounted for about 3% of exchanges on average, with other developmental categories including cognitive and social/emotional

development accounting for less than 1% of exchanges each. Stylized examples of exchanges focused on language development and maternal wellbeing can be found in Appendix D.

As shown in Table 6, 77% of mothers communicated with their mentor about at least one problem, sharing an average of five distinct problems. When mothers did discuss problems, mentors were fairly responsive, replying to an average of about 86% of maternal problems within 48 hours. When mentors were providing supports in response to a problem, they offered advice (35%) and emotional support (39%) to the largest percentage of problems. Websites (15%) and referrals (13%) were also common supports offered in response to problems. In addition, product recommendations were offered for approximately 6% of problems, while all other types of supports, such as brainstorming, were offered for less than 5% of problems.

Mothers who did not discuss problems also received information and suggestions. Overall, 93% of mothers received at least one instance of support from their mentor, 16 percentage points more than mothers who discussed at least one problem with their mentor. Further, mothers received an average of 16 instances of support, only four of which were offered in response to a problem. The large number of supports offered relative to the number of problems reflects both that mentors offer supports even when a problem is not present and that mentors can offer more than one support to an individual problem.

Mentors provided information and resources even when mothers did not communicate a specific problem. In addition, mothers also asked for advice with choices for which they would appreciate input, but which were not creating problems for them, for example picking a style of sippy cup or deciding on a bedtime for their baby. An example of such an exchange is as follows:

**Mother:** Hi Carmela, we're trying to move Adrian from bottles to some kind of sippy

cup. Do you have any recommendations?

**Mentor:** Hey Linda! Personally, I found that cups with straws worked well for my kids.

They make cups with weighted straws so your kiddo is able to drink no matter what angle

they're holding the cup at. We used ones made by the munchkin brand, they are also

dishwasher safe which is always a plus!

In contrast to the rates for supports prompted by a mother sharing a problem, when all supports

are considered, websites represented 46% of all supports offered, followed in frequency by

advice (29%) and emotional support (11%). All other support types, such as brainstorming and

referrals, were offered less than 5% of the time.

Although referrals were not offered often, they also represent an important element of the

NurturePA model. Specifically, referrals prompted by concerns around postpartum mood

disorders and potential child developmental delays have the potential to be very impactful for

mothers with such concerns. In our sample, 12% of mothers were referred to professional

resources after concerns were raised about postpartum mood disorders. This rate is encouraging

as it is on-par with CDC research indicating that about 11% of women experience postpartum

depressive symptoms (Ko, Rockhill, Tong, Morrow, & Farr, 2017). In addition, almost 8% of

mothers received referrals to the Alliance for Infants and Toddlers, an Allegheny County

organization that provides free screening and services for developmental concerns. This rate also

aligns with national data. The National Survey of Children's Health found that about 11% of

children are at high risk for developmental delay, based on parent expressed concerns that are

considered predictive of delay (Child Trends, 2013). Together, these rates indicate that mentors

are helping to facilitate connections between mothers and community resources when mothers

are experiencing challenges that are beyond the capacity of the mentor to address.

Finally, the information mentors were providing to mothers through advice, professional

recommendations, websites, product recommendations, and referrals was largely accurate.

Overall, 84% of information provided by mentors was accurate, 5% was inaccurate, and 11%

could not be assessed because the links to which mentors had referred mothers were no longer

active. Of the 5% of information that was inaccurate, none was determined to be potentially

harmful. For example, a mentor recommending drinking more water to support milk production

would be considered inaccurate but not harmful, as increased maternal hydration does not affect

milk production (Institute of Medicine, 1991), but increasing water consumption will also not

harm the mother or her infant..

**RQ2 – Mentor-Dependent Variation**

Different from an intervention like text4baby for which all messages are pre-

programmed, in an individualized intervention like NurturePA, the mentor to which a participant

is assigned might affect a mother's experience of the program. We found little evidence of

mentor assignment influencing mothers' program experience and program behavior. As shown

in Table 4, the ICC values for all measures except the time between exchanges were relatively

low. The ICC values were lowest for measures of maternal response and the total length of

engagement, ranging from 0.00-0.05. The values for the number of exchanges and mean length

of exchanges were slightly higher at 0.11 and 0.14 respectively, indicating that more of the

variance in these variables is accounted for the mentor to which a mother was assigned.

However, even these ICCs are fairly low. By contrast, the ICC for the time between exchanges

was 0.67, indicating that the majority of the variation in this measure can be accounted for by the

mentor to which a mother was assigned.  This finding implies that further emphasis may be needed in training around how often mentors should be reaching out to mothers.  In addition, the program may benefit from building reminder features into their system technology to notify mentors about incoming communication from the mothers with whom they work and to remind them to reach out when the time since their last communication with a mother has gone beyond the program's recommendation.

**RQ3 – Subgroup Analyses**

Our third set of research questions – whether first-time mothers and mothers from different income terciles engage with the NurturePA program differently from other mothers – address subgroup variation.  Our subgroup analysis revealed that first-time mothers did differ in several ways from other mothers in their engagement with the intervention.[4]  First, as shown in Table 7, first-time mothers were statistically significantly more likely to engage on child-focused topics ($p<.05$), with differences concentrated in basic care ($p<0.10$) and motor development ($p<0.01$).  Second, as shown in Appendix Table C.3, first-time mothers were more likely to receive a support response from their mentor when they were experiencing a problem ($p<0.10$). Conditional on sharing a problem, first-time mothers received guidance and support from their mentors within 48 hours 90% of the time, as compared to 82% of the time for other mothers. The results of our comparisons across income terciles (see Table 8), revealed that participants who reside in low-income areas responded to and interacted similarly with this text-based mentorship intervention compared to mothers living in areas in the middle and upper income

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[4] Comparing mothers with two children to mothers with three or more children, there were no statistically significant differences on any of the measures of interest.  .  Comparisons of all exchange topics indicated that mothers with three or more children were statistically significantly more likely ($p<0.05$) to discuss child care with their mentor, but these mothers were not significantly more likely than mothers of two to discuss any other topic.  .  Thus, we collapsed the categories for number of children into mothers of one and mothers of two or more.

terciles in our sample. Indeed, the only statistically significant difference between income

terciles was the frequency with which child-focused topics were discussed, with such topics

making up approximately 10 percentage points more of all exchanges for mothers living in areas

within the highest income tercile than for mothers living in areas within the other two income

terciles ($p<0.05$).

## Discussion

Technology-based interventions are a potentially low-cost, scalable approach for

supporting new parents, but to date, we have little evidence on *how* parents engage with these

interventions (Hall & Bierman, 2015). In our study of NurturePA, we aim to help fill this gap by

investigating patterns of engagement in a new text-based mentoring approach to support new

mothers. Participating mothers stayed engaged with their mentor an average 296 days out of a

year, with an attrition rate of 39%. This rate is on par with attrition rates in home visiting

programs. For example, studies of The Nurse-Family Partnership have found attrition rates

ranging from 39% in the first year to 60-70% within two years (O'Brien et al., 2012). In terms

of content, mothers and mentors spent 36% of their conversations addressing child- or mother-

focused topics, with the remainder of their conversations largely devoted to check-ins and

rapport building. Mentors responded to the large majority of mothers' concerns within 48 hours,

most frequently offering mothers advice and emotional support. Mentors referred 12% of

mothers to professional resources for postpartum mood disorders and 8% of mothers to

professional resources for infant developmental delays. Encouragingly, the rates of referral in

response to concerns about anxiety or depression compare favorably to national rates of

postpartum depression (11%; (Centers for Disease Control and Prevention, 2016). Important for

an intervention format in which mentors and moms never meet in person, the relationships they

built appear to be adequately close that mothers are willing to discuss personal and consequential concerns with their mentors.

Interestingly, some of our engagement patterns converge with findings in text-based interventions in other areas. For example, mothers almost never initiated exchanges with their mentors (only 3% of mothers). Mentors proactively reaching out to mothers was a crucial part of the intervention; despite lack of initiation by mothers, a large majority of mothers (77%) had at least one problem addressed by their mentor, and 93% received at least one support from their mentor. These findings converge with those of interventions for college-intending high school seniors, for example, who likewise did not proactively reach out to counselors in a text-based intervention but who responded when contacted by text by a counselor (e.g., Castleman & Page, 2015). More broadly beyond our specific intervention, text-messaging appears to be a scalable way to proactively reach out to provide help and support that may be beneficial but that individuals are unlikely to search out on their own.

Our findings also suggest, consistent with NurturePA's theory of change, that this intervention format may help mothers navigate two behavioral barriers to optimal parenting -- task complexity (Doss et al., 2018) and information overload (Bawden & Robinson, 2009). Mentors offered moms specific resources in response to mothers' problems at high rates (e.g., mentors offered advice for 35% of mothers' problems and websites for 15% of problems). Also, mother-mentor pairs discussed child, maternal, and family focused topics in 36% of all exchanges. We cannot identify whether mothers' behaviors changed in our study as a result of mentoring, but these findings are encouraging for the potential efficacy of this intervention format in supporting maternal wellbeing and healthy child development.

Findings regarding mentors' offer of emotional support in response to problems (39% of all offers in response to problems) are also notable given today's parenting context. A recent report found that 61% of mothers reported experiencing criticism of their parenting choices, most frequently from their child's other parent (36%), their own parents (37%), or their in-laws (31%) (C.S. Mott Children's Hospital & University of Michigan Child Health Evaluation and Research Center, 2017). The non-judgmental, encouraging approach to supporting new mothers via this new format, in which participants communicate relatively frequently but never meet, might be particularly well suited to mitigating maternal stress widely reported by mothers today.

Finally, our findings around variation across mentors and mothers are also important in considering potential efficacy of this approach to supporting new mothers. Encouragingly, the lack of variation across mentors in engagement patterns indicates that the way mothers interact with the program is not highly dependent on the mentor to which they are assigned. Notably, the mentor training is relatively light touch (five hours total; three hours in person and two hours through videos mentors watch on their own) and thus potentially more scalable than an intervention that required more training time would be. Regarding variation across mothers, we found that there were few differences in how and how much first-time versus multiparous mothers engaged with their mentors. These findings mirror studies of home visiting programs which have found that mothers with more than one child engage at similar rates to first-time mothers (Huntington & Galano, 2013; Lanier & Jonson-Reid, 2014). Finally, our findings on engagement patterns by neighborhood SES contribute to the evidence base on differences in engagement across socioeconomic groups in technology-based parenting interventions, an area in the literature that Hall and Bierman (2015) identify as having mixed results. Specifically, three of the studies included in Hall and Bierman's review found that low-income parents were

less likely to express comfort with parenting information delivered electronically, despite reporting daily use of internet and cell phones. We found that mothers living in areas characterized by different levels of SES needed support around similar topics and were equally likely to engage with a technology-based intervention

Notably, there is considerable variation across mothers' engagement in other respects. For example, we found variation across mothers in the total length of engagement ($SD$=100.4 days), the number of exchanges ($SD$=25.7), and the mean time between exchanges ($SD$=4.2 days). In the next phase of our research on NurturePA (a mixed-methods randomized trial currently underway), we plan to try to unpack the mechanisms driving this variation to inform any additional scale-up and the program's theory of change. We will also examine whether engagement is correlated with applying the information and advice a mother receives from her mentor. We do not yet know yet whether engagement translates into behavior change.

There are several important limitations to our work. First, our data come from the start of the NurturePA program. The program has continued to develop since the first messages were exchanged in early 2014. For example, these data do not reflect more recent efforts within the program to give feedback to mentors or a new partnership with the local library system to provide early literacy content directly to mothers. In addition, our work is purely descriptive and cannot be used to make causal claims. We also have access to limited data on participants' background characteristics with only a few data points available for each mother and varying degrees of missingness within each type of data. Finally, as mentioned previously, we do not yet know whether mentoring translates into behavior change, reduced maternal stress, and/or benefits for babies.

Despite these limitations, our descriptive findings suggest that text-based mentoring is a potentially promising, low-cost approach for supporting new mothers and their babies. Mothers do engage in this format and discuss topics of consequence for maternal health and child development. At this early stage of the literature on technology-based parent interventions (Hall & Bierman, 2015), our study illuminates *how* mothers engaged with one such intervention and sets the stage for further evaluation of the text-based mentoring format for supporting new mothers.

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Figure 1: NurturePA Theory of Change
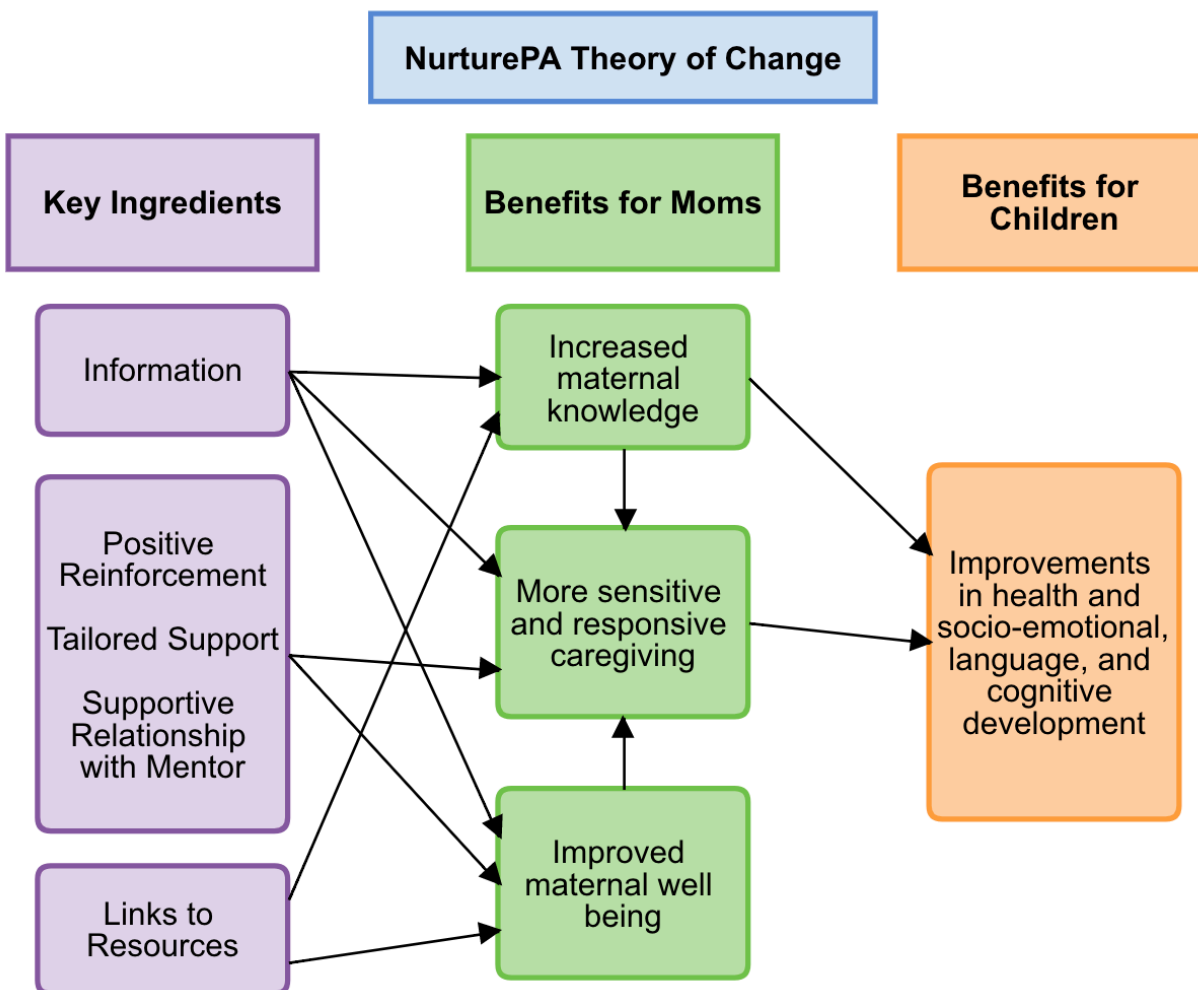
Figure 2: Coding Scheme Flow Chart
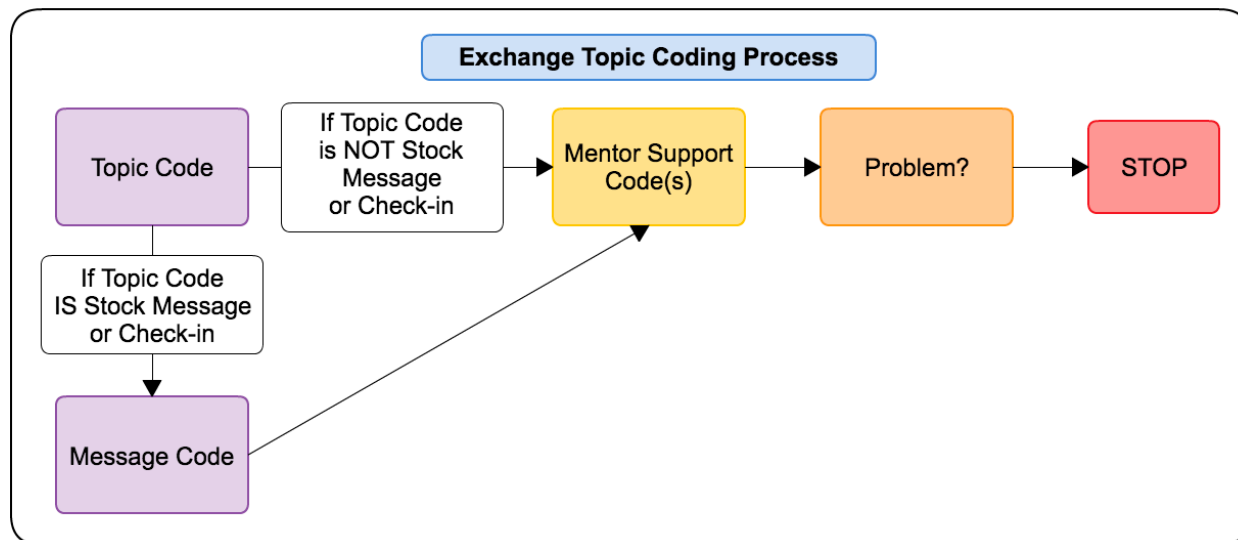
Table 1: Sample Demographics

| | N | % of Subsample | | | |
|---|---|---|---|---|---|
| **Race/ethnicity** | | | | | |
| White | 92 | 87.6 | | | |
| Black/African American | 12 | 7.4 | | | |
| Mixed Race | 1 | 1.0 | | | |
| Total | 105 | | | | |
| | N | Mean | SD | Min | Max |
| Maternal Age | 98 | 31.1 | 5.6 | 19.7 | 47.3 |
| Number of Children | 162 | 1.7 | 0.9 | 1.0 | 7.0 |
| Median Household Income in zip code | 140 | 57,380 | 19,675 | 19,598 | 127,353 |
| Median Poverty Rate in zip code | 140 | 11.6 | 8.3 | 1.5 | 53.0 |

Note: 35.2% of mothers were missing race/ethnicity information, 39.5% were missing age information, and 13.6% were missing zip code and therefore income and poverty rate information.  All mothers had information available on number of children.

Table 2: Exchange Topic Codes and Subcodes

| Topic Code | Subcodes |
| --- | --- |
| **Check-in** | *None* |
| **Child Wellbeing** | *None* |
| **Cognitive Development** | *None* |
| **Data Collection** | *None* |
| **Family Conflict** | *None* |
| **Family Support** | *None* |
| **Mentor Change** | *None* |
| **Partner Relationship** | *None* |
| **Physical Development** | *None* |
| **Program Updates** | *None* |
| **Resources** | *None* |
| **Siblings** | *None* |
| **Social/Emotional Development** | *None* |
| **Stock Messages** | *None* |
| **Work** | *None* |
| **Basic Care** | *Babyproofing; Bathing; Dressing; Fussiness/Soothing Strategies; Gas; Other* |
| **Childcare** | *Anxiety; Cost; Other; Search* |
| **Feeding** | *Appetite; Breastfeeding, Latch; Breastfeeding, Other; Breastfeeding, Pumping; Breastfeeding, Return-to-Work Issues; Breastfeeding, Soreness/Mastitis/Mother Physical Problem; Breastfeeding, Supply; Formula Feeding; Health Concerns; Options; Other; Solids; Weaning* |
| **Language Development** | *Strategies, Talking; Strategies, Singing; Strategies, Reading; Strategies, Back-and-Forth Vocalizing; Recognizes Object Names; Simple Words; Takes Turns Vocalizing; Attending to Sounds; Babbling; Cooing; Recognizes Facial Expression & Tone; Response to Name/Simple Requests; Gestures* |
| **Maternal Wellbeing** | *Emotional Health; Mental Health; Other; Physical Health* |
| **Motor Development** | *Milestones; Strategies* |
| **Sleep** | *Disruptions; Napping; Nighttime Wakeups; Other; Quantity; Safety; Strategies; Training* |
| **Termination** | *Disenrollment; Inactive; Inquiry* |

Table 3: Mentor Support Codes

| Mentor Support Code | Description |
|---|---|
| **Advice** | Mentor offers advice or tips based on personal experience or the experience of others. |
| **Professional Recommendations** | Mentor offers information or recommendations from official sources such as the American Academy of Pediatrics. |
| **Website** | Mentor provides a link to a website. |
| **Product Recommendation** | Mentor recommends a product. |
| **Brainstorming** | Mentor helps the mother to think through a plan to address a problem she is having. |
| **Emotional Support** | Mentor offers words of support, affirmation, empathy, or sympathy. |
| **Referral** | Mentor refers mother to an outside resource. |
| **Phone Call** | Mentor speaks with the mother on the phone. |

Table 4: Duration, frequency and focus of mother-mentor communication ($N$=162)

| Measure | Mean | *SD* | Min | Max | ICC |
|---|---|---|---|---|---|
| Total length of engagement (in days) | 296.0 | 100.4 | 6 | 365 | 0.00 |
| Number of exchanges | 42.7 | 25.7 | 2 | 119 | 0.11 |
| Mean length of exchanges | 2.5 | 1.2 | 1.1 | 7.4 | 0.14 |
| Mean time between exchanges (in days) | 9.8 | 4.2 | 3 | 29.1 | 0.67 |
| % of mother initiated exchanges | 2.6 | 6.2 | 0 | 43.7 | 0.05 |
| % of exchanges addressing a problem | 9.8 | 11.4 | 0 | 74.1 | 0.06 |

Note: ICCs were produced by fitting empty multi-level models with random intercepts for mentors.

Table 5: Exchange Topic Distribution

| Topic | Mean # of Exchanges | SD | Mean % | % At least once |
|---|---|---|---|---|
| **Child Focused** | **13.74** | **15.23** | **27.61** | **92.59** |
| *Basic Care* | 2.45 | 3.35 | 4.78 | 64.20 |
| *Child Wellbeing* | 1.76 | 2.99 | 3.26 | 50.62 |
| *Feeding* | 3.52 | 4.34 | 7.83 | 79.63 |
| *Resources* | 0.18 | 0.64 | 0.41 | 11.10 |
| *Sleep* | 2.13 | 3.70 | 4.11 | 63.64 |
| *Cognitive Development* | 0.40 | 0.83 | 0.72 | 25.31 |
| *Language Development* | 1.71 | 2.31 | 3.33 | 62.35 |
| *Motor Development* | 1.99 | 2.63 | 3.89 | 64.81 |
| *Physical Development* | 0.26 | 0.66 | 0.53 | 16.67 |
| *Social/Emotional Development* | 0.30 | 1.28 | 0.50 | 16.05 |
| | | | | |
| **Maternal and Family Focused** | **3.56** | **4.08** | **8.46** | **74.07** |
| *Childcare* | 0.30 | 1.11 | 0.66 | 15.43 |
| *Family Support* | 0.44 | 0.76 | 1.09 | 32.72 |
| *Family Conflict* | 0.06 | 0.51 | 0.08 | 2.47 |
| *Maternal Wellbeing* | 1.50 | 2.04 | 3.75 | 54.32 |
| *Partner Relationship* | 0.11 | 0.42 | 0.21 | 8.02 |
| *Siblings* | 0.60 | 1.24 | 1.44 | 29.63 |
| *Work* | 0.54 | 0.54 | 1.12 | 28.40 |
| | | | | |
| **Other** | **19.64** | **9.60** | **54.41** | **100.00** |
| *Check-in* | 17.39 | 9.14 | 48.76 | 100.00 |
| *Stock Messages* | 2.25 | 4.04 | 5.65 | 50.00 |
| | | | | |
| **Program Functioning** | **1.91** | **1.22** | **5.81** | **87.65** |
| *Data Collection* | 0.22 | 0.53 | 0.39 | 16.67 |
| *Mentor Change* | 0.23 | 0.46 | 0.68 | 20.99 |
| *Program Updates* | 0.98 | 0.94 | 2.28 | 60.49 |
| *Termination* | 0.49 | 0.69 | 2.45 | 38.89 |

Table 6: Mentor support type descriptive statistics

| | # of moms with at least one problem | N Problems | % problems offered a support | # of moms offered at least one support | N Supports offered |
|---|---|---|---|---|---|
| N | 124 | | | 151 | |
| % of total | 77% | | | 93% | |
| Mean | | 4.88 | 86.04 | | 15.83 |
| SD | | 7.23 | 23.67 | | 14.87 |
| Range | | 0-47 | 0-100 | | 0-73 |

| Mentor support | Mean # of offers made in response to problem ($N=124^{1}$, or 77%) (SD) | Mean % of offers made in response to a problem ($N=124^{2}$, or 77%) (SD) | Mean # of all offers ($N=151^{1}$, or 93%) (SD) | Mean % of all offers ($N=151^{2}$, or 93%) (SD) |
|---|---|---|---|---|
| Advice | 2.39 (3.49) | 35.20 (33.35) | 4.73 (5.98) | 29.09 (24.60) |
| Professional Recommendations | 0.19 (0.60) | 3.19 (12.40) | 0.91 (1.95) | 4.69 (9.83) |
| Website | 0.90 (1.43) | 14.56 (22.52) | 7.62 (7.36) | 45.99 (28.33) |
| Product Recommendation | 0.31 (0.69) | 6.32 (17.51) | 0.37 (0.79) | 1.93 (4.29) |
| Brainstorming | 0.44 (1.15) | 4.09 (9.74) | 0.37 (1.06) | 1.31 (3.58) |
| Emotional Support | 1.88 (3.73) | 38.88 (37.25) | 2.01 (3.83) | 11.06 (16.48) |
| Referral | 0.73 (1.36) | 12.99 (23.06) | 0.94 (1.47) | 4.22 (6.86) |
| Phone Call | 0.01 (0.09) | 0.04 (0.45) | 0.01 (0.11) | 0.06 (0.50) |

[1]These results include the subsample of mothers who had at least one problem.
[2]These results include the subsample of mothers who were offered at least one support by their mentor.

Table 7: Comparison of mother-mentor transcripts characteristics for first-time moms vs all other moms

| Measure | Mean for first time moms (N=85) | Mean for other moms (N=77) | Diff | P-value |
|---|---|---|---|---|
| Total length of engagement (in days) | 288.99 | 303.75 | 14.77 | 0.35 |
| Number of exchanges | 41.31 | 44.31 | -3.01 | 0.46 |
| Mean length of exchanges | 2.56 | 2.42 | 0.14 | 0.46 |
| Mean time between exchanges (in days) | 9.79 | 9.83 | -0.04 | 0.95 |
| % of mother initiated exchanges | 2.80 | 2.46 | 0.34 | 0.73 |
| % of exchanges addressing a problem | 9.77 | 9.84 | 0.07 | 0.97 |
| % with at least one problem | 76.47 | 76.62 | -0.15 | 0.98 |
| % received at least one support | 91.76 | 94.81 | 3.04 | 0.45 |

| Exchange Topic | Mean % for first time moms (N=85) | Mean % for other moms (N=77) | Diff | P-value |
|---|---|---|---|---|
| **Child Focused** | **31.06** | **23.80** | **7.27\*\*** | **0.03** |
| *Basic Care* | 5.52 | 3.97 | 1.55~ | 0.08 |
| *Child Wellbeing* | 3.31 | 3.21 | 0.10 | 0.89 |
| *Feeding* | 8.55 | 7.04 | 1.52 | 0.25 |
| *Resources* | 0.47 | 0.34 | 0.13 | 0.61 |
| *Sleep* | 4.62 | 3.55 | 1.07 | 0.23 |
| *Cognitive Development* | 0.87 | 0.55 | 0.32 | 0.18 |
| *Language Development* | 3.75 | 2.86 | 0.89 | 0.11 |
| *Motor Development* | 4.84 | 2.83 | 2.01\*\*\* | 0.00 |
| *Physical Development* | 0.61 | 0.43 | 0.18 | 0.39 |
| *Social/Emotional Development* | 0.66 | 0.33 | 0.33 | 0.16 |
| **Maternal and Family Focused** | **7.72** | **9.27** | **-1.55** | **0.29** |
| *Childcare* | 0.91 | 0.38 | 0.53 | 0.19 |
| *Family Support* | 1.03 | 1.15 | -0.12 | 0.71 |
| *Family Conflict* | 0.11 | 0.04 | 0.07 | 0.43 |
| *Maternal Wellbeing* | 3.71 | 3.78 | -0.07 | 0.95 |
| *Partner Relationship* | 0.22 | 0.20 | 0.02 | 0.85 |
| *Siblings* | 0.29 | 2.71 | -2.42\*\*\* | 0.00 |
| *Work* | 1.42 | 1.01 | 0.31 | 0.29 |
| **Other** | **53.12** | **55.84** | **-2.71** | **0.42** |

| | | | | |
|---|---|---|---|---|
| *Check-in* | 47.52 | 50.13 | -2.61 | 0.45 |
| *Stock Messages* | 5.61 | 5.71 | -0.10 | 0.95 |
| **Program Functioning** | **5.99** | **5.61** | **-0.38** | **0.66** |
| *Data Collection* | 0.37 | 0.41 | -0.04 | 0.82 |
| *Mentor Change* | 0.55 | 0.83 | -0.28 | 0.25 |
| *Program Updates* | 2.24 | 2.32 | -0.08 | 0.85 |
| *Termination* | 2.82 | 2.05 | 0.78 | 0.30 |

Note: These results were produced by fitting multi-level models with random intercepts for mentors.

Table 8: Comparison of mother-mentor transcripts characteristics for moms across income terciles

| Measure | Tercile One (N=47) | Tercile Two (N=48) | Tercile Three (N=45) | P-Value |
|---|---|---|---|---|
| Total length of engagement (in days) | 274.44 | 235.51 | 263.15 | 0.26 |
| Number of exchanges | 37.84 | 39.13 | 44.36 | 0.38 |
| Mean length of exchanges | 2.24 | 2.27 | 2.60 | 0.21 |
| Mean time between exchanges (in days) | 10.71 | 10.84 | 10.17 | 0.56 |
| % of mother initiated exchanges | 1.19 | 2.58 | 2.02 | 0.38 |
| % of exchanges addressing a problem | 6.56 | 10.34 | 9.18 | 0.18 |
| % with at least one problem | 72.33 | 72.92 | 82.23 | 0.46 |
| % received at least one support | 86.36 | 95.89 | 92.89 | 0.19 |
| % of exchanges that address child focus | 23.98** | 22.67** | 33.29** | 0.03 |
| % of exchanges that address maternal and family focus | 7.32 | 9.28 | 8.04 | 0.56 |
| % of exchanges that address other topics | 57.98 | 58.47 | 51.66 | 0.21 |
| % of exchanges that address program functioning | 6.08 | 6.36 | 5.82 | 0.90 |

Note: *P*-value generated from a test comparing tercile one and tercile three to tercile two and calculating $\chi^2$. These results were produced by fitting multi-level models with random intercepts for mentors.

**Appendix A: Exchange Coding**

This appendix will provide an overview of the process used to code the text-message transcripts in preparation for analysis with a focus on how the transcripts were broken down into exchanges, our unit of analysis. When we coded mother-mentor transcripts to describe the topics being covered, the frequency and length of communication, and the types of supports being supplied to mothers, we coded them by exchange, or conversation, rather than by individual text. Analyzing transcripts at the level of the discrete exchange level rather than the level of the individual text prevents over-coding of topics for mothers or mentors who ask questions or offer responses across multiple text messages. Coding discrete exchanges required attention to both the time stamps available for each text and the content of the texts. Figure 1 below provides examples of the application of the rules used to code these exchanges. We primarily defined exchanges by the application of a time-based rule illustrated by the top example in the figure: any text that falls outside a window of approximately 48 hours since the previous text is considered to be part of a new exchange, regardless of the content of the texts. In the example shown, approximately one week has elapsed between the texts sent by the mentor and thus a new exchange is coded. We applied additional rules to define separate exchanges that occur within a 48-hour window, attending primarily to the content of the text, with a focus on texts that either do or do not engage with the topic of the preceding text in a substantive way. As shown in the middle example in the figure, we consider texts that do engage an ongoing topic to be part of an ongoing exchange. In this example, the same exchange is continued because the mentor replies within 48 hours and continues to discuss the motor development of the child. Finally, as shown in the bottom example in the figure, we considered texts that do not engage an ongoing topic or which acknowledge a previous topic in a cursory manner before moving on to a different topic of

focus to be part of a new exchange.  A new exchange is coded in this example because, although the mother sends another message within 48 hours, rather than continuing to discuss solid foods, she asks her mentor a new question about moving her child to his own room to sleep.  Per our data use agreement with NurturePA, all transcript examples included in this paper are fictional examples created by paraphrasing actual conversations.  None of the names or conversations represent verbatim conversations from the sample.

Figure 1: Application of Exchange Coding Rules

| Timestamp | Sender | Exchange Number | Message |
|---|---|---|---|
| 2/7/2015 11:34am | Mentor | 13 | Hi Laurie, how's Carson doing?  Anything I can help with? |
| 2/7/2015 3:42pm | Mother | 13 | We're great, thanks.  I think we saw his first smile today! |
| 2/8/2015 7:09am | Mentor | 13 | Aww, that's so great, baby smiles just melt your heart! |
| 2/15/2015 8:03am | Mentor | 14 | Hi Laurie, how's your smiley baby doing?  Singing to him can really help his language development.  Does he have a favorite song? |
| 2/15/2015 11:12am | Mother | 14 | Hi Jeannie, he really seems to like Old McDonald, especially the animal noises!  I always thought I had a singing voice that would make a baby cry, but he does mind at all, lol |
| 2/15/2015 1:13pm | Mentor | 14 | Ha ha, I know what you mean!  I've never been known for my singing, but my two boys love to hear me anyways, and it's so good for them! |

Here, the time elapsed exceeds 48 hours, so a new exchange is started.

| Timestamp | Sender | Exchange Number | Message |
|---|---|---|---|
| 5/8/2015 2:34pm | Mentor | 34 | Hi Laurie, has Carson starting crawling for you yet? |
| 5/8/2015 10:11pm | Mother | 34 | Sort of, he kind of sticks his behind up and rocks back and forth, and sometimes he gets going backwards.  Is that normal? |
| 5/10/2015 8:02am | Mentor | 34 | Sounds like your little man is making great progress!  That's totally normal.  Lots of babies get the hang of going backwards before they manage moving forwards.  Both of my girls did it, they were so funny to watch. |
| 5/10/2015 8:03am | Mentor | 34 | If you want to encourage him to work on going forwards you could try putting a favorite toy just out of reach and see if he'll try and move towards it. |
| 5/10/2015 11:12am | Mother | 34 | Thanks Jeannie!  Glad to hear Carson isn't the only baby who is stuck in reverse, ha ha.  I'll definitely try tempting him with toys today and see if we can help him get his gears shifted |

The time elapsed is less than 48 hours and the message content does not reflect a change in topic. Thus, the current exchange is continued.

| Timestamp | Sender | Exchange Number | Message |
|---|---|---|---|
| 4/8/2015 2:34pm | Mentor | 21 | Hi Laurie, how did Carson do with trying solids?  Did he like the bananas? |
| 4/8/2015 10:11pm | Mother | 21 | Hi Jeannie, he liked the bananas, although I think more ended up on his clothes than in his mouth, lol |
| 4/10/2015 1:09am | Mother | 22 | Hey Jeannie, sorry to text so late.  We tried to move Carson to his own room tonight and he has just been screaming non-stop for hours.  I feel like I'm going crazy! Any tips? |
| 4/10/2015 8:03am | Mentor | 22 | I'm so sorry Jeannie, I hope you all finally got some sleep, it's so hard for everyone when baby is having a rough night.  Where does Carson nap during the day?  Maybe start by having him nap in his own room so he starts to feel safe sleeping in there! |
| 4/10/2015 11:12am | Mother | 22 | He did finally fall asleep around 2, I think he just cried himself out.  He normally naps wherever he falls asleep.  I'll try putting him in his room. |

While the time elapsed is less than 48 hours, the message content reflects a change in topic. Thus, a new exchange is coded.

**Appendix B: Topic Coding**

This appendix will provide an overview of the process used to code the text-message transcripts in preparation for analysis with a focus on how the transcripts were coded for topics, discussion of problems, mother initiation, and the provision of support by the mentor. The coding team coded each exchange to indicate whether it had been initiated by the mother or by the mentor. Next, they attended to the exchange topic and mentor responses in a multi-step process diagramed in Figure 2. As shown in the first purple box, first the exchange topic was selected from a set of codes and subcodes. If a single exchange covered multiple topics, each was coded. Table 2 provides the topic choices available in the coding scheme. Primary codes are listed in bold with subcodes in italics. For primary codes with available sub-odes, coders were required to select a subcode. If for example, a mentor was leaving the program and a mother was notified that her mentor would be changing, the exchange would be coded as Mentor Change, which can be found listed under Topic Code in Table 2. As this code does not have subcodes, the process of selecting a topic would end there. By contrast, if a mother asked a mentor whether her child was old enough to eat cereal, the exchange would be coded as Feeding, but the subcode of Solids, found listed under Subcodes in Table 2, would also be coded. The only topics coded were those with which the mother engaged. For example, if a mentor asked about napping and latch during breastfeeding and the mother only replied about her experience with breastfeeding, Sleep - Napping would not be coded as a topic for that exchange.

Then, for all exchanges coded as Stock Message or Check-in, indicating respectively that a nonpersonalized, form message was sent or that the mentor contacted a mother but the mother did not engage around a specific topic, the topic of the mentor's message was coded using the full set of code and subcode options listed in Table 2. This step is represented by the second

purple box below the Topic Code box.  This step gave the team access to information about which topics mentors were trying to engage mothers around or provide information about,

      For each exchange topic, including Stock Messages and Check-ins, the coding team then indicated what if anything was offered by the mentor, represented by the yellow box in Figure 2. Then, as shown in the orange box, they coded whether the mother was having a problem in this area, completing the coding process.  As shown in Table 3, when coding what was offered to the mother by the mentor, coders selected from eight options.  For example, if a mother inquired about dealing with gas problems and the mentor suggested gas relief drops, the code for product recommendation would be selected.  The coding scheme did not limit the number of mentor offerings that could be coded per topic.  In many cases mentors did offer more than one support for a problem.  For example, if a mother asking about a stuffy nose that was keeping their baby awake at night, a mentor might suggest running a hot shower to humidify the air, recommend a nose aspirator that had worked well for them in the past, and use supportive and encouraging language to acknowledge the worry, frustration, or stress the mother might be feeling and to reassure the mother that the symptoms will pass and that she is doing a good job.  In such a case, the exchange would be coded with three mentor offer codes: advice, product recommendation, and emotional support.

**Appendix C: Additional Key Tables**

Table C.1: Distribution of Check-in Topics

| Topic | Mean # of Exchanges | SD | Mean % | % At least once |
|---|---|---|---|---|
| Basic Care | 1.72 | 1.86 | 8.00 | 67.90 |
| Child Wellbeing | 0.45 | 0.77 | 2.16 | 32.10 |
| Feeding | 0.91 | 1.24 | 4.43 | 47.53 |
| Resources | 0.46 | 0.78 | 1.95 | 32.10 |
| Sleep | 0.42 | 0.70 | 2.40 | 32.72 |
| Cognitive Development | 0.62 | 0.93 | 3.19 | 41.36 |
| Language Development | 0.85 | 1.26 | 3.84 | 43.21 |
| Motor Development | 1.14 | 1.36 | 5.09 | 55.56 |
| Physical Development | 0.14 | 0.38 | 0.61 | 12.35 |
| Social/Emotional Development | 0.67 | 0.98 | 3.24 | 41.36 |
| Childcare | 0.04 | 0.19 | 0.17 | 3.70 |
| Family Support | 0.10 | 0.32 | 0.66 | 9.26 |
| Family Conflict | 0.00 | 0.00 | 0.00 | 0.00 |
| Maternal Wellbeing | 0.81 | 1.10 | 4.76 | 47.53 |
| Partner Relationship | 0.04 | 0.19 | 0.16 | 3.70 |
| Siblings | 0.17 | 0.53 | 0.80 | 11.73 |
| Work | 0.10 | 0.35 | 0.53 | 9.26 |
| Rapport Building Only | 7.87 | 4.67 | 58.01 | 94.44 |

Table C.2: Distribution of Stock Message Topics

| Topic | Mean # of Exchanges | SD | Mean % | % At least once |
|---|---|---|---|---|
| Basic Care | 0.50 | 1.36 | 12.50 | 19.14 |
| Child Wellbeing | 0.02 | 0.18 | 0.32 | 1.23 |
| Feeding | 0.01 | 0.11 | 0.10 | 1.23 |
| Resources | 0.44 | 1.06 | 15.59 | 22.84 |
| Sleep | 0.00 | 0.00 | 0.00 | 0.00 |
| Cognitive Development | 0.17 | 0.53 | 6.06 | 13.58 |
| Language Development | 0.28 | 0.80 | 8.52 | 17.28 |
| Motor Development | 0.11 | 0.70 | 3.57 | 4.94 |
| Physical Development | 0.00 | 0.00 | 0.00 | 0.00 |
| Social/Emotional Development | 0.04 | 0.27 | 2.53 | 2.47 |
| Childcare | 0.00 | 0.00 | 0.00 | 0.00 |
| Family Support | 0.00 | 0.00 | 0.00 | 0.00 |
| Family Conflict | 0.00 | 0.00 | 0.00 | 0.00 |
| Maternal Wellbeing | 0.12 | 0.41 | 3.40 | 57.41 |
| Partner Relationship | 0.00 | 0.00 | 0.00 | 0.00 |
| Siblings | 0.00 | 0.00 | 0.00 | 0.00 |
| Work | 0.00 | 0.00 | 0.00 | 0.00 |
| Affirmations/Well Wishes | 1.03 | 1.85 | 47.41 | 83.33 |

Table C.3: Comparison of mentor supports offered to first time moms vs all other moms

| | % moms with at least one problem | N problems | % problems offered support | % moms offered at least one support | N supports offered |
|---|---|---|---|---|---|
| Mean for first time moms | 76.47 | 4.24 | 90.40 | 91.76 | 16.03 |
| Mean for other moms | 76.62 | 4.80 | 82.06 | 94.81 | 14.77 |
| Diff | -0.15 | -0.56 | 8.34 | -3.05 | 1.26 |
| P-Value | 0.98 | 0.61 | 0.04 | 0.45 | 0.58 |

| | Distribution of offers made in response to problems | | | | Distribution of all offers made | | | |
|---|---|---|---|---|---|---|---|---|
| Mentor support | Mean for first time moms | Mean for other moms | Diff | P-Value | Mean for first time moms | Mean for other moms | Diff | P-Value |
| Advice | 39.62 | 30.32 | 9.30 | 0.12 | 30.77 | 27.91 | 2.86 | 0.45 |
| Professional Recommendations | 4.76 | 1.46 | 3.30 | 0.13 | 4.70 | 4.59 | 0.11 | 0.95 |
| Website | 17.00 | 14.11 | 2.89 | 0.43 | 44.01 | 49.02 | -5.01 | 0.20 |
| Product Recommendation | 4.09 | 8.79 | -4.70 | 0.13 | 1.98 | 1.71 | 0.27 | 0.69 |
| Brainstorming | 5.30 | 2.75 | 2.55 | 0.14 | 1.33 | 1.21 | 0.12 | 0.84 |
| Emotional Support | 10.97 | 11.15 | -0.18 | 0.95 | 10.54 | 10.94 | -0.40 | 0.88 |
| Referral | 14.48 | 12.12 | 2.36 | 0.56 | 4.59 | 4.06 | 0.53 | 0.63 |
| Phone Call | 0.00 | 0.08 | -0.08 | 0.29 | 0.00 | 0.12 | -0.12 | 0.14 |

**Appendix D: Stylized Example Exchanges for Language Development and Maternal Wellbeing Topics**

**Language Development**

**Mentor:** Hi Cami, how are you today?  I wanted to share some information with you about how important it is to talk to your baby: www.talkingtoyourbaby.org/whytalk.  The website gives more detail but the important point is that it really helps their language development.  Do you talk to Andy a lot?  Do you ever feel silly when you do?

**Mother:** I try to talk to him throughout the day, but it can make me feel like a crazy person sometimes, like why am I carrying on conversations with a baby who can't talk back and doesn't understand what I'm going on about, ha ha.

**Mentor:** I know exactly what you mean!  It made me feel goofy at first as well.  It's so important though, and once you get into the habit it feels much less silly, I promise!  Definitely keep up the good work.  I would narrate what I was doing, it gave me a place to start when I couldn't think of what to say to my little girl.

**Maternal Wellbeing**

**Mentor:** Good morning Jackie!  I hope you had a good weekend.  Were you able to make some time for yourself?  Self-care is so important for us mommies, you can't give your baby your best if you aren't meeting your own needs!

**Mother:** Not really.  Carson was with his dad this weekend so it was just me and Sloane.  I tried to get out but I've been feeling really stressed and pretty blah.  I used to take her out jogging with me in her stroller, but I haven't been able to find the energy or the motivation recently, so we spent most of our weekend cuddling in bed.

**Mentor:** I'm sorry to hear things have been feelings a little rough.  Have you thought about talking to your doctor about how you're feeling?  Sometimes we all need a lazy weekend in, but being a mom can take a lot out of you and it's important to get support if you feel like you might need it.

**Mother:** I don't really have a doctor I feel very comfortable talking to at the moment.  I felt like my most recent GP didn't really listen to me or understand me.

**Mentor:** Would you like me to get you some information about how to find a new doctor or connect with a therapist?  I also have some links to mother support groups I can dig up.

**Mother:** That would be so great.

**Mentor:** Awesome!  I will get that information to you as soon as I am home and in front of my computer.  Let me know if there is anything else I can help you with!