Technology Components as Adjuncts to Family-Based Pediatric Obesity Treatment in Low-Income Minority Youth

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Abstract

Background: Strategies to treat pediatric obesity are needed, especially among high-need populations. Technology is an innovative approach; however, data on technology as adjuncts to in-person treatment programs are limited.

Methods: A total of 64 children [body mass index (BMI) ≥85th percentile, mean age = 9.6 ± 3.1 years, 32.8% female, 84.4% Hispanic] were recruited to participate in one of three cohorts of a family-based behavioral group (FBBG) treatment program: FBBG only, TECH1, and TECH2. Rolling, nonrandomized recruitment was used to enroll participants into three cohorts from May 2014 to February 2015. FBBG began in May 2014 and received the standard, in-person 12-week treatment only ($n = 21$); TECH1 began in September 2014 and received FBBG plus a digital tablet equipped with a fitness app (FITNET) ($n = 20$); TECH2 began in February 2015 and received FBBG and FITNET, plus five individually tailored TeleMed health-coaching sessions delivered via Skype ($n = 23$). Child BMI z-score (BMI-z) was assessed at baseline and postintervention. Secondary aims examined weekly FBBG attendance, feasibility/acceptability of FITNET and Skype, and the effect of technology engagement on BMI-z.

Results: FBBG and TECH1 participants did not show significant reductions in BMI-z postintervention [FBBG: $\beta = -0.05(0.04)$, $p = 0.25$; TECH1: $\beta = -0.006(0.06)$, $p = 0.92$], but TECH2 participants did [$\beta = -0.09(0.02)$, $p < 0.001$] and TeleMed session participation was significantly associated with BMI-z reduction [$\beta = -0.04(0.01)$, $p = 0.01$]. FITNET use and FBBG attendance were not associated with BMI-z in any cohort. Overall, participants rated the technology as highly acceptable.

Conclusions: Technology adjuncts are feasible, used by hard-to-reach participants, and show promise for improving child weight status in obesity treatment programs.

Keywords: behavioral interventions; minority groups; pediatric obesity; technology

Background

The prevalence of children with obesity [body mass index (BMI) for age and sex ≥95th percentile] remains high; minority populations are disproportionately affected with higher obesity rates observed in Hispanic and black children.[1] Children with obesity are at greater risk for health complications such as hypertension, type II diabetes, and metabolic syndrome, and are more likely to continue their unhealthy weight trajectory into adulthood.[2,3] Therefore, it is essential that efficacious treatment programs are available. A variety of interventions, including drug therapy, diet-only, or physical activity-only programs, have had modest success in addressing pediatric obesity in the

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short term, while combined lifestyle interventions (diet and physical activity) that include parental involvement show greater impact.[4,5]

Current standards for treatment recommend implementing family-based behavioral group (FBBG) programs to promote healthy lifestyle modification as part of a staged treatment approach.[6,7] These programs typically involve parents as the main agents of change, incorporate behavioral techniques (*e.g.*, self-monitoring, goal setting), and focus on modifying multiple health behaviors, including diet and physical activity.[8] The effectiveness of family-based childhood obesity treatment has been well documented, however, changes in child weight status tend to be small.[9,10] Furthermore, very few programs have targeted low-income minorities, indicating that these programs are not effectively reaching the populations most in need of treatment.[11] Given the modest outcomes and the limited reach of current obesity treatment programs, novel strategies are needed to enhance reach and effectiveness.

Using technology-based approaches (*e.g.*, Internet, tablets, or mobile phones) could be one strategy to address these challenges.[12] Technology components (*e.g.*, apps, websites, and telemedicine) may provide easier access to treatment services[13] and could reinforce strategies that support behavior change, such as goal setting, immediate feedback, and increased intervention contact.[14] Research from other child treatment literature has shown that telemedicine is an adequate strategy for delivering interventions and therapies to children, and is deemed acceptable by families.[15] In addition, a study by the American Heart Association identified the inclusion of new technologies into treatment programs as a gap in the current childhood obesity literature.[16] Despite this, few studies have examined the use of technology, specifically in the treatment of pediatric obesity,[17] and the evidence for the use of technology interventions in youth indicates a dearth of rigorous study designs and evaluations.[18]

Although limited, existing studies show that the use of technology may be a promising avenue for behavior change.[19] A study examining a text-messaging component in addition to in-person clinic visits found the approach was acceptable, and associated with modest improvements in parents' knowledge and beliefs.[20] A recent review indicated interventions with mobile and wireless technologies as the primary component do positively impact some health behaviors such as physical activity and fruit and vegetable intake.[21] In addition, a pilot program using a web-based intervention for overweight children 8–12 years impacted BMI z-score (BMI-z) and found that change was related to usage of the intervention technology; those that were frequent users reduced BMI-z after 4 weeks, whereas infrequent users showed increases.[22] Another review of electronic interventions in obesity treatment and prevention programs suggests these approaches can improve child weight status, but few studies examined technology targeting both parents and children, and findings were constrained by poor study quality and design.[23] Collectively, these studies suggest that the use of technology in pediatric obesity treatment warrants further investigation. Given the insufficient evidence for child treatment interventions delivered via technology platforms only, testing the effect of technology adjuncts might be a more sound strategy for learning about these approaches in children. Moreover, there is evidence from the adult obesity treatment literature to support this methodology.[24]

The primary purpose of the current study is to examine the effect of three Health Hawks (HH) cohorts, two of which include the addition of various technology components alongside a 12-week FBBG treatment program, on changes in child BMI-z postintervention. Secondary aims examine the effect of technology adjuncts on feasibility, engagement, retention, and change in child BMI-z.

Methods

Intervention Design

The three cohorts in this study (FBBG, TECH1, TECH2) were part of HH, a multicomponent pediatric obesity intervention designed to improve weight status in children with overweight and obesity.[25] Parents and children in all three cohorts participated in 12 weekly 2-hour FBBG sessions, which included 1-hour educational sessions on strategies to promote behavior change (*i.e.*, goal setting, self-monitoring, parent role modeling, diet/physical activity/lifestyle modification) and 1 hour of physical activity. Parents and children were separated for the first hour; parent groups were organized based on language preference (English/Spanish), children were placed into groups based on age, and all child sessions were conducted in English. The stoplight diet was used as a framework for promoting dietary changes[26] and strategies for increasing physical activity were presented and practiced as a group during the second hour. Parents and children were given daily self-monitoring sheets to track servings of ''red foods'' (*i.e.*, foods high in calories and fat and low in nutrients), servings of fruits and vegetables, and physical activity. Parents were given pedometers to track daily steps and children received incentive points each week for returning their self-monitoring sheets.

Children were referred by their physician, and rolling, nonrandomized recruitment was used to enroll participants in the program in an ongoing basis. The three cohorts were implemented using a pre/post design and a new cohort was implemented approximately every 4 months with FBBG implemented in May 2014, TECH1 in September 2014, and TECH2 in February 2015. Participants recruited between February 2014 and May 2014 participated in the FBBG cohort. Participants recruited between June 2014 and September 2014 participated in the TECH1 cohort, and participants recruited between October 2014 and February 2015 participated in the TECH2 cohort. In addition to receiving the standard 12-week FBBG intervention, the enhanced cohorts in this study (TECH1, TECH2) received technology adjuncts added alongside the 12-week HH program. The

FBBG ($n = 21$) received the standard 12-week FBBG treatment only and no technology components; TECH1 ($n = 20$) received the FBBG sessions plus one technology component—digital tablets equipped with a fitness app (FITNET), to increase physical activity at home; TECH2 ($n = 23$) received the FBBG sessions and two technology components—the digital tablets with the fitness app and individual TeleMed health-coaching sessions delivered via Skype. Additional details of the technology components are presented below and a description for each cohort is presented in Figure 1.

Participant Eligibility

Children and their families were recruited from urban pediatric clinics in the Kansas City area. Children were referred and eligible to enroll if they had a BMI ≥85th percentile, were 2–18 years of age, and did not have a diagnosis that would make participation in a group setting difficult without individualized support (*e.g.*, severe autism spectrum disorder). At least one parent had to agree to attend program sessions and complete measures. However, another innovative aspect of this study was that all family members were invited to attend sessions and participate. If the enrolled children had a sibling attend the HH program who was eligible based on the criteria specified above, the sibling was also enrolled. The Institutional Review Board at the University of Kansas Medical Center approved all study procedures.

Technology Delivery for TECH1 and TECH2 Cohorts

Each family in TECH1 and TECH2 received a digital tablet (Apple iPad with Retina Display, 16GB, Wi-Fi + Verizon LTE, 4th Generation) equipped with a data plan for the duration of the 12-week intervention. All participating families were guided on how to use the tablets in the first group session and encouraged to bring their tablets to the weekly sessions to troubleshoot any issues. Families had to return the digital tablets at the end of the 12-week program.

FITNET. FITNET was implemented in TECH1 and TECH2. FITNET is a free physical activity app that can be downloaded from the App Store. The app features workout videos of varying lengths and difficulty levels (*e.g.*, yoga, strength conditioning, and dance fitness), and was used to encourage and guide child physical activity at home. The app integrates theoretically supported behavioral change strategies such as goal setting, feedback, and personal tailoring. FITNET was downloaded on the tablets and each family was given their own program-specific login. While the accounts were open to the entire family, families were instructed to use the app (1) together or (2) parents could guide the child's use of FITNET or (3) older children could use the app independently. Participating children were initially instructed to use FITNET for 30 minutes per week. The usage goal increased every week, with the ultimate goal of reaching the recommended 60 minutes of physical activity per day for children.[27] Total FITNET usage was recorded in minutes per week from the data report automatically generated by FITNET.

Web-based health coaching sessions. In addition to FITNET, TECH2 participants received tailored health coaching videoconferencing sessions via Skype on the digital tablets. Trained health coaches provided individualized, one-on-one support for each family, addressing questions and challenges specific to parents and their children, and

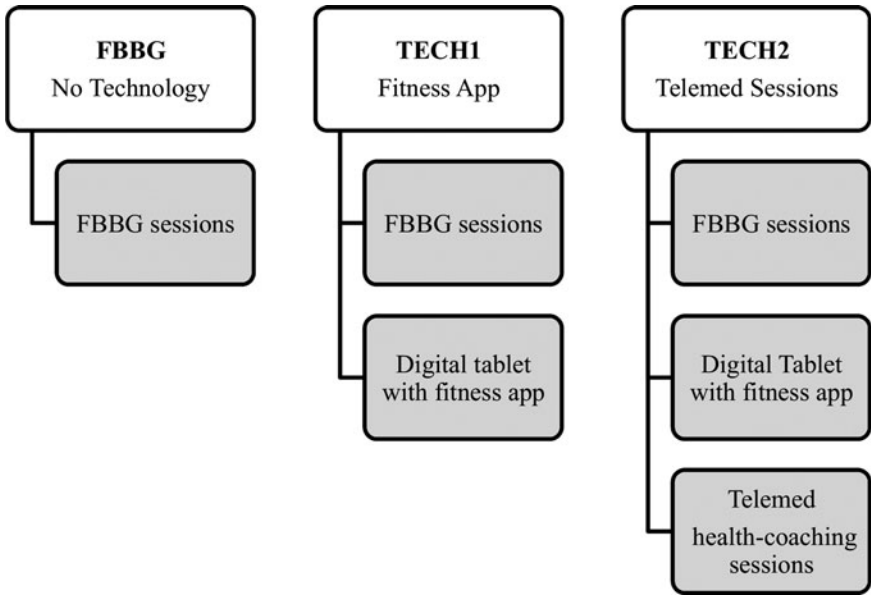

Figure 1. Intervention components for each cohort; FBBG ($n = 21$) received the standard in-person sessions only; TECH1 ($n = 20$) received FBBG sessions and a digital tablet equipped with a fitness app; TECH2 ($n = 23$) received FBBG sessions, a digital tablet with fitness app, and web-based health-coaching sessions.

sessions were conducted in Spanish or English depending on family preference. Before conducting sessions, the health coaches were trained on protocols, motivational interviewing, and behavior modification techniques. Sessions were scheduled every other week and were anticipated to last 30 minutes, but some families opted to alter this schedule based on availability and calls lasted as long as needed. The goal for each family was to receive five sessions and the purpose was to reinforce teachings from the FBBG program. While it was encouraged that the calls be conducted together as a family, the attendance for each call could vary between families. Families and health coaches were given unique, program-specific usernames and Skype accounts to ensure personal security. In addition, the health coaching team met regularly to discuss common challenges presented by families, review recommendations, and troubleshoot any technology issues.

Measures

Participants completed measures at baseline and postintervention (12 weeks). Parents self-reported race/ethnicity (white/Caucasian, black/African American, Hispanic/Latino, other), date of birth, gender (male/female), and insurance status (private, Medicaid, no insurance) for themselves and their child at baseline. Although no data were collected on the use of government assistance, educational attainment, or household income, self-reported insurance status was used as a proxy of socioeconomic status. Trained program staff objectively collected anthropometric data. Child height and weight were measured with participants wearing light clothing and no shoes. Height was measured in centimeters using a stadiometer (Holtain Ltd., Crymych, Dyfed, United Kingdom), and weight was measured in kilograms using a digital scale (Temp-StikDigitron 8000 digital scale National Medical Corp., Temp-Stikcorp). Height and weight were used to calculate BMI, and BMI *z*-scores and percentiles were calculated using appropriate age- and sex-specific cutoffs for height and weight.[28]

Process measures included attendance at the 12 in-person FBBG treatment sessions, FITNET usage, and TeleMed session participation. Total FITNET usage was objectively reported in minutes per week and recorded directly from the data report automatically generated by FITNET. The trained health coaches tracked TeleMed session attendance and completed reports to summarize the topics discussed with each family. Acceptability surveys were developed for this study to assess FITNET use and TeleMed sessions. Parents in TECH1 and TECH2 responded to open-ended questions on FITNET acceptability and usage (*e.g.*, "What could be done to improve FITNET?"), although wording of the questions varied slightly for each cohort. TECH2 parents completed a postintervention survey assessing how helpful the TeleMed sessions were in achieving behavior change goals for both themselves and their children. Parents were asked to rate their experience separately from their child's and response options were rated on a 5-point scale (1 = not helpful; 5 = extremely helpful). Additional participant feedback was provided via open-ended questions (TeleMed Usage Survey: Appendix 1).

Analysis

Descriptive statistics were used to assess baseline participant characteristics. In-person weekly FBBG session attendance, FITNET usage, TeleMed session participation, and an acceptability survey, including open-ended questions, were summarized for completers. For the purpose of this study, participants were considered completers if child height and weight measures were collected at baseline and postintervention. T-tests and chi-squared tests assessed differences at baseline between cohorts, and between completers and noncompleters postintervention. Linear regression models were used to examine BMI-z change for each cohort (FBBG, TECH1, and TECH2). Model 1 controls for clustering by family only and Model 2 controls for clustering by family, race/ethnicity, and gender. One-way analysis of variance (ANOVA) was used to examine differences in BMI-z change between the three cohorts. Finally, linear regression models were used to examine the intervention components (*i.e.*, treatment attendance, FITNET usage, and TeleMed sessions) as predictors of child BMI-z change in each of the TECH cohorts. Model 3 tested FITNET usage and treatment attendance on BMI-z change in TECH1, while Model 4 tested FITNET usage, treatment attendance, and TeleMed sessions on BMI-z change in TECH2; both models controlled for clustering by family. All analyses were conducted using STATA version 14.

Results

Baseline descriptive characteristics are presented in Table 1. A total of 64 children were recruited and participated in one of the three cohorts (FBBG $n = 21$; TECH1 $n = 20$; TECH2 $n = 23$). On average, children were 9.6 ± 3.1 years of age, 32.8% female, 84.4% Hispanic, and had a mean BMI percentile (BMI%) of 98.6 ± 1.6. Parents were predominately Spanish speaking (68.8%) and all study parents were female (100.0%, $n = 61$). There were no differences between the three cohorts by child age ($F = 0.06$, $p = 0.90$), child gender ($\chi^2 = 5.6$, $p = 0.06$), parent language ($\chi^2 = 0.8$, $p = 0.69$), or child baseline BMI% ($F = 1.9$, $p = 0.20$), but the cohorts did differ in their racial/ethnic composition ($\chi^2 = 16.6$, $p = 0.01$) at baseline.

Retention and engagement data for completers are presented in Table 2 and described below. Although not significantly different ($\chi^2 = 1.2$, $p = 0.56$), postintervention retention rate was slightly lower in FBBG with 66.7% ($n = 14$) of children completing BMI follow-up at 12 weeks. TECH1 had 80.0% retention ($n = 16$) and TECH2 had 78.3% retention ($n = 18$). There were no differences between completers and noncompleters by child age [$F(1,62) = 0.2$, $p = 0.70$], child gender ($\chi^2 = 0.02$, $p = 0.88$), race/ethnicity ($\chi^2 = 1.6$, $p = 0.67$), parent language ($\chi^2 = 1.6$, $p = 0.21$), or child baseline BMI% [$F(1,62) = 2.1$, $p = 0.15$].

Table 1. Baseline Descriptive Characteristics and Differences by Cohort

	Total ($n = 64$)	FBBG ($n = 21$)	TECH1 ($n = 20$)	TECH2 ($n = 23$)	p value
Age (years)	9.6 (3.1)	9.8 (1.4)	9.5 (3.6)	9.5 (3.2)	$F(61) = 0.06$, $p = 0.90$
Gender (% male)	67.2	47.6	80.0	73.9	$\chi^2 = 5.6$, $p = 0.06$
Race/Ethnicity (%)					$\chi^2 = 16.6$, $p = 0.01$*
White	1.6	0.0	5.0	0.0	
Black	12.5	33.3	0.0	4.3	
Hispanic	84.4	66.7	90.0	95.7	
Other	1.6	0.0	5.0	0.0	
Language (% Spanish)	68.8	42.9	75.0	72.2	$\chi^2 = 0.8$, $p = 0.69$
BMI percentile	98.6 (1.6)	98.7 (1.4)	99.1 (0.6)	98.2 (2.2)	$F(61) = 1.9$, $p = 0.20$

*$p < 0.05$.

FBBG, family-based behavioral group cohort; TECH1, technology 1 cohort; TECH2, technology 2 cohort; BMI, body mass index.

FBBG participants attended an average of 10.3 ± 1.1 in-person treatment sessions out of 12. Participation in TECH1 and TECH2 was slightly lower, with an average of 9.4 ± 2.0 and 9.6 ± 2.0 sessions, respectively. All but three families in TECH1 (81.3%) and every family in TECH2 (100.0%) used FITNET at least once. The total number of usage minutes in TECH1 was 225.2 ± 148.4 compared to 425.4 ± 275.6 minutes in TECH2. Participants in TECH2 used FITNET significantly more than participants in TECH1 ($F = 5.6$, $p = 0.02$). Every family in TECH2 received at least one TeleMed session and almost half (44.5%) received the goal of five sessions or more ($M = 3.4 \pm 1.7$). TeleMed sessions were intended to be 30 minutes and on average lasted 30 minutes to 1 hour. Health coaches reported requiring significant time and multiple call attempts to reach families, so the total time period to make and complete calls was about 1–2 hours. Typically, parents and children attended sessions together, but occasionally, just parents or just children would participate due to scheduling conflicts for the entire family. The primary topics covered in the sessions as reported by the health coaches included specific goal setting, reinforcing benefits of physical activity and healthy eating, addressing reported barriers to making lifestyle changes (*e.g.*, lack of time, knowledge), initiating and supporting new routines, and reviewing content from weekly FBBG sessions, especially if families missed a session.

Child BMI z-Score

FBBG and TECH1 participants had no significant change in BMI-z postintervention [$\beta = -0.05$ (0.04), $p = 0.25$, and $\beta = -0.006$ (0.06), $p = 0.92$, respectively] (Table 3). TECH2 did have significant reductions in child BMI-z [$\beta = -0.09$(0.02), $p < 0.001$], but results from ANOVA indicated that the between group differences are not significant ($F = 1.11$, $p = 0.34$). In Model 3, when FITNET usage and treatment sessions were tested as a predictor of BMI-z change, FITNET usage was not significantly associated with change in TECH1 [$\beta = 0.0009$ (0.0005), $p = 0.13$] nor was treatment session attendance [$\beta = 0.02$ (0.02), $p = 0.40$]. In Model 4, TeleMed session participation emerged as a

Table 2. Completers' Intervention Participation Data by Cohort

	FBBG $n = 14$	TECH1 $n = 16$	TECH2 $n = 18$	p value
Retention postintervention	66.7%	80.0%	78.3%	$\chi^2 = 1.2$, $p = 0.56$
Treatment session attendance	10.3 (1.1)	9.4 (2.0)	9.6 (2.0)	F (2,45) = 1.0, $p = 0.37$
FITNET usage (minutes)	—	225.2 (148.4)	425.4 (275.6)	F (1, 29) = 5.6, $p = 0.02$*
		$n = 13$		
Skype session attendance	—	—	3.4 (1.7)	—

Treatment session range 5–12 sessions; TECH1 FITNET usage range 41–507 minutes.

TECH2 FITNET usage range 53–873 minutes; TECH2 Skype session range 1–6 sessions.

*$p < 0.05$.

Table 3. BMI z-Score Change Postintervention for Each Cohort

		β (SE)	CI	p value
FBBG				
Model 1[a]		–0.05 (0.04)	(–0.13, 0.03)	0.25
Model 2[b]		–0.06 (0.05)	(–0.16, 0.04)	0.22
TECH1				
Model 1[a]		–0.006 (0.06)	(–0.13, 0.12)	0.92
Model 2[b]		–0.0003 (0.06)	(–0.12, 0.12)	0.99
Model 3[c]	Treatment sessions	0.02 (0.02)	(–0.02, 0.05)	0.40
	FITNET usage	0.0009 (0.0005)	(–0.0003, 0.002)	0.13
TECH2				
Model 1[a]		–0.09 (0.02)	(–0.14, –0.05)	<0.001***
Model 2[b]		–0.09 (0.02)	(–0.14, –0.04)	<0.001***
Model 4[d]	Treatment sessions	–0.01 (0.01)	(–0.03, 0.01)	0.18
	FITNET usage	0.00002 (0.00007)	(–0.0001, 0.0002)	0.80
	TeleMed sessions	–0.04 (0.01)	(–0.06, –0.01)	0.01*

[a]Model 1 is adjusted for clustering by family.

[b]Model 2 is adjusted for clustering by family, gender, and race/ethnicity.

[c]Model 3 is adjusted for clustering by family and includes treatment session attendance and FITNET usage as predictors of BMI z-score change.

[d]Model 4 is adjusted for clustering by family and includes treatment session attendance, FITNET usage, and TeleMed session participation as predictors of BMI z-score change.

*$p < 0.05$.

***$p < 0.001$.

β, beta coefficient; SE, standard error; CI, 95% confidence interval.

significant predictor of BMI-z change [$\beta = -0.04$ (0.01), $p = 0.01$]. FITNET and treatment session attendance were not significant [FITNET $\beta = 0.00002$ (0.00007), $p = 0.80$; Treatment sessions $\beta = -0.01$(0.01), $p = 0.18$].

Treatment Acceptability

Overall, 100% of TECH2 parents reported that the online sessions were ''very'' or ''extremely'' helpful in enhancing their ability to reach *their own* health goals ($M = 4.4 \pm 0.5$), 90% rated them just as helpful for their *children* ($M = 4.3 \pm 0.7$), and 100% said they would be ''very'' or ''extremely'' enthusiastic to recommend online sessions to other families ($M = 4.8 \pm 0.5$). Parents reported that the online sessions ''*helped to keep my daughter active*,'' ''*motivated us*,'' and ''*when I had doubts they helped me find the solution*.'' Other parents expressed benefits related to health behavior change such as ''*learning a lot of things…to eat portions and fruits, vegetables*,'' and ''[my kids] *want to do more and more exercises*.''

In response to open-ended FITNET acceptability surveys, participants reported ''*Exercises are very good for my child…''* and ''[there are a] *variety of hard and easy exercises*.'' TECH1 participants who completed a survey said they would use FITNET if it were available after the program ended, and participants in TECH2 who completed a survey reported that FITNET was very helpful for becoming active, and helped them stay active.

Discussion

The purpose of the current study was to assess the addition of technology components to an existing pediatric obesity treatment program. To our knowledge, this is the first study to examine technology adjuncts in a family-based treatment program in low-income, minority youth. Participants in the TECH cohorts successfully used the provided technology components and this engagement did not seem to displace participation in in-person sessions. In addition, both TECH cohorts had slightly higher retention postintervention. There has been a great deal of attention in recent years focused on how to get low-income, minority participants to stay in weight-loss programs,[29] and our results suggest that supplementing treatments with TeleMed support may be one option to consider.

Interestingly, TECH2 is the only cohort that demonstrated significant changes in BMI-z postintervention.

FBBG and TECH1 participants did not see significant changes in child weight status postintervention. Although the standard HH intervention has been shown to be effective when implemented alone, observed changes in child weight status after participation in the 12-week FBBG program are modest.[25] The sample size in the FBBG and TECH1 cohort was small and therefore not powered to detect change, but these null findings could also suggest that the HH program might require optimization, such as web-health coaching enhancements, to produce efficacious results.

When assessing technology usage, TECH1 participants used FITNET for an average of approximately 20.5 minutes per week and TECH2 participants used FITNET about 38.7 minutes per week. While this indicates that participants were somewhat successful in reaching the initial goal of 30 minutes per week, they did not increase their goals or their FITNET usage over the course of the study. This might suggest that participants did not find the technology as supportive in helping them reach their daily 60-minute physical activity goals, or that other strategies and activities presented in the group sessions were more appealing (*e.g.*, outdoor activities, physical activity games, and sports). Additional questions in follow-up surveys could have probed for this information and should be included in future studies. TeleMed session participation in TECH2 was significantly associated with reductions in BMI-z, and participants in TECH2 used FITNET significantly more than participants in TECH1. Therefore, it is possible that the TeleMed sessions increased participants' self-efficacy for using other technologies, or participants were able to receive tailored support for the FITNET app during their TeleMed sessions. More rigorous study designs, that include randomization, baseline evaluations of technology use, and well-measured changes in technology-related self-efficacy, would help disentangle these findings.

While implementing the technology components, there were some barriers and challenges. The most common technology issue was weak or inconsistent Internet connection. While we do not fully know the extent to which this impacted FITNET usage, this was an issue during the web-based health coaching calls. Some calls were dropped or required multiple attempts to establish a good connection. Another barrier for participants was logging out and logging back in. Many had issues remembering passwords or using proper tabs (*i.e.*, ''login vs. sign up''). Finally, specific to the web-based health coaching sessions, some families had issues with the cameras on their tablets and would only be able to use voice call instead of video. Despite these barriers, the health coaching sessions were very well received and seem to have positively impacted child weight status. The tailored one-on-one support provided by health coaches could have been very impactful in addressing issues and challenges that families did not have time to discuss in the weekly group sessions, or did not feel comfortable talking about in a group setting.

Although this study provides exciting evidence for the use of technology in pediatric obesity treatment, there are limitations. First, this was a treatment-seeking sample from an ongoing clinical program, and children were not randomly assigned to cohorts, limiting experimental control and subsequently the conclusions that can be drawn. Second, all participants in the TECH cohorts were provided with digital tablets and data plans to use for the duration of the study, limiting external validity. Next, technology malfunctions could have disrupted participants' ability to use the technology as intended, presenting a threat to internal validity. All participating parents were female, presenting another limitation. While there were no specific efforts to recruit dads, all adults living in the household were encouraged to attend the weekly FBBG sessions. In the future, auxiliary adults who attend should be tracked and measured. Also, child comorbidities were not assessed, limiting an understanding of the challenges facing children and families in achieving health behavior change and child weight reduction. Finally, as a pilot study, all family members in the respective TECH cohorts were invited to use the fitness app and participate in the TeleMed health coaching sessions. Families were assigned a single digital tablet with one user account for Skype and one user account for FITNET. Therefore, we were unable to determine who actually used the technology and for how long. In addition, we cannot examine how parents and children might have varied in their use of the components, or if parents and children found the various technology components differentially acceptable.

While the technology was generally accepted, it is interesting to note that three families refused to accept and use the digital tablets out of concern for them getting lost or broken, even despite being told that they would not be held responsible. At the end of the study, all tablets distributed to study families were returned without any damage. Future studies should examine the willingness of participants to use their own technology devices to better understand the potential for dissemination. Dissemination approaches are likely feasible, even in hard-to-reach populations, given that 68% of adults in the United States have a smartphone, and even among low-income households, more than half (52%) are smartphone owners.[30] More research is also needed to learn how overall technology usage intersects with technology used for obesity treatment, especially given that excessive use of these platforms, including tablets and smartphones, is associated with obesity and related risk factors.[31] Future studies should more carefully look at how participant characteristics influence the usage of technology intervention components. For example, the effect of child age should be examined to better understand if older or younger children and their parents participated differentially. If so, strategies to better capture individual engagement are needed (*e.g.*, weekly reporting via survey of who used the technology in the previous week). Finally, the version of Skype that was used for this study did not provide tracking data on sessions. Future studies should use an upgraded version of Skype or other web-based communication platforms that track call

attempts, call duration, and session frequency. These data could be very useful for understanding how much time health coaches invested in providing tailored support to each family.

In summary, this study contributes novel information regarding the use of technology components as adjuncts to family-based interventions for pediatric obesity treatment in low-income, minority youth. Technology components, specifically digital tablets with a fitness app and TeleMed health coaching sessions, are typically used even by hard-to-reach populations and are deemed highly acceptable when the necessary equipment is provided. Additionally, these findings support the use of TeleMed health coaching as a promising strategy for improving child BMI-z in treatment programs and suggest that this technology addition might improve outcomes by providing tailored treatment support to families. Future studies should examine technology-based enhancements with larger samples, using designs that isolate effects.

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(*Appendix follows* →)

Appendix: The Health Hawks Online Skype Health Coaching Satisfaction Survey

These ratings are based on YOUR experience. Overall, how helpful to you were the online Skype health coaching meetings for:

	1 = Not Helpful	2 = Little Helpful	3 = Moderately Helpful	4 = Very Helpful	5 = Extremely Helpful
Reaching your HH behavior goals?	1	2	3	4	5
Improving your physical activity?	1	2	3	4	5
Improving your healthy eating behaviors?	1	2	3	4	5
Improving your parenting skills?	1	2	3	4	5
Improving role modeling for your child?	1	2	3	4	5
Learning positive reinforcement of your child's behavior?	1	2	3	4	5

The following ratings are based on your CHILD/CHILDREN'S experience. Overall, how helpful were the online Skype health coach meetings for:

	1 = Not Helpful	2 = Little Helpful	3 = Moderately Helpful	4 = Very Helpful	5 = Extremely Helpful
Helping your child reach his/her behavior goals?	1	2	3	4	5
Improving your child's physical activity?	1	2	3	4	5
Improving your child's healthy eating behaviors?	1	2	3	4	5
Improving your child's enjoyment of the HH program?	1	2	3	4	5

Do you have another device on which you can use Skype if we did not provide the iPad?	Yes	No
Do you have Internet access at your home?	Yes	No

	1 = not enthusiastic	2 = Little enthusiastic	3 = Moderate enthusiastic	4 = Very enthusiastic	5 = Extremely enthusiastic
How enthusiastically would you recommend Skype coaching sessions for other families?	1	2	3	4	5

1. How specifically did the use of the iPad and the online Skype health coaching sessions help you reach your goals?
2. Do you wish you had more or fewer calls? Why?
3. What did you like most about the online Skype health coach calls? What did your child like most about the online Skype health coach calls?
4. How would you change the online sessions to make it more beneficial for you and your child?
5. Please provide any other thoughts and comments about the online Skype health coaching sessions here.