Supporting immigrant caregivers during the COVID-19 pandemic: Continuous adaptation and implementation of an early childhood digital engagement program

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Abstract
Digital messaging programs have the potential to be a powerful, low-cost, technological tool to support multiple facets of caregivers' knowledge, and implementation of developmentally appropriate caregiver-child activities among diverse immigrant populations. However, involving caregivers and community stakeholders in the cultural and linguistic tailoring of interventions to optimize utilization and engagement may be critical to ensuring messaging programs' usability and acceptability. The purpose of this mixed-method study was to use the dynamic adaptation process (DAP) within an Exploration, Preparation, Implementation, Sustainment (EPIS) framework to examine the implementation of a digital messaging program, developed at the beginning of the COVID-19 pandemic, aimed at providing Spanish-, English-, and Mandarin-speaking immigrant caregivers with caregiver-child activities that supported children's development and caregivers' knowledge. Building upon the EPIS framework, using DAP, we assessed the feasibility and acceptability of a messaging program via short message service or multimedia message service, WeChat, and Remind and webinar program during the COVID-19 pandemic. The study illustrated how a digital messaging program is a feasible mechanism for sharing developmentally and culturally appropriate information with immigrant caregivers. In addition, the use of the DAP and the EPIS framework allowed us to continuously track the process of cultural adaptation, identify barriers and facilitators of the outreach program, and examine how implementation unfolded across all three groups of caregivers.

KEYWORDS
caregivers, immigrant, implementation, mixed-method, school readiness

Highlights
- Digital messaging programs support caregivers' knowledge of developmentally appropriate activities.
- Caregivers and community stakeholders' input supports cultural and linguistic tailoring of programs.
- Using an implementation framework helps track implementation across various groups of caregivers.

INTRODUCTION
Over 24% of children under the age of five in the United States are children of immigrants (MPI, 2019). Immigrant families have many important strengths for children's school readiness (De Feyter & Winsler, 2009; Kao & Tienda, 1995). For example, compared to children of United States origin parents, children of immigrants have higher rates of two-parent households (Leventhal et al., 2006), have access to close, extended family networks,
including grandparents and siblings to help with childcare (Hernandez et al., 2008), enter kindergarten with strong social and emotional skills and few behavior problems (Crosnoe, 2006; De Feyter & Winsler, 2009), and are more likely to be bilingual (Bialystok, 2005). However, immigrant caregivers, compared to nonimmigrant caregivers, often face more stressors (e.g., low paid work, punitive immigration policies), resources imbalance (e.g., lack of social support network), and differences in beliefs about caregiving (Bornstein & Cote, 2004; Crosnoe & Cooper, 2010; Farver et al., 2006). Nonetheless, immigrant caregivers are just as motivated to support their children's school readiness and bring their own strengths that help their children develop and learn (Hammer, 2018).

Through interactions, caregivers can enrich children's development by explicitly teaching new concepts and they can also encourage them to explore stimulating environments by engaging in rich activities (Vallotton et al., 2017). Therefore, one approach to supporting children's school readiness skills is to improve caregiver-child engagement at home. A range of programs that directly target parenting practices of immigrant caregivers exist (see Crosnoe & Cooper, 2010 for a review), but they often only focus on families of Latin-American origin and fail to make cultural adaptations to the content.

Encouraging immigrant families to engage with their children in developmentally-appropriate ways requires researchers to be intentional in rethinking traditional approaches to supporting caregiver-child activities (Cohen-Vogel et al., 2010). To start, when working with immigrant caregivers, programs must recognize that culturally defined caregiver-child activities vary within and across cultural groups (Burchinal et al., 2012). Cultural adaptations of evidence-informed interventions must be sensitive to language, culture, and context in a way that resonates with the intended audience but does not compromise the core dimensions of a program (Bernal et al., 2009). When conducting cultural adaptations, researchers should consider: (1) culture-relevant language, colloquialisms, and examples; (2) culturally accepted norms of behaviors; (3) culture-relevant definitions; and (4) culturally and context-appropriate systems and service providers (Allen et al., 2007). Adaptations to a program for immigrant caregivers that appropriately consider these criteria will likely improve engagement, acceptability, recruitment, and retention (Kumpfer et al., 2002). Although making cultural adaptations can be time-consuming and expensive, utilizing technology reduces cost, and increases impact when implementing interventions in diverse populations (Supplee & Meyer, 2015).

Dynamic adaptation process using the exploration, preparation, implementation, and sustainment implementation framework

Making cultural adaptations while monitoring implementation requires a structure that supports an iterative learning process. Doing so allows researchers to adjust their strategies in response to feedback and results (Castro et al., 2004). Integrating these two principles can specify the optimal balance between adaptation and fidelity while addressing essential implementation outcomes (e.g., acceptability, appropriateness; Cabassa & Baumann, 2013). Moreover, explicitly incorporating cultural adaptation into implementation science is necessary to support programs' responsiveness to the needs and preferences of immigrant populations.

In this paper, the exploration, preparation, implementation and sustainment (EPIS) model was used as an implementation framework because it allows for the examination of a change process at multiple levels, across time, and through successive stages that build deliberately toward implementation (Moullin et al., 2019). The EPIS model describes the implementation of programs as a process moving through four stages (Aarons et al., 2011): Exploration (identifying practices to be implemented, assessing various-level factors that explain gaps and potential barriers/facilitators); Preparation (redesigning the system to enhance the programming and ensure consistent implementation of proposed changes); Implementation (training, coaching, and active facilitation of practices); and Sustainment (maintaining the use of the newly installed practices).

Yet, implementation science suggests that any program's maximal benefit can only be realized through ongoing development, evaluation, and refinement in diverse populations and systems (Chambers et al., 2013). Therefore, a dynamic adaptation process (DAP) was overlaid on the traditional linear application of the EPIS (e.g., Becan et al., 2018). Specifically, DAP is a data-informed, collaborative, cyclical approach to assessing implementation, and adapting programming (Aarons et al., 2012). The DAP embeds feedback loops from the Implementation phase to the Exploration phase in the EPIS model (Figure 1); this continuous cycle allows community stakeholders, caregivers, and researchers to refine and improve programs on an ongoing basis (Chambers et al., 2013).

Present study

Together Growing Strong (TGS) is a community partnership that supports primarily Asian- and Latin-American-origin caregivers and young children in a low-income Southwest Brooklyn community in all aspects of school readiness, from health to social development. The TGS community outreach team, which includes the authors of this paper, matches the linguistic, race/ethnicity, and immigrant experience of the demographics of the community. Moreover, the team has diverse educational experience, ranging from bachelor's to doctorate degrees in

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1 In this paper, we do not discuss the Sustainment phase of the EPIS because we are still adapting within the first three phases of the EPIS framework.
education, early childhood development, public health, mental health, research, and community programming. When the TGS initiative was launched, the TGS community outreach team gathered contact information from interested families at community sites such as libraries, parks, and health clinics. These families were invited to participate in events led by TGS staff, such as monthly playgroups (e.g., story time, arts, & crafts) and parent webinars (e.g., Individualized Education Program, Ready for Kindergarten). These in-person events attracted an average of 30–50 Spanish-, English-, and Chinese-speaking caregivers. However, when COVID-19 was declared a global pandemic in March 2020, all TGS in-person programming was suspended. Due to the strong connections to families and leaders in the school, health, and community settings established over several years of work in the community, in-person programs were able to shift to virtual programming.

This mixed-method study adds to research on both parenting and implementation science by presenting one of the first real-world application of a DAP of the EPIS framework (Aarons et al., 2011) of a culturally appropriate early childhood developmental content for immigrant families. Specifically, in this paper, we explore the implementation of a digital engagement program, including messaging via short message service or multimedia message service (SMS/MMS), WeChat, Remind, and webinars, during the COVID-19 pandemic. The digital engagement program provides immigrant caregivers with caregiver-child activities that support children's development and caregivers' knowledge. Using quantitative and qualitative measures, the current research describes the process of making cultural adaptations, identifying barriers and facilitators of the program, and examining how implementation unfolded by generating a community-focused feedback loop throughout the program's implementation. The research aims are as follows: (1) to illustrate how we adapted our community programming, using the EPIS framework in a DAP; and (2) to collect implementation indicators.

![FIGURE 1 The dynamic adaptation process (DAP) of the Exploration, Preparation, Implementation, and Sustainability framework](image)

**METHODS**

**Setting and study population**

The project was determined to be exempt from Institutional Review Board review according to guidelines outlined by the university of the authors. The primary participants were caregivers with children from birth to age 5 from a predominantly immigrant community in a low-income Southwest Brooklyn, NY. Forty-one percent of caregivers had children aged 0–2, 43% had children aged 3–5, and 12% had children both in the 0–2 and 3–5 age ranges. Throughout this paper, we refer to the caregivers as English-speaking, Spanish-speaking, and Chinese-language. Nine percent of caregivers preferred receiving content in English (70% with children aged 0–2; 30% with children aged 3–5), 34% preferred receiving content in Spanish (48% with children aged 0–2; 52% with children aged 3–5), and 57% received messages in Mandarin (43% had with children aged 0–2; 57% had children aged 3–5). Two components of the digital engagement program are addressed: digital messaging and webinars.

**Procedures**

The first three phases of the EPIS framework (Exploration, Preparation, and Implementation) were repeated in three DAP cycles (see Figure 1). This process is continuously iterative; that is, the implementation experience in EPIS informs adaptation as needed. The specific programmatic activities and data collected during each phase and cycle varied (see Table 1 for more details). However, in general, the main task of the Exploration phases included engaging in conversations with key stakeholders and caregivers regarding the implementation data (when available) that were focused on identifying barriers and facilitators to implementation. In the Preparation phase, the TGS team reviewed summaries of the qualitative information gathered in the Exploration phase from key stakeholders and caregivers to decide (a) what adaptations were needed to ensure uptake and culturally relevancy; and (b) how to accomplish such adaptations. Specific attention was

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2 We refer to our Chinese population as Chinese-language, instead of Chinese-speaking, because while most Chinese residents in this neighborhood speak Mandarin, a small percentage (approximately 5% of TGS Chinese families) speak Cantonese. All our programming was delivered in Mandarin.
| DAP 1 (March 2020–May 2020) | Programmatic activities conducted | Exploration | Preparation | Implementation |
|-----------------------------|----------------------------------|-------------|-------------|---------------|
|                             |                                  | • Explored the digital literacy, availability of technology, and potential digital platforms | • Connected and recruited caregivers | • Delivered digital messaging texting program |
|                             |                                  | • Literature review of messaging programs | • Selected a messaging platform for language groups |               |
|                             | Data collected                   | • Conversations with stakeholders and caregivers informed decisions about digital messaging program | • Developed messaging content |               |
|                             |                                  | • Conversations with stakeholders and caregivers informed decisions about digital messaging program | • Conducted a survey with caregivers about their experiences of the digital messaging program | • Measured feasibility |
|                             |                                  | • Literature review of messaging programs | • Measured acceptability |               |

| DAP 2 (June 2020–August 2020) | Programmatic activities conducted | Exploration | Preparation | Implementation |
|-------------------------------|----------------------------------|-------------|-------------|---------------|
|                              |                                  | • Analyzed barriers and facilitators to digital outreach program as reported from the survey and implementation outcomes | • Developed expanded messaging content through collaborations with local experts | • Launched webinars |
|                              |                                  | • Initiated connections with local experts | • Adapted WeChat structure |               |
|                              | Data collected                   | • Conversations with stakeholders and caregivers informed decisions about digital messaging program | • Measured feasibility | • Measured acceptability |
|                              |                                  | • Conversations with stakeholders and caregivers informed decisions about digital messaging program | |               |

| DAP 3 (September 2020–December 2020) | Programmatic activities conducted | Exploration | Preparation | Implementation |
|-------------------------------------|----------------------------------|-------------|-------------|---------------|
|                                     |                                  | • Analyzed barriers and facilitators to digital outreach program as reported from the survey | • Piloted new messaging platform for Spanish- and English-language group | • Implemented new messaging platform for Spanish- and English-language group |
|                                     |                                  | • Explored additional messaging platforms | • Measured feasibility | • Measured acceptability |
|                                     | Data collected                   | • Conversations with stakeholders and caregivers informed decisions about digital messaging program | |               |

Abbreviations: DAP, dynamic adaptation process; EPIS, Exploration, Preparation, Implementation, and Sustainability framework.
paid to differences that emerged across immigrant groups to develop appropriate messaging content. Finally, based on the decisions and resources that emerged from the Exploration and Preparation phases, we implemented the digital messaging program, including the adaptations, and collected implementation data during the Implementation phases.

Measures and analytic approach

As described in the procedure section, qualitative and quantitative data were collected to inform the development and adaptation of the digital engagement program (see Table 1). The integration of the qualitative and quantitative data allowed for a more comprehensive understanding of the needs of caregivers and the factors influencing the implementation. The data were shared with stakeholders to guide our conversations about the implementation of the digital engagement program. All data were collected in caregivers’ and stakeholders’ preferred language and summarized by TGS team members who were native speakers. Stakeholders were not compensated for their time.

Qualitative data were collected from meetings in each language group with caregivers, including family, friend, and neighbor caregivers, and community stakeholders, including health workers, and community programs staff, with detailed field notes prepared by the TGS study team. Field notes included basic information about meeting (e.g., date/time, location, participants) and summaries from meetings. Field notes were analyzed through a rapid qualitative inquiry which uses a team-based approach to ensure triangulation of interpretation among multiple team members (Beebe, 2014). To generate consensus, we carefully compared themes within and across all meetings and generated the common themes. Credibility of information obtained through the different meetings were assessed through a process of triangulation in which themes that emerged from meetings with different stakeholders were compared with one another to determine if they converge in providing the same or similar learnings.

The quantitative implementation data included two indicators of the digital engagement program’s uptake: (a) feasibility (i.e., the number of caregivers recruited and retained); and (b) acceptability (i.e., the satisfaction and engagement of the caregivers to the programming; Proctor et al., 2011). Feasibility and acceptability were measured in the following ways.

Feasibility

The feasibility of the digital engagement program was measured by calculating reach; that is, the number of caregivers enrolled in each DAP phase. Attrition was calculated as the number of caregivers who opted out of receiving digital content during each DAP phase.

Acceptability

Four measures of the acceptability of the digital engagement program were collected throughout the study. First, a one-time survey was given to caregivers over the phone during the first DAP cycle. Specifically, to understand whether messages were read, caregivers were asked a yes/no question, “Have you read these text messages?” To explore what activities were implemented and what they liked about them, two nominal questions were asked: (1) “Have you tried these activities?” and (2) “What did you and your child like about the activities you tried?” To understand their digital literacy, the survey also asked a yes/no question, “Would you be interested in attending a workshop?” and a nominal question, “What apps are you comfortable using?” $\chi^2$ tests of independence were performed to examine the relation between the survey results and the language group of caregivers.

Three other types of acceptability were measured. The percentage of spontaneous replies sent by caregivers to TGS staff when they received messages was calculated across all three DAP phases; a higher percentage of replies suggested that caregivers were reading and satisfied with the messages. The number of times caregivers viewed a video shared by TGS on YouTube was calculated, when possible, across all three DAP phases; a higher percentage of views reflected higher rates of caregivers’ engagement with the content. Fourth, attendance at webinars were examined; we report the number of caregiver participants.

RESULTS

First DAP (March 2020–May 2020)

Exploration

Given the COVID-19 pandemic, the TGS community programming team shifted from in-person to virtual platforms. First, we reviewed whether we should shift our previously planned in-person webinars to an online platform like Zoom. Through conversations with community stakeholders and caregivers, a few barriers to technology and digital literacy emerged: lack of internet access, limited knowledge of the various digital platforms (e.g., Webex, Zoom), and limited devices within each household. Therefore, it was determined that shifting our programming to virtual webinars at the beginning of the COVID-19 pandemic was not feasible without providing caregivers with extensive tech support and ensuring that they had access to digital devices.

As such, given prior work illustrating that text messages are an effective and relatively inexpensive way to communicate with caregivers (e.g., Evans et al., 2012), we investigated the potential to share information with caregivers through text messages. Discussions with other early childhood programs within the community indicated that texting was a culturally accepted means of
communicating with caregivers from diverse immigrant backgrounds. In the final step of the first Exploration phase, we informally asked a set of randomly selected Spanish-, English-speaking, and Chinese-language caregivers (n = 13 Spanish & English-speaking caregivers; n = 60 Chinese-language caregivers) whether they would like to receive messages focused on early childhood development and parent-child activities. Because 100% of caregivers indicated that they would be interested in receiving messages with these resources, we moved to the Preparation phase.

Preparation

Building upon what was learned in the Exploration phase, our primary objective was to develop a culturally appropriate implementation plan during the Preparation phase. To do so, several critical issues needed to be addressed. The first issue included determining whom to include in the messaging program. A contact list of caregivers was developed based on attendees of various other programming offered by the larger TGS initiative (e.g., English-language classes, ParentChild+, Healthy Families, playgroups, and webinars). We also explored ways to recruit new caregivers through discussions with key stakeholders in the community. As a result, we discovered several Facebook groups for caregivers that shared resources and neighborhood events. Similarly, we expanded the messaging reach by sharing flyers that advertised the messaging program at a local weekly food pantry and other remaining person-facing programs.

Next, to select the most culturally-appropriate messaging platform, we examined the various messaging services used by each group of caregivers. Initially, we intended to use the same messaging platform for all caregivers, but stakeholders and caregivers indicated that each group of caregivers had preferred platforms. Among our Chinese-language caregivers, WeChat is the primary messaging platform used. In contrast, the Spanish-speaking caregivers tended to use WhatsApp as a group messaging platform. But during conversations with stakeholders and Spanish-speaking caregivers, privacy concerns with WhatsApp emerged. Several caregivers mentioned that it would feel “too personal” to be included in a WhatsApp group with other caregivers that they did not know because individual cell phone numbers were visible. We decided to share our messages via WeChat groups for the Chinese-language community and send text messages (SMS) to our Spanish- and English-speaking communities to adhere to the different concerns that emerged.

The final task of this phase included developing messaging content that was developmentally appropriate and culturally relevant (see Table 2). To ensure that age-appropriate content was delivered to caregivers, messaging content was organized and created based on children's age ranges: 0–2 and 3–5 years. Two messages per week prompted caregivers to engage in learning activities with their children oriented around a weekly theme such as language development, early literacy, socioemotional

| Age group (years) | Topic               | Message content                                                                 | Attached content                                                                 |
|-------------------|---------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| 0–2               | Gross motor skills  | Movement and exercise is so important for a babies' health and emotional well-being. It helps improve their focus and sense of self and helps decrease negative thoughts and feelings. Try incorporating simple movement and exercise in your baby's day! Here is a video with some movement exercises you can try with your baby—follow their lead on what's comfortable to them. | https://www.youtube.com/watch?v=f7ujXu4z8rI |
| 3–5               | Gross motor skills  | Fingerplays tell stories by combining movement with singing or words. They are a great way to help develop your child's early literacy development! They help children increase their vocabulary and promote fine and gross motor skills. Here is a song you can practice with your child. | https://www.youtube.com/watch?v=9LbZSyx-7Xo |
| 0–2               | Early math skills   | Babies and toddlers naturally recognize patterns in language and shapes. Naming images and shapes and counting them out loud for your child will help them build their math skills! Diapering, meal, and bath times are great times to count, point out shapes and sizes, talk about patterns, and describe how things are the same and different. | https://www.youtube.com/watch?v=DR-cfDsHCGA |
| 3–5               | Early math skills   | Organizing and sorting objects is an important math skill. Gather different colored items around the house such as shoes, clothing, or food. Mix the items. Then, ask your child to sort the items by color, then by size. You and your child can make patterns (big shoe, little shoe, big shoe…). You can also count the items in each category together! | https://www.youtube.com/watch?v=9LbZSyx-7Xo |

Abbreviation: TGS, Together Growing Strong.
learning, and early math skills. These activities could be conducted by the caregivers and any other adult or older sibling. Study staff drew upon the content and expertise available from evidence informed TGS programs already being implemented, including Vroom (Vroom.org), ParentCorps (Brotman et al., 2011), ROSE (Zlotnick et al., 2016), and Video Interaction Project (Mendelsohn et al., 2005) when creating the weekly content. Multimedia content was also drawn from educational organizations like Sesame Street and Zero to Three. The third message sent each week was not tied to a theme. Instead, it provided content for the messages were approved by TGS leadership, who were like Sesame Street and Zero to Three. The third message content was also drawn from educational organizations

### Implementation

Shortly after the preparation phase, the TGS study team moved to the Implementation phase. In this phase, we sent weekly messages and monitored the messaging program reception by assessing implementation indicators.

#### Implementation indicators

**Feasibility (reach and attrition of the program)**

At the beginning of the first implementation phase, the total reach was 300 caregivers (93 Spanish-speaking; 29 English-speaking; 178 Chinese-language). To assess the messaging program's feasibility, we examined how many caregivers initially opted out of receiving messages and the messaging program's total reach at the end of the first phase. After the first week of sending out messages, in March 2020, a total of four caregivers (4.3%) opted out of receiving the messages (all Spanish-speaking caregivers). In the following months (between March and May), a total of 12 other caregivers (9.6%) opted out of the messages: four English-speaking, five Spanish-speaking, and three Chinese-language caregivers (one of whom moved to another state). In addition, six Spanish-speaking families were added between March and May. Thus, by the end of the first DAP phase, the total reach of our digital engagement program was 290 caregivers.

Acceptability (messaging replies, survey, and content views)

To assess the messaging program's acceptability, we examined caregivers' level of engagement and satisfaction with the program in several different ways. Although our messages did not prompt a response, caregivers often replied to our SMS/MMS and WeChat messages, which reflected their engagement and interest in the messaging content. Each week, approximately 8.5% Spanish-speaking, 1% English-speaking, and 28.5% of Chinese-language caregivers sent a spontaneous response following receipt of a message. Some examples included, “Thank you for sharing” and “I would like to know how I can help [my son] with writing.” Study staff briefly replied to these messages with notes such as, “You’re welcome, have a great day!” and “Thank you, we will plan to share activities for writing in the future.” Whenever we posted a video to our YouTube channel, we tracked the number of views each video received; this was another measure of acceptability. The posted videos had moderate to high rates of views from caregivers: early literacy (78% of Spanish-speaking caregivers; 100% English-speaking caregivers), making routines at home (69% Spanish-speaking caregivers), and an arts-and-crafts/math activity (71% Spanish-speaking caregivers). We also assessed acceptability through a caregiver telephone survey. The survey was completed in April and May 2020, about two months after the digital engagement program began. One hundred eighty-six families (approximately 55% of caregivers in the digital engagement program) completed the survey (26% in Spanish, 7% in English, and 67% in Chinese). Results indicated that 90% of caregivers read the messages. Spanish- and Chinese-speaking caregivers (94%) were more likely to report reading the messages than English-speaking caregivers (62%), \( \chi^2 (1, N = 54) = 0, p < .01 \). All caregivers reported that nearly all the five types of activities (i.e., reading, singing, connecting words with objects, using language, self-care strategies) were implemented (range 68%–94%). A \( \chi^2 \) test of independence showed that there was a significant difference between caregivers and their implementation of singing, \( \chi^2 (1, N = 54) = 9.37, p < .01; \) Spanish-speaking caregivers were more likely to report trying the singing activities (98%) than the English-speaking group (75%). When caregivers were asked whether the activities were fun and easy to complete, additional statistically significant differences across the groups of caregivers emerged. Ninety-three percent of Chinese-language caregivers and 100% of English-speaking caregivers indicated that the activities were easier to complete compared with 58% of Spanish-speaking caregivers, \( \chi^2 (1, N = 54) = 4.59, p < .01; \) English-speaking (100%) and Spanish-speaking (82%) caregivers were more likely to describe the activities as fun compared to 56% of Chinese-language, \( \chi^2 (1, N = 54) = 6.12, p < .01 \).

During the survey, we also sought to understand caregivers' interests in joining webinars and their technical ability. Sixty percent of English and Spanish-speaking caregivers and 74.5% of Chinese-language caregivers said they were interested in online webinars. However, fewer English- and Spanish-speaking caregivers reported that

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3We created a Spanish equivalent video of an already existing English video. Thus, we only have view counts for the Spanish video. Unfortunately, WeChat did not allow us to create counts of views of Chinese-language videos.
they were comfortable using webinar platforms such as Zoom (32%), Google Hangouts (14.5%), and WebEx (9.6%) compared to the Chinese-language caregivers (Zoom [74%]; Google Hangouts [0%]; WebEx [4.1%]), \( \chi^2 (1, N = 54) = 3.45, p < .01 \).

**Second DAP (June 2020–August 2020)**

**Exploration**

The second Exploration phase focused on sharing the knowledge generated in the initial implementation phase with key stakeholders to get their feedback and thoughts about potential ways to adapt the digital engagement program. Given differences emerging regarding beliefs about the ease and enjoyment of the activities, stakeholders encouraged the TGS team to use the topics of interest that caregivers suggested in the survey to create content that is more aligned with the interests of the different groups of caregivers. These additional topics of interest included (1) children’s early literacy; (2) social-emotional learning; (3) screen-time for young children; (4) COVID-19 updates and back-to-school information; (5) bilingualism; and (6) self-care for caregivers.

Through discussions with stakeholders, the TGS study team also identified cultural barriers that needed to be addressed. For example, the team often selected relevant and identical multimedia content (e.g., Sesame Street resources) to share with the English- and Spanish-speaking caregivers, but there was a limited amount of multimedia resources available in Mandarin. As a result, the Mandarin-speaking TGS staff translated or recreated content (e.g., videos, posters) from English to Mandarin. However, some topics were flagged by TGS staff and stakeholders as not being culturally relevant to all groups (e.g., the process of learning the alphabet is different in Mandarin characters compared to a Latin-based alphabet). In addition, cultural preferences and needs for each messaging platform emerged when trying to share multimedia content. For example, Chinese-language caregivers informed the team that videos exceeding two minutes in length were often not delivered due to the amount of data needed, and they preferred to watch videos directly embedded as an MP4 in the WeChat groups rather than opening a link to videos posted to YouTube. Also, some caregivers in the WeChat groups mentioned that it was difficult to find the messages sent by TGS staff when many caregivers were responding with questions and comments.

**Preparation**

Based on learnings from the implementation indicators collected during DAP 1 and the discussions with stakeholders during the second Exploration phase, we collaborated with local experts to cocreate messaging content. We worked together with various entities, including institutions (e.g., Brooklyn Public Library), community-based organizations, health centers, and research institutes to develop or adapt available content that was initially created for white, English-speaking caregivers to be linguistically and culturally relevant to the communities. The cultural adaptations included translating into the appropriate language and literacy level, adapting examples and pictures to reflect race/ethnicity and culture, and exchanging content to address caregivers’ customs and learning styles. For example, we modified a video describing how decoding letters and symbols support children’s understanding of decoded objects. Because the sounds and the way of using Chinese Pinyin are different from that of the Latin-based alphabet, and most Chinese characters are difficult to introduce to children before the age of five (Tse et al., 2007), we revised the letter activity to use Chinese hieroglyphs to demonstrate how some Chinese characters are stylized drawings of the objects they represent.

Some of the topics that were of interest to caregivers were identified by TGS staff as being more appropriate for a webinar format instead of concise messages. Given that caregivers indicated on the survey that at this point in the pandemic they were more comfortable using virtual platforms, we also worked with our partners to create Zoom webinars including, (1) an early literacy webinar in English, (2) a social-emotional skills webinar in Spanish, (3) and a COVID-19 health webinar in Mandarin. Our cultural adaptation process for messages and webinars often required multiple rounds of revisions between collaborators and the TGS team to ensure that our message was clear, informative, and accurate, in addition to being culturally relevant.

Finally, to address logistic concerns that emerged only within the Chinese-language group, the TGS team created two sets of WeChat groups for each age range and invited caregivers to join whichever group (or both) they preferred: one group enforced a rule that only TGS messages should be sent, and another group allowed caregivers to ask questions and engage with one another in a free-form chat, in addition to receiving the TGS messages.

**Implementation**

**Implementation indicators**

**Feasibility (attrition and reach of the program).** From June 2020 to August 2020, 21 new families joined the program, and one English-speaking caregiver opted out of receiving messages. As a result, our reach increased to 310 caregivers (86 for Spanish-speaking, 30 for English-speaking, and 194 for Chinese-language caregivers).

**Acceptability (message replies and content views).** On average, seven percent of Spanish-speaking and 0% of English-speaking caregivers replied to TGS messages each week. Nineteen percent of caregivers in the WeChat group responded to messages each week. Overall, spontaneous
responses mainly included expressions of appreciation, emojis, and questions regarding food pantry openings, Medicaid renewals, COVID-19 allowance, and help with scheduling doctor appointments. The percentage of caregivers who watched the videos that were posted on YouTube remained moderate but slightly lower than during the first DAP: Developing math skills (58% of Spanish-speaking caregivers; 100% of English-speaking caregivers), language development (42% of Spanish-speaking caregivers; 100% of English-speaking caregivers), emotion regulation (51% of Spanish-speaking caregivers).

During the second Implementation phase, in addition to sending SMS/MMS and WeChat messages, we conducted six webinars (one English, one Spanish, and four Mandarin). Attendance ranged from 20 to 60 caregivers at each webinar.

Third DAP (September 2020–December 2020)

Exploration

After a few months of implementation, the TGS team shared implementation data with key stakeholders again to explore potential modifications to the digital engagement program. One of the major implementation challenges that emerged was our method of sharing messaging content with our English- and Spanish-speaking caregivers. Manually messaging caregivers was not practical if our program was to have long-term sustainability and scalability due to the reliance on TGS team members to be available to message families' multiple times a week. In addition, this process increased the likelihood of errors (e.g., sending the wrong content or messaging to the wrong phone numbers) and limited our ability to continue expanding our community reach. As such, we explored the possibility of shifting from manually sending messages to our English- and Spanish-language caregivers to an automated, mass-messaging platform.

There were a few features of a potential messaging platform that TGS staff and stakeholders felt were necessary. Most importantly, the messaging platform needed to send messages to a group of caregivers but allow the TGS team to reply directly to individual caregivers who responded with comments or questions to the content. Additionally, we needed a messaging platform that could send multimedia messages, support multilingual interactions, hide caregivers phone numbers, and was approved by our institution as a platform that adequately protected caregivers' privacy and data. Working with our IT department and experts in the field, we explored multiple platforms. Ultimately, the Remind app, widely used by many schools in the community to communicate with caregivers, was selected. To gauge whether caregivers would switch to the Remind app, in October 2020, we asked some Spanish-speaking caregivers if they would be willing to be added to a Remind group chat consisting of other caregivers who have similarly aged children and speak Spanish; this was to create a potential social network like the WeChat groups we were providing for the Chinese-language families. Seventy-three percent of caregivers said they would switch to Remind.

Preparation

Building upon what was learned during the second round of the Implementation phase and the third round of the Exploration phase described above, to prepare to switch our 116 English- and Spanish-speaking caregivers from receiving SMS/MMS messages to the Remind app, the TGS team extensively tested the app to anticipate potential questions and problems that may arise. The TGS team was most concerned with what language the caregiver would receive the automated “Join Remind” text. During our internal testing, it seemed as though the initial Remind text appeared in the language preprogrammed by the phone. However, some caregivers reported receiving English messages that they could not read. As such, we called all our caregivers, sent them screenshots, and directions in Spanish.

Implementation

Implementation indicators

Feasibility (attrition and reach of the program). From September 2020 to December 2020, 28 new families joined the program. As a result, our reach was 338 caregivers (92 for Spanish-speaking, 30 for English-speaking, and 216 for Chinese-language caregivers). Only one English-speaking and 6 Spanish-speaking caregivers opted out of receiving TGS messages during this period. Caregivers reported opting out because their children had either returned to in-person learning or their older children had too many school assignments; this suggests that caregivers may have been overwhelmed with all the resources they were receiving. Approximately 25 (20%) caregivers were switched from receiving messages via SMS/MMS to the Remind app.

Acceptability (messaging replies and content views). During these three months, four percent of caregivers spontaneously responded to SMS/MMS weekly among the English- and Spanish-speaking groups. Among the Remind app users (only Spanish- and English-speaking caregivers), 5% of caregivers responded, unprompted, to TGS messages every week. On WeChat, approximately 11.5% of caregivers responded to messages each week during this time frame. In addition, we shared two videos on YouTube during this time: an arts-and-crafts activity in English and 4The English videos for emotions were texted or shared through other video channels, making it impossible to calculate their views. Likewise, we could not track the number of video views for the Chinese-language videos because they were not posted to YouTube.
Spanish (38% of English and Spanish-speaking caregivers viewed this video), and a recording of a live nutrition webinar facilitated by the NYC Department of Health in Spanish (17% of Spanish-speaking caregivers viewed this video). During this third implementation phase, the TGS outreach team conducted nine webinars in Spanish and Mandarin (e.g., screen-time, early literacy, COVID-19, and school) with attendance ranging from five to 35 caregivers.

**DISCUSSION**

While immigrant caregivers may have both the motivation and resources, they often lack the knowledge of how best to support their children's readiness for American schools (Sonnenschein et al., 2018). Programs that directly target caregivers' skills show promise; however, access to these programs in underserved communities is often low and rarely have they been adapted to meet the diversity of immigrant caregivers' interests, values, and practices (Welsh et al., 2014). Moreover, even when barriers to access are considered, keeping caregivers involved and attending regularly is also a challenge (e.g., Baker et al., 2011). As a result, the educational opportunities for children may be limited far more by an inability to engage immigrant caregivers' than by a lack of positive goals for the children, limited time to spend interacting with children, or not having toys and other material resources. This mixed-method study provided a preliminary look into whether a digital engagement program might be a feasible and sustainable mechanism for sharing developmentally- and culturally-appropriate information for a diverse set of immigrant caregivers of children. Moreover, this study served as an example of how to apply a dynamic implementation science process to the cultural adaptation of a caregiver program. The findings suggest that this type of outreach can support immigrants, and these implementation results add to the growing literature on interventions designed to promote behavior change and knowledge growth through digital outreach to facilitate caregiver-child engagement (e.g., Hurwitz et al., 2015). By addressing caregiver-child engagement, these digital engagement programs can support families and their children.

Indicators of feasibility suggested that the digital engagement was appropriate for all three sets of caregivers. It is important to note that we had more Spanish-speaking caregivers opting out of the program initially. Based on data from the survey and conversations, we suspect that there were several reasons that more Spanish-speaking caregivers opted out including, (1) they reported greater food insecurity, financial worries, and more limited access to technology, and (2) they believed that receiving texts from strangers was too personal. Over time, the TGS team strived to continue to build trust with caregivers by addressing these concerns. For instance, the larger TGS initiative provided technology clinics that aimed to understand the digital needs of the neighborhood and to provide real-time device support. In addition, the messaging program switched to a texting platform that was more widely acceptable. The addition of webinars to our digital outreach enabled caregivers to receive information and connect with other caregivers, as well as experts in the field. Facilitating webinars was possible due to our strong partnerships with community programs and experts. Bridging critical resources from our collaborators to community members enabled caregivers to be equipped with knowledge and support that may have otherwise been missed. Finally, we increased our reach despite many of our traditional avenues for recruiting caregivers (e.g., in-person community events) disrupted by the COVID-19 pandemic. This suggests that the digital engagement program resonated with interests and needs of the community.

Despite results suggesting that sending messages that support children's school readiness through various digital programs was feasible, indicators of acceptability among caregivers went down over time. Specifically, the percentage of caregivers who watched the videos decreased over time. This occurred even after attempts to make the content easier to implement—a modification resulting from survey findings. These differences in views between the two language groups suggest that the videos may be more appropriate for or acceptable to the English-speaking group. Similarly, the number of spontaneous replies to our messages decreased over time as well. While our indicators of acceptability are not necessarily an indicator of attrition, text message-based interventions generally face similar attrition levels as interventions delivered face-to-face (in the 30%–50% range; Hall & Bierman, 2015; Kable et al., 2012). Strategies for capturing and maintaining caregivers' attention in technology-delivered interventions should be examined systematically in future research.

The various digital engagement programs used in this project likely resulted in different experiences for the groups of caregivers. The Chinese-language caregivers, who received messages in WeChat, were also part of a social messaging group to bring up issues and receive social support from other immigrant caregivers. The TGS team found that sharing content to caregivers in groups was ideal for our messaging program due to the (perceived) benefits to the caregivers. Groups built on WeChat tend to bring Chinese people a stronger sense of community and connection than traditional text messaging (Bourdeau et al., 2016). Because it was outside of the scope of this project, we cannot conclude whether the social network aspect of the WeChat groups resulted in a different set of experiences for the Chinese-language caregivers; however, we suspect that the Spanish- and English-speaking caregivers who received traditional SMS/MMS messages, may have missed out on potential opportunities to gain both informational and emotional support from a group of similar caregivers. Sending messages to caregivers via WeChat also provided the TGS team with the opportunity to monitor caregivers' topics and questions, which helped us be more responsive to their needs and interests. The transition to the Remind app provides an alternative...
method that allows Spanish- and English-speaking caregivers to interact with each other and the TGS team but respects any participants who do not wish to be part of a social group. Increasing the utilization of Remind will be an important next step in our work.

The content in the messages was generally well-received across all three community groups. Codeveloping content with key community stakeholders and regularly asking for feedback on the materials helped ensure that the message content was relevant, met cultural expectations, and was easily understood. Nonetheless, when trying to leverage existing materials and resources to share with our caregivers, we encountered several challenges, especially finding translations in Mandarin and activities that did not require extensive material resources (e.g., toys, books). Like other studies, we also found that partnerships with community groups allowed us to leverage resources that are already available in the community but may not have been utilized by our caregivers (Burke, 2008).

The iterative process of adopting the messaging program primarily based on community-driven feedback helped ensure that our content was meeting families where they were and was grounded in their beliefs and interests. Thus, in addition to making adaptations to the language of the content and the systems that the digital engagement programs were delivered, the need emerged to account for cultural differences regarding how school readiness is defined and fostered by caregivers (Hill & Torres, 2010). For instance, our survey results suggested cultural differences regarding each language group’s types of activities. Specifically, Spanish-speaking caregivers were more likely to report trying the singing activities (98%) than the English-speaking group (75%). This finding aligns with previous work indicating that singing activities are more accessible than literacy activities to Spanish-speaking caregivers (Bradley et al., 2001; Feng et al., 2014). Another key difference to highlight between the different groups of caregivers is that the Chinese-language caregivers were approximately half as likely to find the activities “fun to implement” compared to English- and Spanish-speaking caregivers. This finding likely highlights differences in how supporting children’s education are viewed and perceived across cultures. It may be that because Chinese-language caregivers tend to teach their children in more formal ways, are more directive, and structure their children’s use of time to a greater degree (e.g., Huntsinger et al., 1998), the expectation is not for caregiver-child activities to necessarily be fun.

Finally, this study extends previous implementation research and offers new insight into a mixed-method EPIS and DAP application with a diverse population during a time of significant societal change, like the COVID-19 pandemic. As demonstrated, the EPIS proved helpful in documenting the implementation process through three phases and identifying and measuring barriers and facilitators to key implementation domains. However, by overlaying the DAP onto the EPIS framework, this mixed-method study demonstrates the utility of systematically applying a dynamic structure to the traditional step-by-step procedures often outlined in implementation science (Meyers et al., 2012). This is particularly critical when trying to identify culturally specific themes that are likely to enhance programs that are targeted to multiple underserved immigrant groups. Furthermore, given that implementation rarely occurs in an exact sequence of events, particularly when working with diverse groups of participants, both the DAP and EPIS provided the TGS team with a structure to map the approach in a replicable way.

Strengths and limitations

The relatively large sample of diverse immigrant families was a strength. Given the multiple challenges low-income immigrant caregivers face and the difficulties programs experience in engaging them, it is highly encouraging that such a low-cost program was possible. While allowing us to be responsive to caregivers’ preferences, the multiple messaging platforms also made it challenging for our implementation measures to fully capture the experiences and differences between the three groups of caregivers. Moreover, developing a deeper understanding of whether there were, in fact, different levels of engagement and why that was the case across the three groups of caregivers is an essential next step. It was outside the scope of this study to explore implementation differences between caregivers who received the 0–2 content compared to the content for 3- to 5-year-olds, but future studies should systematically examine acceptability and engagement across the age groups. Finally, the use of a mixed-methods implementation framework allowed us to track modifications made. In the future, more in-depth questions that focus on better understanding caregivers’ beliefs on culturally syntonic socialization activities and the balance between acculturation versus cultural preservation would be beneficial for creating culturally relevant content.

CONCLUSIONS

Messaging programs appear to have the potential to be a powerful, low-cost, technological “nudge” to support multiple facets of caregivers’ knowledge, and implementation of developmentally appropriate caregiver-child activities among diverse immigrant populations. However, involving caregivers and community stakeholders in the cultural and linguistic tailoring of interventions to optimize utilization and engagement may be critical to ensuring messaging programs’ usability and acceptability.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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