Promoting Healthy Lifestyles for Diverse Families: Usability Testing of a mHealth App

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Abstract

Background: MICCO (Mobile Integrated Care for Childhood Obesity) is a multi-component intervention to promote healthy lifestyles among young children with obesity from rural communities that was developed in collaboration with community, parent, and healthcare partners. It includes community programming to promote healthy lifestyles and address social needs and healthcare visits with an interdisciplinary team. A digital mobile health (mHealth) platform – the Healthy Lifestyle dashboard – was designed as a self-management tool for families to use as part of MICCO.

Objective: This study aimed to test and refine the English and Spanish language versions of the Healthy Lifestyle dashboard through usability testing with a diverse group of parents.

Methods: Seven mothers of children with obesity from rural communities (average age of 39 years; four Spanish-speaking and three English-speaking) provided feedback on a prototype of the dashboard and indicated their preferences in a three-phased approach. Participants verbalized their thoughts while using the prototype to complete four tasks. Qualitative and quantitative data regarding usability, acceptability, and understandability were analyzed.

Results: The dashboard was noted to be acceptable by 100% of the participants. Overall, participants found the dashboard easy to navigate and found the resources, notifications, and ability to communicate with the healthcare team to be especially helpful. However, Spanish-speaking participants identified challenges related to numeracy and literacy, which informed iterative refinements to make the dashboard clearer and more literacy-sensitive.

Conclusions: Conducting usability testing with key demographic populations, especially Spanish-speaking populations, was important to developing a mHealth intervention that is user-friendly, culturally relevant, and literacy-sensitive.

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Abstract

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communities that was developed in collaboration with community, parent, and healthcare partners. It includes community programming to promote healthy lifestyles and address social needs and healthcare visits with an interdisciplinary team. A digital mobile health (mHealth) platform – the Healthy Lifestyle dashboard – was designed as a self-management tool for families to use as part of MICCO. **Objective:** This study aimed to test and refine the English and Spanish language versions of the Healthy Lifestyle dashboard through usability testing with a diverse group of parents. **Methods:** Seven mothers of children with obesity from rural communities (average age of 39 years; four Spanish-speaking and three English-speaking) provided feedback on a prototype of the dashboard and indicated their preferences in a three-phased approach. Participants verbalized their thoughts while using the prototype to complete four tasks. Qualitative and quantitative data regarding usability, acceptability, and understandability were analyzed. **Results:** The dashboard was noted to be acceptable by 100% of the participants. Overall, participants found the dashboard easy to navigate and found the resources, notifications, and ability to communicate with the healthcare team to be especially helpful. However, Spanish-speaking participants identified challenges related to numeracy and literacy, which informed iterative refinements to make the dashboard clearer and more literacy-sensitive. **Conclusion:** Conducting usability testing with key demographic populations, especially Spanish-speaking populations, was important to developing a mHealth intervention that is user-friendly, culturally relevant, and literacy-sensitive.

*Keywords***:** obesity, user-testing, mHealth, Spanish

Introduction

Childhood obesity persists as a significant public health concern in the United States (US). [1,2] Notably, one in every five children in the US lives with obesity. Obesity in childhood is linked to increased risks of comorbid and future health conditions such as diabetes, cardiovascular diseases, cancer, and psychosocial concerns, leading to increased healthcare costs and utilization.[1,3] This is especially the case for children from communities of color, communities with fewer resources, and

rural communities, who continue to have the highest rates of obesity.[2] Challenges in affording and accessing nutritious food, accessing safe spaces for physical activity, having transportation to get to healthcare services, and managing family stressors are a few of the many systemic barriers that perpetuate disparities in childhood obesity.[4,5] While lifestyle behavior interventions are first-line treatments for improving health behaviors and obesity outcomes, most available interventions do not address these systemic barriers and are often not effective when implemented in the communities with the greatest need.[6,7] Thus, more studies are needed that consider the needs and preferences of diverse patient families when designing an intervention.

Dietz and colleagues have proposed the Clinical-Community Integration Framework to optimize the treatment of obesity.[8] This framework emphasizes the integration of community systems and healthcare delivery to address the multifaceted nature of obesity and increase patient family engagement. Within this integrated framework, community systems, including social services and resources embedded in the environments in which families live, work, study, and play, provide resources to facilitate healthy behaviors within a patient's community. Healthcare systems provide interdisciplinary evidence-based care, leveraging technology to support clinical decision-making, promote self-management, and patient family engagement.[8]

Drawing on this framework, a multi-component intervention called Mobile Integrated Care for Childhood Obesity (MICCO) was designed for families from rural communities (Figure 1). MICCO combines evidence-based interdisciplinary obesity treatment, community-based programming for families to engage in a physical activity and have a healthy affordable meal together, and community health worker outreach to address psychosocial needs and barriers to achieving lifestyle goals. Importantly, MICCO was developed with the input of a Council of Community Partners that included four parents of children with obesity from rural communities, five primary care providers from clinics serving rural communities, and four community organizations serving rural communities. This Council met once a month by video conference to provide valuable feedback on

the development and implementation of the MICCO intervention, drawing on their knowledge about the needs of families of children with obesity and resources in the community to support families.

Figure 1. Mobile Integrated Care for Childhood Obesity (MICCO) model.

Given the ubiquity of smartphone access and use among our patient families, a digital mobile health (mHealth) platform was designed for patient families to access self-management tools as part of the MICCO intervention.[9] A custom Healthy Lifestyle dashboard on a mobile application (app) linked to the Nemours Children's Health electronic health record (EHR; Nemours App) was built, with input from interdisciplinary specialists from the Nemours Healthy Weight and Wellness Clinic and Council of Community Partners and in collaboration with app designers from the Nemours Center for Health Delivery Innovation. Psychoeducational tools based in social cognitive theory[10], behavior change techniques[11], and the socio-ecological model of obesity[12] were included on the dashboard, including a self-monitoring function to track daily progress towards lifestyle goals formed during treatment visits and culturally relevant videos to promote positive parenting and healthy lifestyle behaviors. The video resources, including six that were created specifically for the MICCO intervention, provided content related to mood and behavior, physical activity and healthy eating, were available in English and Spanish, and featured families and healthcare providers of

diverse backgrounds. Through the dashboard, families can also track their weight using an integrated Bluetooth scale, send messages to their healthcare team, connect to telehealth appointments, and receive reminders about community-based programs and resources. Since many of the patient families with obesity served by Nemours Children's Health are Hispanic/Latino, the dashboard was developed in English and Spanish. A parallel dashboard was created for healthcare providers to access data entered by patient families about their goals and weight progress to assist with clinical decision support.

Digital applications have several advantages, including greater or more convenient access to support and the removal of common barriers to treatment such as financial, travel, and time constraints.[9,13] A recent systematic review and meta-analysis revealed that digital interventions for treating youth with obesity have a significant yet small effect on BMI z-scores.[14] Still, there are important limitations to digital interventions that require consideration, especially regarding their uptake and implementation. For one, digital interventions are subject to high non-usage attrition such as low uptake and disengagement.[15,16] Although some digital interventions for pediatric obesity have included diverse samples in their studies, there remains concerns about their cultural sensitivity. [14] For example, most of these interventions do not include content related to systemic barriers, social determinants of health, or community resources.[17] Additionally, there is only one published study of a digital intervention for pediatric obesity available in Spanish, which is a major gap given the prevalence of Hispanic/Latino children with overweight or obesity in the United States.[5,18,19] Therefore, there is a need to incorporate human-centered design principles into the design of digital interventions, such as partnering with target users to enhance the usability of these interventions. This way, digital intervention designers can maximize engagement by building an intervention that centers on the needs and preferences of its users. Key principles of human-centered design include but are not limited to the active involvement of users with lived experiences relevant to the intervention in design activities as well as iteratively refining and updating intervention features

based on user feedback.[20]

With these principles in mind, mixed methods were used to test and refine the MICCO Healthy Lifestyle dashboard to enhance the usability of the intervention for families of diverse backgrounds. Parents of children with obesity provided feedback on the usability of the Healthy Lifestyle dashboard through Think Aloud testing, an iterative human-centered design technique and evidence-based method for obtaining in-vivo feedback that has been used in the development of digital health interventions.[21] Qualitative feedback from English and Spanish-speaking patient families provided opportunities to iteratively improve the design of the dashboard, increasing cultural sensitivity and readiness for future trials and clinical settings. No hypotheses were made a priori.

Methods

Sample and Recruitment

Target users of the MICCO intervention are legal guardians of children ages 4-12 years with obesity (BMI percentile ≥ 95th percentile) receiving primary care from a Nemours Children's Health practice that serves rural communities. Therefore, we recruited participants matching these characteristics for the user testing. Legal guardians also had to be able to read English or Spanish and have access to the internet. A primary aim of the study was to incorporate diverse perspectives in refining the Healthy Lifestyle dashboard; therefore, purposeful sampling was used to recruit a diverse group of parents including Spanish-speaking parents of Hispanic/Latino ethnicity and English-speaking parents of Black and White race. A list of potentially eligible participants was pulled from the Nemours EHR. A total of 196 parents (63 Spanish-speaking and 133 English-speaking) received a text message informing them of the study. Thirty-four parents (15 Spanish-speaking and 19 English-speaking) responded to the text. Of these, 7 agreed to participate (4 Spanish-speaking and 3 English-speaking), 2 declined after hearing about the study, and the remainder did not respond to any additional contact by the study team. Interested participants

completed an e-consent process and received a $50 gift card after completing the Think Aloud session. The Nemours IRB (#1812070) approved all study procedures.

Data Collection

Think Aloud testing was conducted via video calls through a secure Zoom platform, accessible to participants either on their mobile device or computer. A web link to an interactive, high-fidelity prototype of the Healthy Lifestyle dashboard was shared with participants. The online prototype mirrored the app and allowed participants to easily access the design for Think Aloud testing. Conducting the session remotely was important to simulate the environmental context within which the actual digital application would be experienced. The testing sessions were video-recorded, and the audio was transcribed. Spanish-language recordings were translated and transcribed into English. Rarely, participants encountered minor technical issues with Zoom such as slow connectivity or difficulty using Zoom (e.g., how to start the call or share their screen) but the bilingual research coordinator on the call was able to guide them through these issues.

Testing sessions were conducted with a semi-structured interview guide. Participants were asked to complete four major tasks: 1) enter daily goal completion and review their weekly progress; 2) enter the child's height and weight and review a growth curve; 3) contact their healthcare team; and 4) find resources for their family. Families were also asked about specific design layouts using preference testing (i.e., participants were shown two design options and asked to pick the one they preferred). Throughout the Think Aloud testing, participants were encouraged to verbalize their thoughts as they navigated independently through the tasks. The participants shared their screen with the research coordinator, which allowed the coordinator to see their navigation when using the app. Each session lasted 30 to 60 minutes.

A three-phased approach was used to refine the dashboard and validate that iterative changes were acceptable. In Phase 1, Think Aloud sessions with four Spanish-speaking families were conducted until no new feedback was received. The research and Nemours app team met to discuss

feedback and rapid changes were made to the user interface based on participant feedback. In Phase 2, Think Aloud sessions with three English-speaking families were completed with the revised prototype until no substantive changes were recommended. In Phase 3, a final prototype based on all of the Think Aloud feedback was shown in a virtual meeting to a group that consisted of three parents from Phase 1 and one parent from Phase 2. This meeting was facilitated by a bilingual research coordinator and participants received an additional $50 gift card for participating.

Data Analysis

All Think Aloud transcripts were uploaded into Dedoose[22], an online qualitative data analysis program, to complete a formal qualitative analysis. A preliminary codebook of a priori codes was established based on the interview guide. The goal of the codebook was to capture usability, understandability, and acceptability of the dashboard and its specific features during the Think Aloud sessions (see Table 1). Three members of the research team (LP, APR, and AO) met regularly to review the transcripts and codebook. The first transcript was coded by LP and APR together to test the codebook. All three members then independently coded two more transcripts. The team met to review discrepancies and revise the codebook as needed. The fourth transcript was used to test reliability amongst the coders and the established codebook. Given the strong inter-coder reliability (83.5%), the codebook was finalized, and then all the transcripts were coded with the final codebook by APR and LP. They met regularly to resolve any discrepancies. After all transcripts were coded, feedback for each of the four specific tasks and overall app were pulled. The research team noted specific challenges and features highlighted by participants. This feedback was analyzed for each phase given that there were changes in-between phases. Quantitative data regarding the number of participants who reported overall acceptability of the dashboard and usability and understandability of each task was also extracted by coding specific mentions and counting the frequency of the codes.

Table 1: Mobile Integrated Care for Childhood Obesity (MICCO) – Think Aloud Code Book.

Code #	Code Name	Definition	Subcodes
1.0	Experiences with Healthy Lifestyle	Use when participant describes how their family lives/tries to live a healthy lifestyle Use subcode (**1.1**) when participant shares specific activities/habits they do to live a healthy lifestyle Use subcode (**1.2**) when a participant shares challenges with living a lifestyle	• 1.1 Current Habits • 1.2 Challenges • 1.3 Nutrition • 1.4 Physical activity • 1.5. Psychosocial (sleep, behaviors, etc.) • 1.6 Importance of health

		Use subcodes (**1.3-1.6**) when a participant discusses a particular aspect of healthy lifestyles	
2.0	App Usability	Use to describe participant's feedback about navigating the App (or an App feature) May be double coded with specific App function code (**6-9**) if feedback is specific to a certain function/section within the App	• 2.1 Easy • 2.2 Challenging • 2.3 Neither easy nor challenging
3.0	App Acceptability	Use when participant discusses whether they like the App (or an App feature) May be double coded with specific App function code (**6-9**) if feedback is specific to a certain function/section within the App Use subcode (**3.3**) when participant shares thoughts about barriers one may face to using the App	• 3.1 Like • 3.2 Dislike • 3.3 Barriers o 3.3.1 Technology o 3.3.2 Competing priorities/busy o 3.3.3 Literacy/language barriers o 3.3.4 Motivation • 3.4 Neither like nor dislike • 3.5 Important features to include
4.0	App Understandability	Use when participant provides feedback about whether App (or an App feature) content is understandable May be double coded with specific App function code (**6-9**) if feedback is specific to a certain function/section within the App.	• 4.1 Understandable • 4.2. Not understandable • 4.3. Neither understandable nor not understandable • 4.4 Numeracy challenges
5.0	Wording	Use when participant shares feedback about specific wording/phrasing being used in the app May be double coded with specific App function code (**6-9**) if feedback is specific to a certain function/section within the App. Use subcodes (**5.1; 5.2**) if wording suggestion is for English or Spanish version of the App, respectively	• 5.1 English • 5.2 Spanish
6.0	Tracking Lifestyle Goals function	Use when participant shares feedback about the Tracking Lifestyle Goals function Use subcodes (**6.1; 6.2; 6.3**) when	• 6.1 Entering lifestyle goals • 6.2 Reviewing 7-Day Summary

		talking about specific features in the Tracking Lifestyle Goals function	• 6.3 Receiving notifications
7.0	Entering Measurements function	Use when participant shares feedback about Entering Measurements function Use subcodes (**7.1; 7.2; 7.3**) when talking about specific features in the Entering Measurements function	• 7.1 Entering new measurement • 7.2. Using scale • 7.3 Reviewing growth chart
8.0	Contacting Community Health Worker function	Use when participant shares feedback about contacting the care coordinator Use subcodes (**8.1; 8.2**) when talking about specific features in the Contacting Community Health Worker function	• 8.1 Selecting community health worker • 8.2. Entering and sending message
9.0	Accessing Resources function	Use when participant shares feedback about Resources function Use subcodes (**9.1; 9.2**) when talking about specific features in the Resources function	• 9.1 Finding resource section • 9.2 Finding specific resource
10.0	Formatting of Resources (A/B Testing)	Use subcodes (**10.1; 10.2**) depending on option chosen during A/B Testing	• 10.1 A-Option • 10.2 B-Option
11.0	App Icons (A/B Testing)	Use subcodes (**11.1; 11.2**) depending on option chosen during A/B Testing	• 11.1 Person • 11.2 Apple

Results

Seven mothers (average age of 39 years) participated in Think Aloud sessions. Four parents were Hispanic/Latino, one parent was Hispanic/Latino White, one parent was Non-Hispanic/Latino White, and one parent was Non-Hispanic/Latino Black. Overall, MICCO was accepted and liked by 100% of the participants. Participants shared that the Healthy Lifestyle dashboard would be an easy-to-use tool to help them develop healthier habits as a family. As one participant described, “It is a tool that is within my reach. I can contact my son’s doctor to know what he can or cannot eat, and not have to make an appointment to go to the hospital. I can use the application to solve the doubts I

have about some things that my son can or cannot get. For me, it would be an easy tool to handle as a mom." While it was generally well-received, participants shared some challenges with specific tasks and highlighted features that were important to them, as described below.

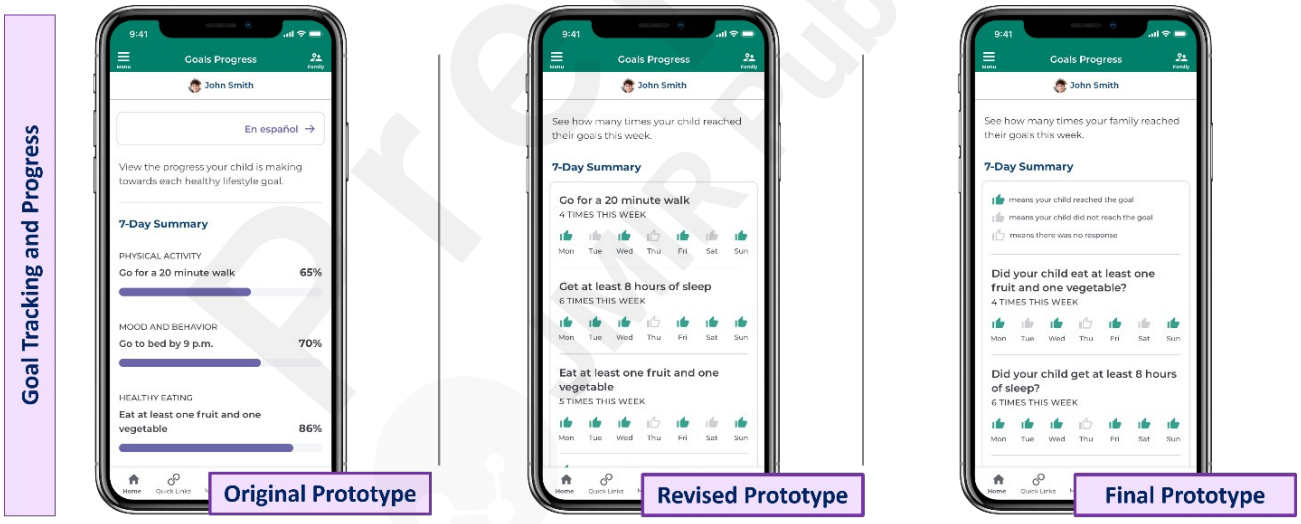
Phase 1

Spanish-speaking participants reported challenges surrounding understandability and usability of certain features of the Healthy Lifestyle dashboard. For example, three participants did not understand the lifestyle goal progress feature, four did not understand the growth curve feature, and three had trouble using the tool to communicate with the healthcare team. Themes surrounding numeracy and literacy challenges emerged and specific changes were made to the dashboard to ease these challenges after Phase 1 (Figures 2 and 3, respectively).

Numeracy

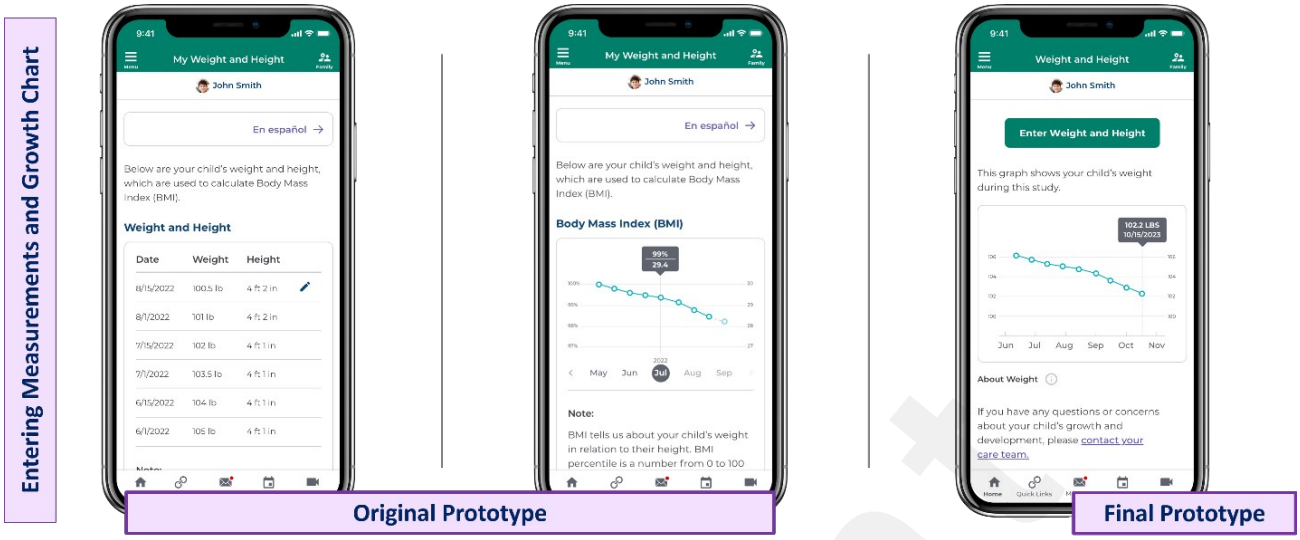
All four participants reported numeracy issues when reviewing the lifestyle goal progress and growth curve in the dashboard. In particular, some of the participants did not understand how to interpret the percentage of goals reached over the past seven days and some interpreted it as a "grade" or "score." To simplify the weekly summary and ensure it would not be seen as punitive, the percentages were removed and substituted with a weekly view that used a green, white, or grey thumbs-up icon to show which goals were achieved on a certain day. In the first iteration of the growth curve, participants were shown their child's BMI over time. Despite having a note that explained how BMI was calculated and what it meant, all four participants struggled with the interpretation of the growth curve. Given this, the growth curve was simplified to show weight instead of BMI and to have entry of height and weight appear on the same page as the weight curve.

Figure 2. Revisions to address numeracy challenges experienced during Think Aloud testing.



“Why is 9:00 P.M… 70%? That’s very – should it be earlier, or what? I don’t understand.”

"It is telling me that what was done equals 65%, it is telling me that not 100% of what needs to be done has been done. The 70% is a little closer to the target, and healthy eating has a higher percentage than the other two questions that were asked during the day."



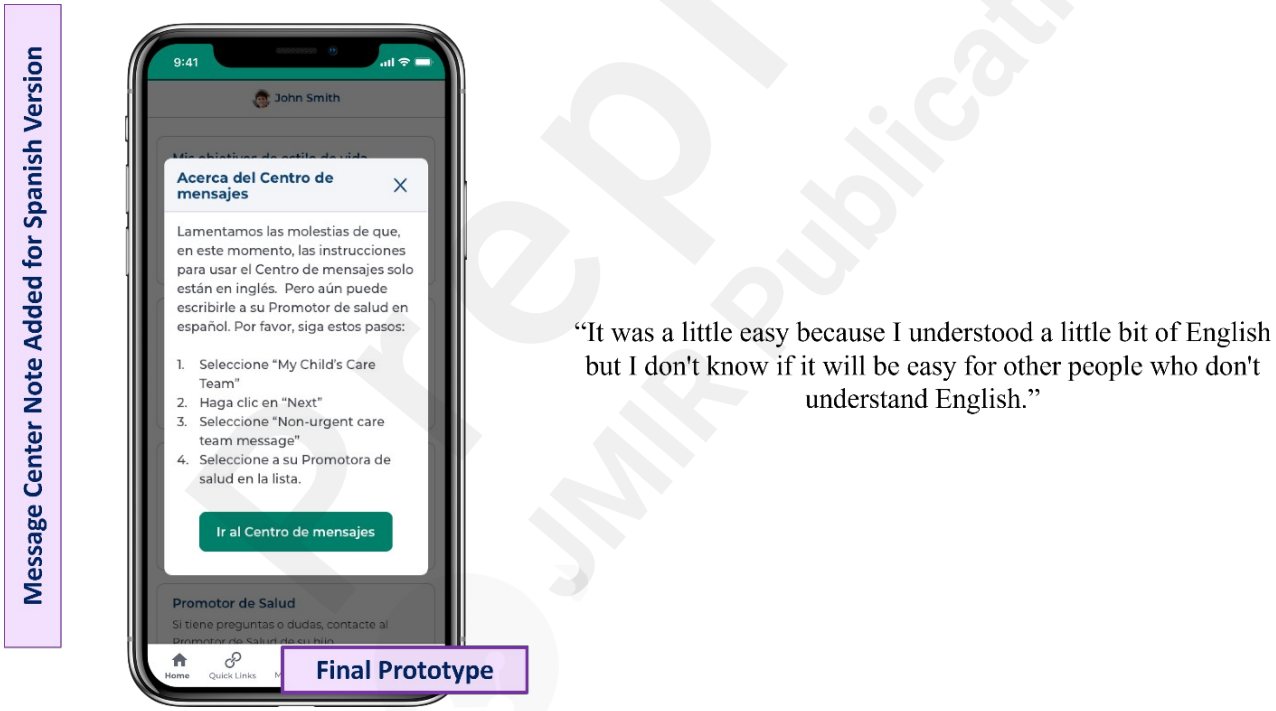
"Well, what I see is, I think the numbers – 100%. That's what I see. I don't know what it means – 28 and 100%. I don't know, maybe height, or weights, I don't know, maybe growth."

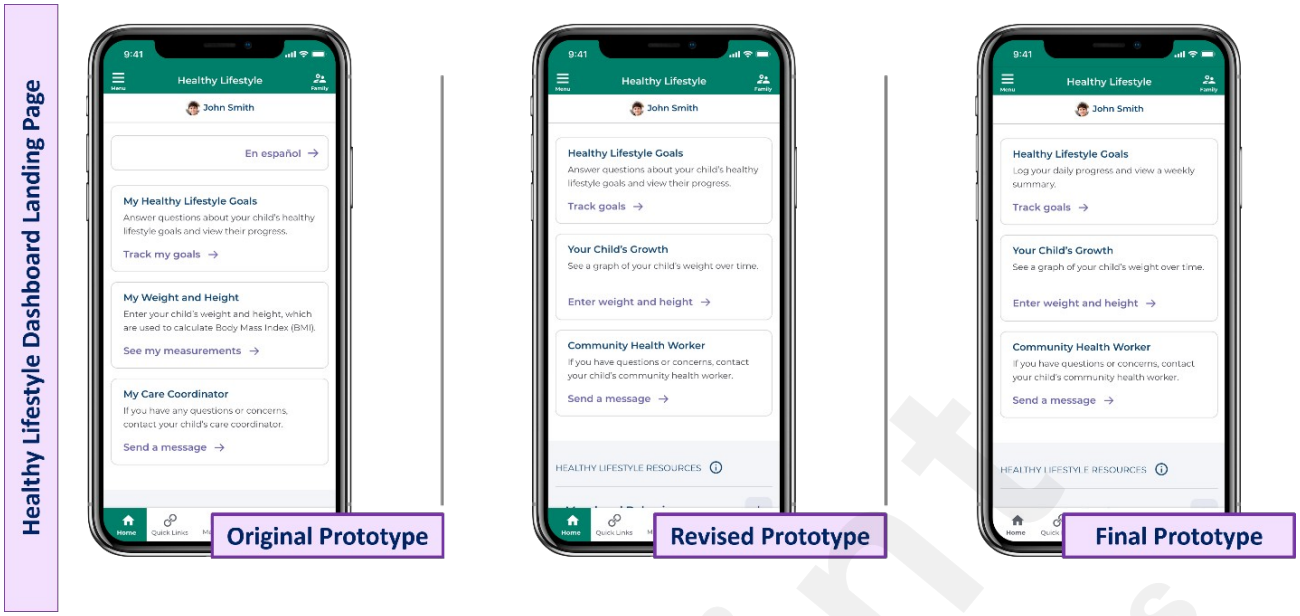
"That I am reaching 99, maybe I am reaching the goal for which I am using the application. I don't understand what 29 is."

Literacy Challenges

While all of the content in the Healthy Lifestyle dashboard was available in Spanish, there were some features of the overall Nemours app there were only available in English at the time of testing. This created some challenges. For example, participants were asked to send a message to their community health worker during Think Aloud testing. Since the Nemours app message center was only available in English, the language barrier caused some difficulty for participants. To provide families with more guidance when using the message center, a note in Spanish was added to the revised prototype to provide instructions on how to use the message center. In addition to this messaging task, two participants shared concerns about language barriers. As one participant stated, "For example, I have my mom … she definitely has trouble with technology. One, because she doesn't really work with technology, and secondly, because there is a language barrier. Even when things are in Spanish, she still feels uncomfortable." In recognition of these barriers, changes were made to simplify the language throughout the Healthy Lifestyle dashboard.

Figure 3. Revisions to address literacy challenges experienced during Think Aloud testing.



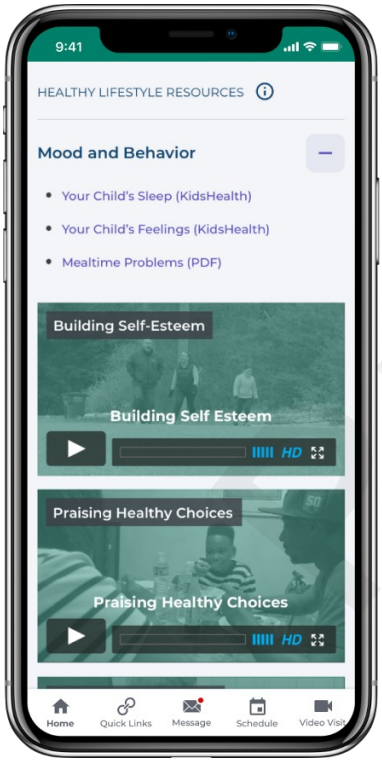


"I think it was a bit complicated with the options they give … maybe – only if we are the patient, we'll look for it, but there are people who won't have any idea."

Phase 2

In Phase 2, participants were shown a revised version of the Healthy Lifestyle prototype based on the feedback from Phase 1. New changes were well received by parents and all three reported that the revised prototype was usable and understandable. Feedback during this phase highlighted the importance of certain features in the dashboard (Figure 4), with only minor suggestions provided.

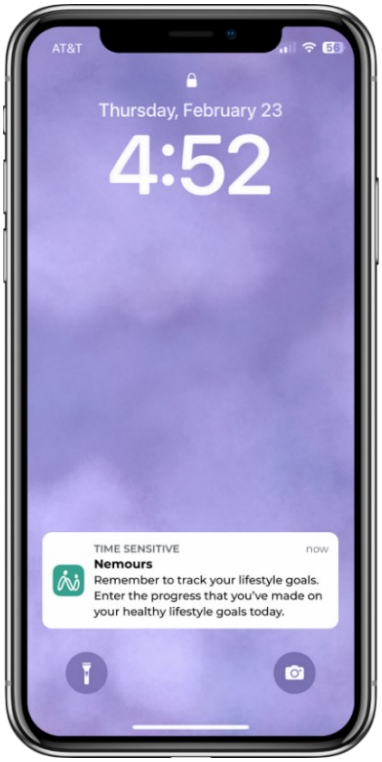
Figure 4. Features to include in the Healthy Lifestyle dashboard, based on participant preferences.



Healthy Lifestyle Resources

"I think it would help me a lot because I wouldn't be going through it Googling and trying to find out what I should be doing and what's healthier. It's all laid out there, and it would be a great resource to go to all at once and find out everything you need to know. And I wouldn't feel lost."

"At the bottom of the page, there is Healthy Lifestyle Resource … I would select that, and it gives you all the things that you can do together, even videos – wow, this is nice – on how to be active together, which I would definitely watch and do."



Daily Notifications

"I think that would be beneficial. I also think if there was a notification at the end that you could set for the end of the day to ask to fill it out to do the log for that day – so you're reminded. Like a reminder notification."

"Yeah, as a parent, sometimes we need that reminder, so that would be great if the app could do that."

Important Features to Include

Participants liked many of the features already included in the Healthy Lifestyle dashboard and thought they would help motivate families. Participants found the multimedia resources (i.e., videos, handouts, links to external sources) embedded in the dashboard to be particularly useful. Participants especially liked the videos and thought they were a user-friendly way to view the resources. Having a set of curated resources in one centralized location was also an advantage because participants found it challenging to find reliable, evidence-based resources on their own. As one participant commented, "I would definitely promote all the things that app can help with – not just that it's about healthy living, healthy eating, and things like that, but also that it has resources for everything, because every family's different, and they deal with different things and different things within their children. There are great resources that you guys have and that you guys are offering." Finally, while participants liked the lifestyle goal feature and understood the importance of tracking their lifestyle goals, many participants talked about competing priorities that may get in the way of inputting their data. As a solution, they discussed how an evening reminder to log their goals would help keep them on track.

Communication and Integration with Healthcare Team

All participants discussed the importance of being able to communicate with their healthcare team through the dashboard, whether by sending messages or by having lifestyle goals and weight data available to their healthcare team. One participant highlighted how the transfer of the dashboard data to the child's care team could help keep families accountable for their goals: "I also think maybe to some parents, it would also be motivating to know – like if this is going to the provider, you want to show that as a parent, you're being proactive, and you're doing what you need to do for your child." Despite the appeal of communicating with their healthcare team through the app, participants expressed a need for more clarity about who would view their data and how and when the healthcare team would be communicating back to them, which was incorporated into the final prototype.

Preference Testing

Preference testing is a research method during which participants compare two variations of a design, choose one, and explain their preference.[21] This method was used for selecting an icon to represent the Healthy Lifestyle dashboard and determining the preferred way to incorporate resources (Figure 5).

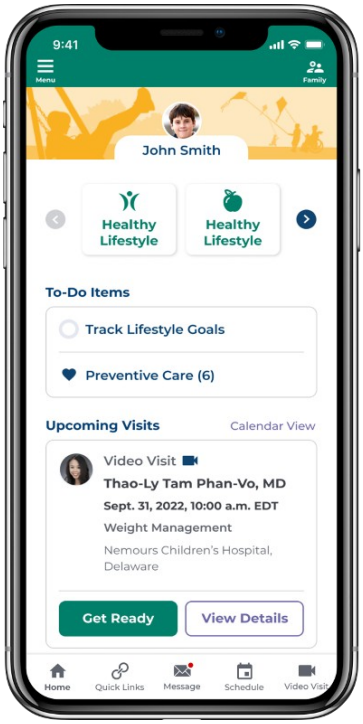
Healthy Lifestyle Dashboard Icon

Since the Healthy Lifestyle dashboard is incorporated into the Nemours app, which is a much broader application designed for a range of healthcare needs, an icon was needed to launch the dashboard. Designers on the Nemours app team explored a range of concepts for the icon. Symbols that represent different aspects of a healthy lifestyle, like physical activity and nutrition, were considered. The top two designs—a joyous person (left) and an apple (right)—were shared during Phase 1 testing. Based on feedback from 100% of participants, the apple icon was chosen to be the branding element for the Healthy Lifestyle dashboard. Participants cited liking the apple more because they associated it with nutrition, which was the primary domain that participants associated with healthy lifestyles.

Resource Page Layout

The list of Healthy Lifestyle resources included 19 items across four domains (healthy eating, being active, mood and behavior, and community programs). Preference testing was utilized to understand how participants preferred to access the resources. Two variations of the Healthy Lifestyle resources were designed. Option A made the resources available at the bottom of each page (like a footer) with expandable sections. Whereas Option B involved adding them to the dashboard as a fourth link, which would open a new page for this section. Participants compared the two options and then indicated their preference. Though 2 of the 7 participants thought Option B looked better, the majority picked Option A. They liked having all the resources easily accessible on every page instead of having to navigate back and forth through the pages.

Figure 5. Results of preference testing.

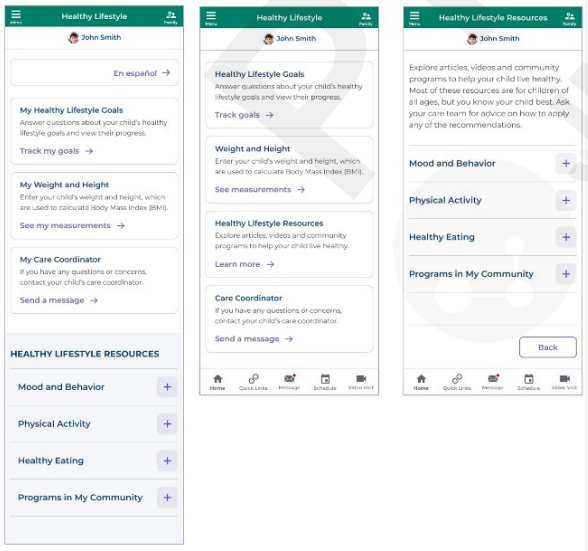


Healthy Lifestyle Icon

"The apple ... I don't know, it calls my attention more. Maybe it speaks more to the importance of knowing how to eat fruit – or maybe it says more about nutrition"

Option A:
Resources Below

Option B:
Resources Page



Healthy Lifestyle Resources

""I think it's nice to have it where it is at the bottom of the page…because you would be here, and then, it would be easy to see because even with it all the way scrolled down, you can still see the words at the bottom: "healthy lifestyle resources", and you don't have to go anywhere else to get to them. And then, you just scroll down and it's easy to get to."

"To me it's all easier because it's all there on one page, so you don't have to toggle between two different things or a whole bunch of screens."

Phase 3

All four parents who participated in Phase 3 were in agreement that the revisions to the dashboard addressed their concerns from Phase 1 or 2. They reported that they final prototype was useful and easy to understand. Given no further feedback about the dashboard, it was finalized for use in future research studies.

Discussion

MICCO is a comprehensive, multi-component intervention that was developed in collaboration with community, parent, and healthcare partners to improve the relevance and accessibility of pediatric obesity interventions for families from underserved and rural communities. Digital self-management tools are a key component of the MICCO intervention and are made available to families through a mobile app dashboard integrated with the EHR. This dashboard component of MICCO addresses notable limitations in the mHealth for childhood obesity literature by including community resources, being available in Spanish and incorporating culturally relevant resources and being integrated into healthcare delivery. Human-centered design methods were applied to ensure that the needs and preferences of families of diverse backgrounds were incorporated. The resulting dashboard is user-friendly, literacy-sensitive, and culturally responsive and incorporates features that will facilitate its usability in future research and clinical practice.

Through a human-centered approach to design, the research team was able to better understand challenges that families, especially those with limited English proficiency and from rural neighborhoods, may experience in using an app to facilitate healthy lifestyle behaviors. Challenges navigating health information are not unique to this study and have been described among larger cohorts of Spanish-speaking individuals of Hispanic/Latino ethnicity.[23,24] Even when health information is available in Spanish, studies have found that reading levels are typically above a sixth-grade level which is higher than the recommended reading level for health information in any language.[25,26] Difficulty understanding health information can contribute to low rates of

engagement with programs and services among Spanish-speaking populations[24,27,28] Therefore, testing mHealth interventions with Spanish-speaking users is critical to ensuring that the intervention is understood and well-received by these populations.

In this study, numeracy and literacy barriers were identified during Think Aloud testing with Spanish-speaking participants. Therefore, pages depicting weight and goal progress were simplified to convey relevant health information more clearly. In addition, information was added to help Spanish-speaking families navigate the one component (messaging function) of the app that was not fully available in Spanish at the time of testing. Not only were these adaptations made as part of this research study, but findings from this line of research in conjunction with other Diversity, Equity, and Inclusion initiatives at Nemours Children's Health, prompted an overhaul of the entire Nemours App to be fully available in Spanish after testing.

Feedback received during usability testing also helped the team develop a deeper understanding of families' busy lifestyles. In particular, the majority of participants expressed challenges balancing competing priorities when taking care of young children. Not surprisingly, time constraints are a commonly cited barrier to adherence in childhood obesity treatment.[29,30] Because of this, many participants reported that an evening reminder about tracking lifestyle goals would be helpful, so a push notification was implemented to remind families to track their lifestyle goals in the app. Participants also liked the curated resources available through the dashboard, especially the brief videos. Having resources that were easily accessible added to the convenience of the app for families and along with automated reminders may be a way to keep families engaged in treatment.

Finally, participants endorsed an appreciation for the integration of the dashboard with their overall healthcare. For example, they reported a desire for information tracked through the dashboard to be shared with their healthcare team and wanted to know more about how to communicate with their healthcare team. The Healthy Lifestyle dashboard was designed to facilitate this bidirectional

communication. This approach is different than most apps designed for childhood obesity, which are stand-alone. While there are advantages to this, findings from this study suggest that mHealth interventions may be more effective if integrated with healthcare delivery especially for rural communities that may experience lower access to healthcare facilities. Not only can this enhance satisfaction and motivation on the part of families, but it can also inform clinical decision-making on the part of the healthcare team.[31,32]

Limitations

There were some limitations to this study. While the recruitment strategy was broad and a diverse sample was recruited, it is possible that our sample was biased towards those with more digital literacy and broadband access. In the future, it will be important to evaluate the app across families from varying socioeconomic backgrounds and with those who face greater barriers to care. Also, while participants endorsed acceptability of the dashboard, the study's focus on usability does not allow for an understanding of whether participants would engage with it on a routine basis. A future study might conduct field testing of the MICCO app, wherein participants can use the app continuously for a shortened duration (e.g., a month) and provide acceptability and usability feedback before it is deployed in a longer trial. Additionally, previous studies have identified that digital interventions are subject to low uptake and engagement levels; therefore, further research utilizing implementation frameworks will be needed to better understand factors that will facilitate routine use of the dashboard as part of the larger intervention.

Conclusion

Collaborating with community and patient partners and conducting usability testing with key demographic populations, especially Spanish-speaking populations, was important to developing a mHealth intervention that is user-friendly, culturally relevant, and literacy-sensitive to promote pediatric healthy lifestyles among diverse families. Designing an intervention that is usable for intended users and in intended settings is a critical first step to trialing and implementing a successful

intervention.

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submitted and agree to be accountable for the work.

Conflict of Interest: All authors have no conflicts of interest to declare.

Data Availability Statement: De-identified data are available upon reasonable request. All requests should be directed to: Alejandra.perezramirez@nemours.org.

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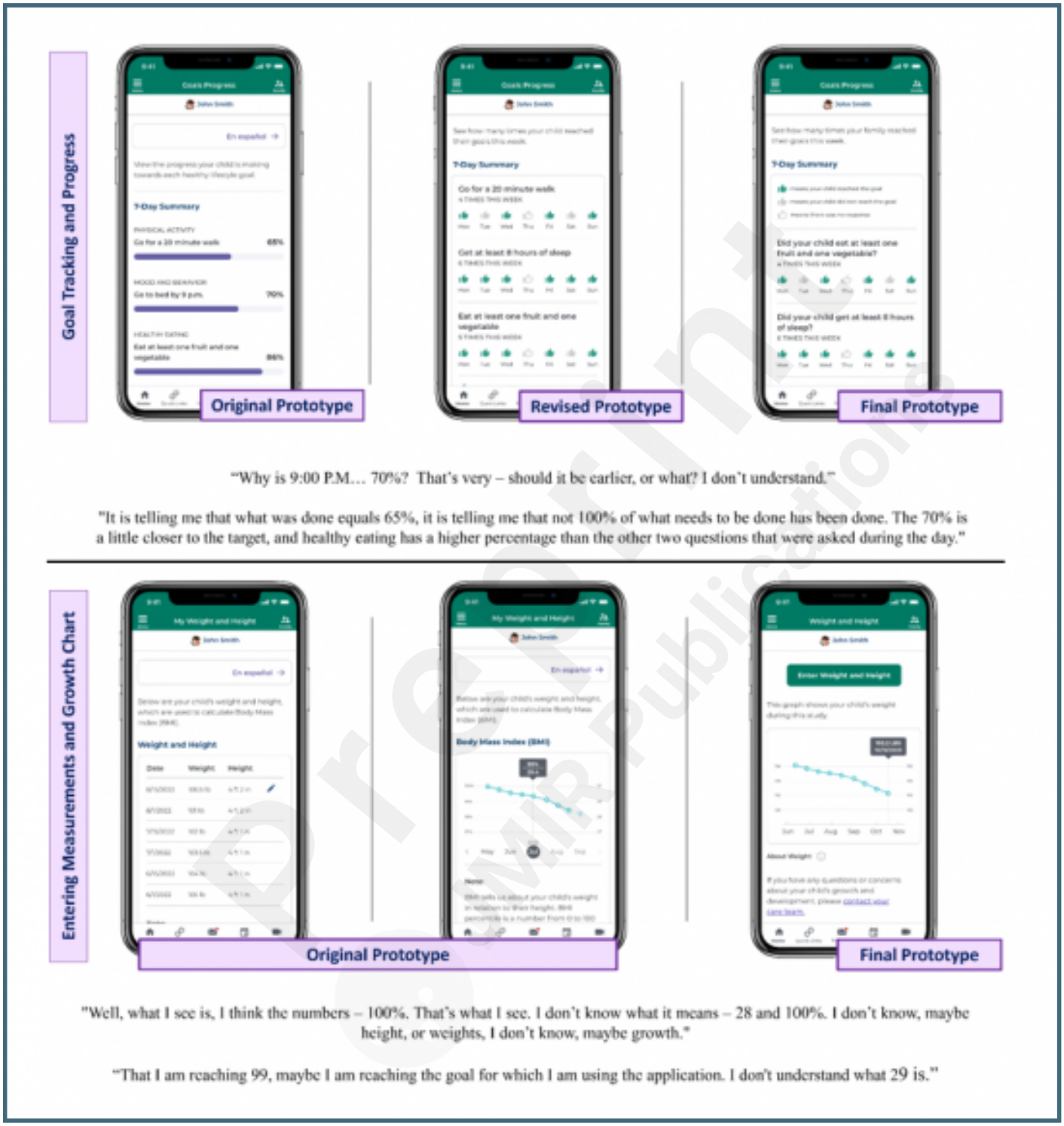
Supplementary Files

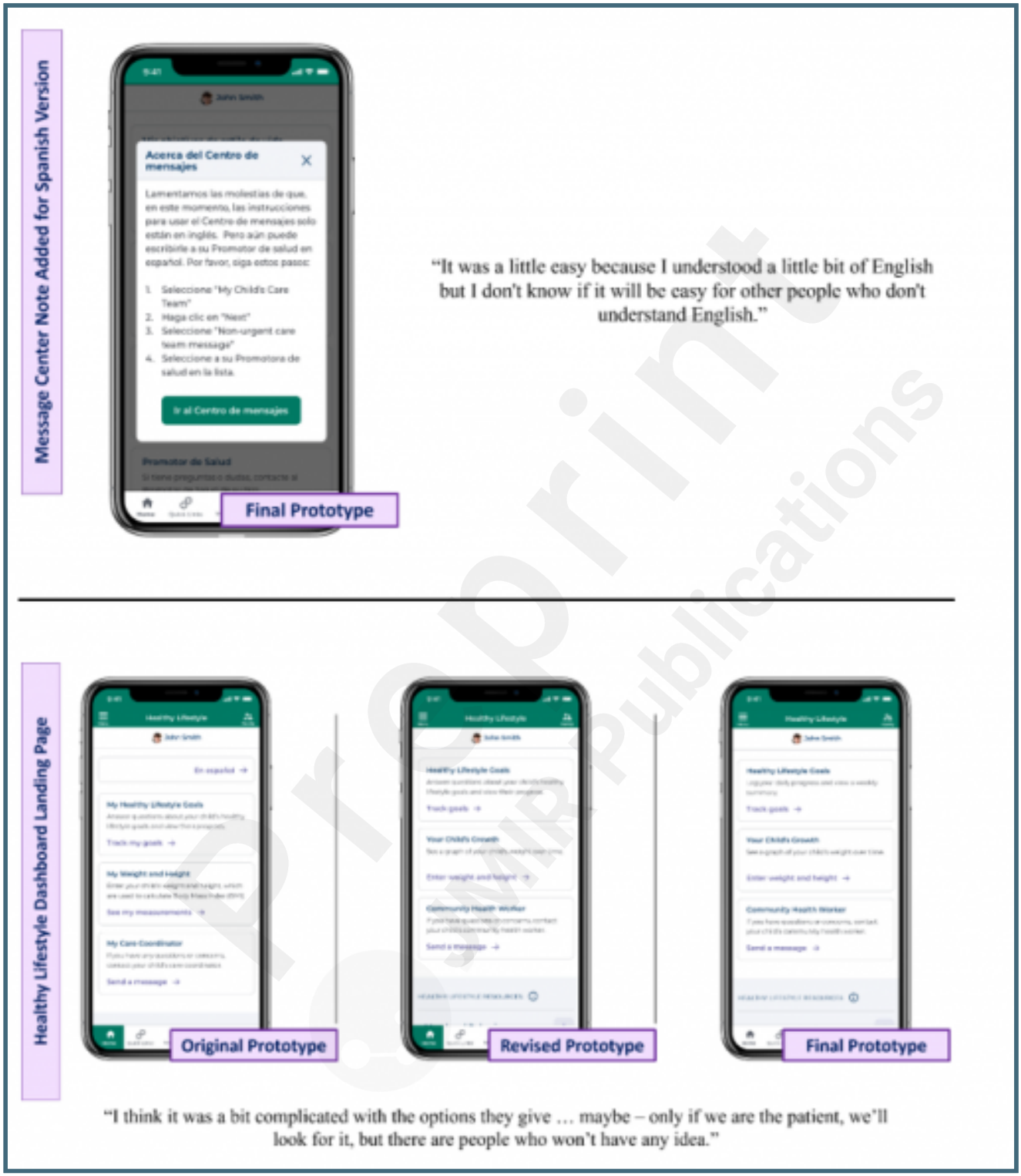
Figures

Mobile Integrated Care for Childhood Obesity (MICCO) model.

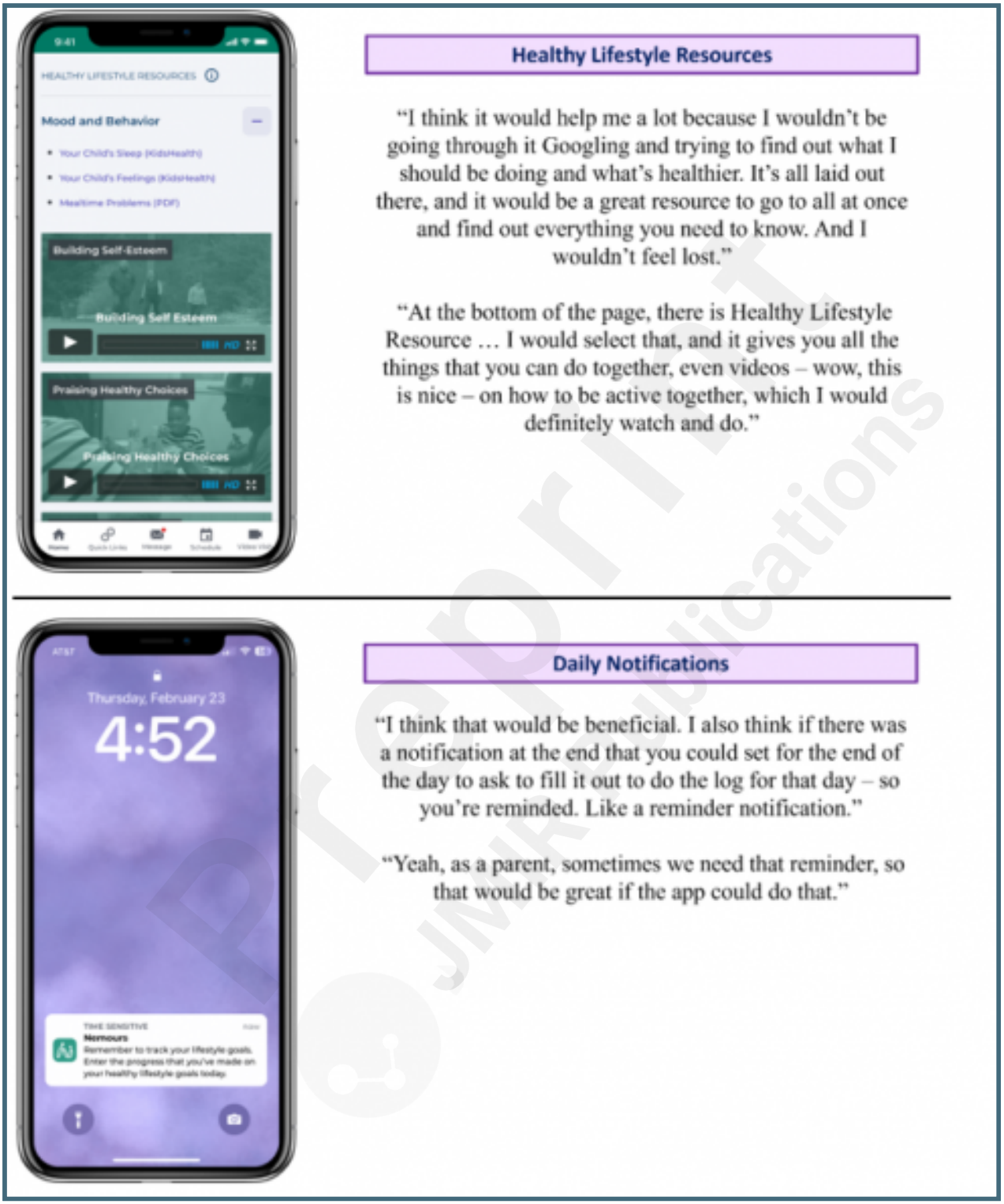
Revisions to address numeracy challenges experienced during Think Aloud testing.



Revisions to address literacy challenges experienced during Think Aloud testing.



Features to include in the Healthy Lifestyle dashboard, based on participant preferences.



Results of preference testing.