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ORIGINAL RESEARCH

A digitally enhanced home-based physical activity intervention for high-risk middle school youth during COVID-19

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Abstract

COVID-19 significantly impacted physical activity among high-risk youth. *Camp from Home,* a digitally enhanced home-based intervention, was developed to address physical activity disparities among middle school youth during COVID-19. *Camp from Home* enrolled 62 youth in 54 families from five schools in Philadelphia during the summer of 2020. The 6-week intervention comprised of (1) three home deliveries of "activity kits" including exercise equipment and activity booklets, (2) asynchronous sport and exercise videos posted to a private YouTube channel, and (3) supportive text-messages from health coaches. YouTube analytics and self-report surveys completed by parents and youth at baseline and at the end of programming were used to assess engagement, acceptability, and preliminary efficacy. Youth participants were 12.4 (1.2) years, 38.7% female and 90.3% Black/African American. At follow-up, 41 parents (75.9%) and 34 youth (54.8%) completed measures. Youth self-reported increases in self-efficacy (ΔM(sd) = 0.4(1.0), p = .03) and physical activity (ΔM(sd) = 4.2(7.9), p = .004), despite suboptimal engagement in digital program components. Overall, participants highly rated the program. Activity kits and text-messages from health coaches were rated as most helpful. Most parents (95.1%) and youth (83.8%) expressed interested in participating again in the future. A 6-week digitally enhanced, home-based physical activity intervention was acceptable and feasible among parents and youth during the summer of 2020, with youth reporting improvements in self-efficacy and physical activity. Summer programs are critical for reducing disparities in physical activity and hold potential for addressing key barriers for high-risk youth even outside the context of COVID-19.

Keywords

Physical activity, Adolescents, Behavioral intervention, Pediatric obesity, Health disparities

Implications

Practice: A digitally enhanced home-based intervention can be successfully delivered to high-risk middle school youth and shows promise for improving self-efficacy and physical activity.

Policy: This type of program, which includes the provision of home-based intervention materials, should be made available to youth residing in low-resource communities, during the COVID-19 pandemic or as appropriate in other contexts where physical activity resources are inadequate, such as the summer.

Research: Future studies should use a randomized controlled trial to examine optimal intervention components and dose, and more rigorously assess impact on physical activity and related disparities for high-risk youth.

BACKGROUND

Disparities in key health behaviors, including physical activity, remain a pressing public health issue that disproportionately affect racial/ethnic minority youth and those from families with lower income [1, 2]. Disparities in key health behaviors observed among youth have also been shown to persist into adulthood, thus perpetuating socioeconomic and demographic health inequalities among adults [3–5]. Adolescence is a crucial period for targeted health promotion efforts because youth experience rapid cognitive development, greater independence, and a greater sense of control over their behavior [6]. Health disparities are driven by a myriad of factors including the social determinants of health, and efforts aimed at targeting these factors can improve outcomes for youth disproportionately at risk for chronic disease [7]. Targeted interventions that aim to improve behaviors like physical activity can help adolescents establish positive health behaviors that last into adulthood, which could reduce long-term chronic disease morbidity and mortality risk [8, 9].

The already pressing public health issue of disparities among high-risk adolescents was compounded by the emergence of SARS-Cov2 (COVID-19) in March 2020 [10]. There was immediate concern that COVID-19 would increase health disparities among the most vulnerable youth, given that schools serve as a key source of resources and programming including nutrition (via school food programs) and physical activity (via walking to school, recess,

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afterschool sports) [11]. In addition to school closures, parks and recreation facilities were closed, youth sports programs were cancelled, and students were transitioned to online activities that increased the amount of time engaged in sedentary activities [12]. Urban youth were disproportionately affected by these changes due to the limited access to safe outdoor space for physical activity [11]. In order to attenuate the potential increase in disparities caused by COVID-19, a digitally enhanced home-based PA intervention was developed for youth from middle schools previously participating in an afterschool intervention (i.e., *Game on Philly*). This adapted program (i.e., *Camp from Home*) was pilot tested during the summer of 2020.

Summer is well recognized as a high-risk time for vulnerable youth since they typically lack access to programs and resources that are available during the school year [13, 14]. Therefore, it was a key concern that disparities would increase due to additional barriers like lack of access to technology and household resources during COVID-19 [11]. The issue of access is especially important to consider for racial/ethnic minority adolescents from lower income communities, as interventions that do not consider the unique barriers and needs of marginalized groups are ineffective and can exacerbate disparities [15]. *Camp from Home* was developed to address key barriers that families encountered during COVID-19 and leveraged readily available technology (e.g. text-messages and YouTube) to provide sport and exercise activities that could be done safely at home. Sport and exercise equipment was delivered directly to participants' homes and health coaching was included to integrate supportive and motivational components shown to be effective in engaging youth for behavior change [16]. The goal of *Camp from Home* was to develop a summer program to address physical activity disparities experienced by high-risk youth during COVID-19 and determine the preliminary efficacy, feasibility, and acceptability of a digitally enhanced home-based intervention to promote physical activity. Although tested within the context of COVID-19, findings could inform implications beyond the context of a global pandemic.

METHODS

Sample and procedure

Camp from Home was a physical activity intervention that was developed in the summer of 2020 in response to COVID-19 and represented a continuation of an in-person afterschool intervention that was being delivered during the 2019–2020 academic year (*Game on Philly*). For the initial in-person program, schools were selected based on location within Qualified Opportunity Zones (i.e., economically distressed community) and student-level socioeconomic (i.e., percent of students receiving free-or-reduced priced lunch) and demographic (i.e., race and ethnicity) data. In addition, the research team consulted with the Office of Athletics at the School District of Philadelphia to identify schools that did not currently offer afterschool sport programming and selected schools from the qualifying list based on need. When the *Game on Philly* in-person intervention was cancelled in March 2020 due to the COVID-19 pandemic, all participating schools were invited to participate in the adapted home-based intervention, *Camp from Home*, during summer 2020. Five of the six participating schools agreed to continue participation.

The 6-week *Camp from Home* program was developed to address key barriers experienced by youth and families during the COVID-19 pandemic and comprised three key components aimed at helping youth reach the recommended threshold of 60 min of physical activity per day [17]. The programming model was guided by Social Cognitive Theory (SCT) and promoted key constructs of self-efficacy and self-regulation (e.g., self-monitoring and goal-setting) shown to be effective for achieving behavior change in high-risk youth [18, 19]. First, three home deliveries of "Activity kits" were made at the beginning, middle, and end of the intervention. Activity kits included fitness and exercise equipment (e.g., basketballs, yoga mats), fresh produce, information to support program activities (e.g., healthy recipes, goal-tracking, and self-monitoring sheets) and incentives for goal achievement (e.g., water bottles in the second and third deliveries). These kits were intended to provide educational materials and to facilitate self-monitoring and goal-directed action. Second, asynchronous digital sport and exercise videos were posted to a private YouTube channel and released to participants each week, resulting in a library of 92 videos by the end of the program. Videos were developed and recorded by sport-based youth development organizations that responded to a request for proposals to contribute to the program curriculum. Videos included general fitness and exercise videos as well as sports-specific content such as martial arts and soccer. Finally, participants received daily text messages from health coaches on weekdays (i.e., Monday to Friday) throughout the 6-week program. The messages were delivered via Remind, an online mobile messaging platform, with the goal of providing participants with positive reinforcement to prompt and support goal-directed behavior and offer reminders about key program activities. Some messages were personalized and promoted self-monitoring (ex., *Hi [Name] - did you earn any stars this week? For 5 stars you'll earn a prize!*), while other messages were intended to provide positive reinforcement for goal-directed behaviors (ex., *Great job!!*), or answer specific parent and child questions (ex., *Parent: [My daughter] wants to learn soccer*; *Coach: Next week there will be a ton of soccer videos* ☺). Messages were delivered to both adolescent participants (if parents consented and provided a contact for

their child) and parents directly. Almost all parents (96.3%, n = 52) agreed to the receive the daily text messages and parents gave permission for 77.4 % (n = 48) of the students to receive the daily text messages directly their child's cell phone (note: it was not assessed whether students had their own phones, but lack of a personal phone could have contributed to the lower rate among youth). Both parents and youth could respond to health coaches by replying to text messages and health coaches were encouraged to engage in back-and-forth communication with parents and youth as much as possible.

A total of 62 participants (aged 9–14 years) from 54 families enrolled from the five public middle schools that participated in the *Camp from Home* program. Since the primary focus of this study was to evaluate the acceptability and feasibility of the *Camp from Home* program, it was not considered human subjects research as defined by U.S. Department of Health and Human Services (DHHS) or U.S. Food and Drug Administration (FDA) and thus received an exemption from xx [blinded for review] University's Institutional Review Board (IRB). Participation in the evaluation components were voluntary and parents and youth had the opportunity to opt-out of the study but still participate in the program (70 youth from 60 families were signed up for the program, but 8 youth did not complete baseline data collection). Parents and youth completed abbreviated self-report surveys at baseline and at the end of the intervention to minimize participant burden. Surveys were modified for digital administration via REDCap and could be completed via phone by trained study staff, or via email or text-message to facilitate access and completion.

Measures

Parents and children completed surveys at the beginning and end of the six-week program. Parents reported child's demographics (child sex, race/ethnicity, age, grade), household characteristics including availability of technology devices in the home, and their own perceived digital literacy at baseline. At follow-up parents completed program acceptability surveys. At baseline and follow-up youth completed self-reported surveys about dietary and physical activity behaviors. Survey questions assessed program acceptability among youth at follow-up. Additional details on measures are provided below.

Youth physical activity

Self-reported physical activity was measured at baseline and end of the program using the four-item Patient Reported Outcomes Measurement Information System (PROMIS) Pediatric Short Form v1.0 — Physical Activity [20, 21]. This scale assesses weekly physical activity through questions such as "How many days did you exercise so much that you breathed hard?" and "How many days did you exercise or play so hard that your body got tired?" Responses were recorded on a five-point Likert scale with endpoints ranging from *No days* (1) to *6–7 days* (5). Consistent with recommended conventions for analyzing PROMIS results, raw scores were converted into standardized *T*-scores [22]. Cronbach's alpha at both baseline (α = 0.906) and follow-up (α = 0.831) indicated strong internal reliability.

Youth self-efficacy

Child self-efficacy for physical activity was measured at baseline and end of the program using a five-item scale adapted from its original eight-item version to better reflect the unique situation presented by the COVID-19 pandemic [23]. For example, the items stating "I can ask my best friend to be physically active with me" and "I can be physically active most days after school" presented scenarios that were not plausible given statewide restrictions on social gatherings at the time of the study, and were thus removed. The remaining five questions assessed youth's belief that they can be physically active in consideration of various circumstances, such as "I can be physically active even if it is very hot or cold outside" and "I can be physical active no matter how busy my day is." Responses were recorded on a five-point Likert scale with endpoints ranging from *Strongly Disagree* (1) to *Strongly Agree* (5). Cronbach's alpha at both baseline (α = 0.790) and follow-up (α = 0.768) indicated good internal reliability.

Home availability of technology

To assess the availability of digital devices and technology in the home, an adapted brief scale to assess physical activity and sedentary equipment in the home was used [24]. The scale measures the availability (yes/no) of 13 different technology devices in the home and has been found to be reliable with parents of adolescents. Perceived digital competency was assessed with four questions related to the technologies used by the *Camp from Home* program. Specifically, parents were asked to rank their level of comfort "Downloading and learning how to use a new app," "Accessing videos on YouTube," "Completing surveys online," and "Receiving text messages about the program." Responses were recorded on a four-point Likert scale ranging from *Not at All Comfortable* (1) to *Very Comfortable* (4).

Program acceptability

Parent program acceptability was assessed through a series of questions that asked how much their children liked the program and how helpful it was for their health using a consistent five-point Likert response scale (*Not at all helpful* (1) to *Extremely Helpful* (5)). Feasibility questions also asked about the helpfulness of each program component using the same scale. Children were asked about the activity kit

deliveries, text messages via the Remind App, their health coaches, the workout videos, and overall program engagement. Both parent and child surveys included open-ended questions to solicit additional insights or feedback on the program. Responses to open-ended questions were taken verbatim from surveys and grouped based on key themes to synthesize and summarize findings. Illustrative quotes were selected to represent key themes expressed by parents and youth (separately) in response to open-ended prompts.

Digital engagement

Digital engagement was measured using YouTube Analytics downloaded from the *Camp from Home* private YouTube channel. Because videos were posted at different times throughout the intervention, data related to reach and engagement were analyzed at the aggregated channel level. Specifically, "views" provided an indication of the overall number of channel views, "watch time" (in hours) provided the total viewing time of all channel content from the audience, and "average views per viewer" indicated the average number of times a viewer watched any video on the channel. Data were extracted and organized by date to assess patterns in user engagement over the course of the 6-week intervention. To further examine user engagement, summative metrics related to audience retention were extracted and organized by video. Specifically, "average view duration" provided the average minutes watched per view for a specific video and "average percentage viewed" indicated the average percentage of a particular video that the audience watched per view.

Analysis

Descriptive statistics were used to summarize demographic characteristics of the youth participants, parent survey responses regarding technology use, and overall program acceptability. Data reported by parents were summarized at the family level and youth data are presented for each individual. Survey data are presented as means (SD) for continuous variables and percentages for categorical variables. For the primary outcomes, paired sample *t*-tests were used to examine changes in perceived self-efficacy and physical activity between baseline and the end of the program. To analyze trends in digital engagement, days were dichotomized into a binary variable representing weekdays (i.e., Monday–Friday) and the weekend (i.e., Saturday and Sunday), and tests for the significance of mean differences (*t*-tests) were used to compare differences in average daily views and total watch time (in hours) on weekdays versus weekends. A one-way analysis of variance (ANOVA) was then utilized to test for the statistical significance of variation in average daily views across each week of the program. Finally, in addition to examining the average percentage viewed metric to understand user engagement, bivariate correlations were run to assess the association between the duration of *Camp from Home* videos and average view duration. All analyses were conducted in SPSS statistical software version 27.0 and Stata version 15.

Results

Sample characteristics are provided in Table 1. A total of 62 youth from 54 families participated in the program evaluation. Youth participants (n = 62) were 38.7% female and 61.3% male, 90.3% non-Hispanic Black/African American, and had a mean age of 12.4 (SD = 1.2) years. Parents (n = 54) reported having an average of 4.4 (SD = 2.2) electronic devices available in the home. The most reported devices were Chromebooks or laptops (90.7%) and Smartphones (85.2%). Access to Internet/Wi-Fi was reported in 79.6% of homes. After these top three devices/technologies, there was a precipitous drop in terms of device availability, with all other devices available in less than half of participant's homes. The least common devices available in the household were non-Wi-Fi enabled video games (14.8%) and e-readers (13.0%). Parents also reported relatively high levels of digital literacy and skills, reporting they felt comfortable or very comfortable receiving text messages about the program (98.1%), accessing videos on YouTube (94.5%), downloading and learning how to use a new app (85.1%), and completing surveys online (83.3%). Forty-one parents (75.9%) and 34 youth (54.8%) completed

Table 1 | Demographic characteristics and home device availability (n = 62)

Youth participants	*M*(*SD*), %
Age (years)	12.4 (1.2)
Child sex	
Male	61.3%
Female	38.7%
Race	
Black/African American	90.3%
Other	4.8%
American Indian/Alaskan Native	3.2%
White	1.6%
Device availability in the home (n = 54)	% available in home
Chromebook or laptop	90.7%
Smartphone	85.2%
Internet/WIFI	79.6%
WIFI-enabled video games	40.7%
Tablet or iPad	40.7%
Desktop computer	20.4%
Home assistant (e.g., Alexa, Google Voice)	20.4%
Regular telephone	18.5%
Wearables (e.g., Apple watch, FitBit)	18.5%
Non-WIFI enabled video games	14.8%
E-readers (e.g., Kindle)	13.0%

the optional follow-up surveys. Though follow-up survey completion was suboptimal, no one formally withdrew from the program and there were no statistically significant differences in baseline characteristics between participants who completed both surveys versus baseline only ($p > .05$).

Program acceptability

A majority of parents (87.8%) reported the program was "helpful" or "extremely helpful" for their child's health over the summer and 97.6% reported the delivery of activity kits as "helpful" or "extremely helpful." Parents also rated the following as "helpful" or "extremely helpful" in response to the following program components: the delivery of sports equipment (97.5%), the delivery of fresh produce and recipes (97.5%), and text-messages from health coaches (82.9%). Most parents (95.1%) and youth (83.8%) expressed interest in participating in the program in the fall. When youth were asked what they thought of the program overall, 82.4% said they "liked it" or "loved it." When asked about how helpful the Remind messages were from their coaches, 79.4% of youth reported they were "helpful" or "extremely helpful," and 70.6% found the messages to be motivating. A majority of youth (82.4%) reported setting goals as part of the program and examples of goals included "learn to jump rope," "to do 100 push-ups by the end of the summer," "to get all the stars," "stay active" and "be more flexible."

Parents and children provided additional insights into their program experience through responses to open-ended questions. Parents commented about the safety of the home-based program, saying, "Bringing their own activities makes it safer for kids to have their own things to play with," and indicated that the program was "Very helpful and kept him out of trouble." Other parents shared that the whole family participated, stating "This program was motivating for the whole family, not just my child…we all loved it and took part in it!" and "It helped us try new things and new recipes…" Youth reported liking a variety of videos and sports including soccer, yoga, jump rope, kickboxing, martial arts, and basketball. Youth also provided excellent insight and feedback for program improvement including the following suggestions: "Videos with kids doing things would be nice since it's for us," "Videos were not diverse enough in terms of race and body types" and "Had Muslim representation which was helpful… but the ads in the video were annoying." Parent recommendations for future programs included an emphasis on opportunities for synchronous interaction that could provide youth with more support including "more meetings including all the members for the kids to talk" and "zoom options for workouts."

Preliminary efficacy

When examining the PROMIS composite measure of self-reported physical activity at baseline and follow-up, youth completers reported significant increases in physical activity at the end of the 6-week program (ΔM(sd) = 4.2(7.9), $p = .004$) as well as increases in self-efficacy for physical activity (ΔM(sd) = 0.4(1.0), $p = .03$). At follow-up, youth were asked a single item question about how many workouts they did per week during the program. Most youth (41.2%) responded that they completed 3–4 workouts per week, 29.4% said 1–2 per week, 11.8% said one per day and 17.6% said more than one per day or 6 or more per week.

Participant digital engagement

Almost all youth participants (91.2%) reported watching the workout videos during the program. A total of 1,513 views and 107 hours of watch time were generated from the 92 videos posted during the 6-week program with a total of 235 unique viewers. Youth reported that basketball, jump rope, kickboxing, soccer and martial arts videos were their favorites. The average total daily channel views were significantly higher on weekdays ($M = 45.83$, $SD = 34.10$) compared to weekends ($M = 11.50$, $SD = 17.37$), $t(40) = 3.03$, $p = .002$). ANOVA results indicated no statistically significant variation in average daily views ($F(5,36) = 1.092$, $p = .382$) or total watch time (hours) ($F(5,36) = 2.001$, $p = .102$) across the six weeks of programming. The average duration of sports and exercise videos created for the *Camp from Home* channel was 25:37 min, yet YouTube Analytics revealed user engagement was much shorter. The average percentage viewed was only 16.8% and the average view duration was only 4:16 min. Although the video was 29:37 min in duration, only 20% of viewers remained after the first 2 min and less than 10% of the audience remained after 10 min. This trend was evident across all videos posted to the *Camp from Home* YouTube channel. Interestingly, there was no statistically significant correlation between video duration and average view duration ($r = -.122$, $p = .248$), indicating longer videos were not associated with longer average views.

Discussion

This study examined the feasibility and acceptability of a 6-week home-based, digitally enhanced physical activity intervention developed for high-risk middle school youth, implemented during COVID-19. Overall, parents and youth reported high levels of acceptability for the program, with the home deliveries of program materials rated the most influential program component. Youth who completed measures at the end of the program reported increases in self-efficacy and physical activity, indicating signals for preliminary efficacy.

Implications

Parents reported comfort accessing the technology needed for the program and a majority of homes were equipped with the technology needed to

engage in the digital components of the intervention. However, it should be noted that parent reports of digital access may have been influenced by two key factors associated with the COVID-19 pandemic. First, in March 2020, the Pennsylvania Board of Education approved an $11 million request from the School District of Philadelphia to purchase 50,000 Chromebooks for students who may not have had access to technology while schools were closed due to the COVID-19 pandemic. In addition, Comcast provided free Internet for families residing in areas with Xfinity Wi-Fi coverage starting in April 2020. Thus, considering this survey was distributed in July 2020, it is likely that the percentage of families with access to Chromebooks or laptops and Internet/Wi-Fi was influenced by these factors. Indeed, a survey conducted by the School District of Philadelphia in 2019 found that only 52% of middle school students had access to the internet from a computer at home at that time [25]. This might also explain the precipitous drop in reported device availability after Chromebook/laptops and smartphones, as less than half of families reported having access to other technology devices in the home. Therefore, reported levels of technology access, specifically laptops and Wi-Fi, might not be generalizable outside the context of COVID-19.

Despite parental report of technology access in the home and comfort utilizing the digital tools for the intervention, overall engagement in the online YouTube videos was low. The custom sports and exercise content created for the 6-week intervention was viewed 1,513 times on the private YouTube channel with 107 h of total watch time across the program. In context, this translates to participants averaging 3–4 views and approximately 16 min of watch time per week, well below the goal of reaching 60 min of physical activity per day. While lower than expected, this does align with the average number of workouts self-reported by youth in the follow-up survey. To increase engagement, our findings suggest that videos need to be shorter in length (5–10 min, 3–5 min is optimal) and include more engaging content at the beginning to compete with other videos typically viewed on the platform. Per student suggestions, videos should also feature a diverse audience of youth who reflect them. These findings are helpful and can inform digital health program approaches for this age group after COVID-19. Also, participants may be more likely to engage with digital content after COVID-19 when they are less likely to experience digital fatigue from virtual schooling (e.g., "Zoom burnout") and other online activities that made them less interested in engaging with digital components of the intervention during the pandemic. Additionally, future approaches should consider monitoring and reinforcing completion of videos if they are an important component of the intervention dose.

Due in part to challenges induced by COVID-19, *Camp from Home* utilized asynchronous videos so that participants could engage with content at times that suited them and their families, which represents a departure from the synchronous formats used in many other digital physical activity interventions targeting adolescents [26]. Although perhaps more logistically feasible for families, the asynchronous format did not provide opportunities for participants to engage in interactive sessions with health coaches and peers, which has been shown to enhance engagement with digital interventions and motivate behavior change [27]. Indeed, most effective digital physical activity interventions, at least prior to the COVID-19 pandemic, had some type of face-to-face component, so replicating this aspect in the digital environment may help increase engagement [28, 29]. Although some previous research has offered encouraging evidence for asynchronous programming to improve physical activity, mostly in the form of active video games (e.g., Pokémon GO; fantasy sports), our results suggest real-time, dynamic interactions may be important to providing the type of rapid feedback and support that youth require in sport environments, especially at this age [30, 31].

Despite low digital engagement, participation in other program components appeared to help improve youth self-efficacy and physical activity during the program. The provision of sports and exercise equipment directly to participants homes, along with behavioral strategies like goal-setting and self-monitoring, were reported as helpful by youth and parents and promoted physical activity in ways that were fun for them and their families. Sports equipment included a basketball, soccer ball, yoga mat, body band, and jump rope. This type of equipment does not require video-based guidance for youth to be active and in some cases, following along to a video may have been inhibitory to youth activity. It is also possible that youth used this equipment outdoors or in spaces where it was logistically challenging to follow along to a video, especially if homes or apartments were smaller or crowded due to stay at home orders. The provision of sports and physical activity equipment has shown promise for improving physical activity in other settings, such as schools, but has not been tested in a home-based program for adolescents [32]. Given that resource constraints due to COVID mimic the common lack of resources available to high-risk urban youth during the summer, a program that offers home-based provisions to enhance physical activity may have utility outside the context of COVID-19.

Self-efficacy is known to be a key psychosocial antecedent to physical activity, and was a particularly important outcome of the *Camp from Home* program considering adolescents from racial/ethnic minority and low income backgrounds typically have lower levels of self-efficacy related to health behaviors, which represents a key psychological barrier for behavioral interventions [33–35]. It is also important to note that baseline levels of physical activity were understandably

low and the toll of COVID-19 on physical activity in this age group should not be underestimated. At baseline, 82.3% of youth reported exercising on three days or less in the previous week, with almost one-third (30.6%) reporting no days of physical activity at all. Although it is unclear if these low levels of baseline physical activity are representative of typical activity levels for high-risk youth over the summer, it is well-established that the summer months are a vulnerable period for excess weight gain [13, 14]. Thus, the observed self-reported improvements in self-efficacy and increases to 1–4 workouts per week hold promise for potential impact of *Camp from Home*. Furthermore, the key tenants of this program could have application for reducing physical activity disparities beyond the context of a global pandemic and should be examined in future studies. Even minor improvements in health behaviors like self-efficacy and physical activity could have a positive impact on preventing long-term negative trajectories in chronic disease risk.

Strengths and limitations

This study has strengths and limitations that should be noted to support interpretation of findings. First, many researchers will face challenges related to the generalizability of intervention findings outside the context of COVID-19. However, one key finding was the high acceptability and feasibility of delivering program materials directly to participants' homes. Future studies should examine the cost effectiveness and efficacy of this approach as it holds promise, especially for addressing barriers to program implementation and equipment availability that exist in low-resource communities. Additionally, in the program it was not possible to sync digital engagement data to individual participant data, so engagement trends were examined in aggregate. This is an important direction for future work, especially in trials with adolescents that aim to leverage technology platforms like YouTube, where adolescents are already spending time and have comfort accessing content. Next, the low response rates at the end of the program provided limited data to draw conclusions about impact. Surveys were administered via REDCap and participants did have the option to complete the surveys via phone with a research assistant, but many chose to complete the surveys on their own on their phones or via email. This resulted in more parents completing the follow-up survey but not successfully having their child complete their portion. While remote data collection methods hold promise for reducing participant burden, strategies should be taken to ensure all participants can reliably access data collection platforms and complete measures. Given the challenges with data collection, this study was limited in sample size which precluded the ability to examine key subgroup analyses, including gender differences. This is an important area for future work as declines in physical activity are more pronounced for females during adolescence, compared to males [36]. Given this trend, it was an objective of this study to recruit at least 40% females to address gaps in female participation and test the efficacy of a program that would be acceptable to both males and females. While female recruitment was close to the goal (38.7%), this indicates that the program may have still been slightly more appealing to males than females. Last, this program showed signals for improving youth self-efficacy and physical activity, but findings are limited by self-report and whether these differences vary by gender is an important area for investigation. Adequate sample sizes and more rigorous measurement approaches should be used to assess key outcomes in future studies.

CONCLUSION

A 6-week home-based, digitally enhanced physical activity intervention was designed in response to COVID-19 and delivered to 62 youth in 54 families from five middle schools during the summer of 2020. Parents and youth found the program highly acceptable and reported that the provision of program materials (including sports equipment and fresh produce) and text-messages from health coaches were the most helpful program components. Families had sufficient access and a high level of comfort with the technology (text messaging and YouTube) used for the *Camp from Home* program, but youth digital engagement with online video content remained relatively low. Future interventions should consider a higher volume of shorter videos (<5 min) that provide engaging introductions and concise demonstrations, which may be more amenable to the learning and viewing styles of tech-savvy adolescents. A home-based, digitally enhanced intervention model holds promise for improving health behaviors in underserved youth. However, more work is needed to clearly elucidate the impact of this approach for improving physical activity and reducing disparities, especially during the summer months when underserved youth are particularly vulnerable.

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Compliance with Ethical Standards

Conflicts of Interest: GT was a paid consultant for Kids Eat in Color. CH was a paid consultant for Weight Watcher international. The other authors declare that they have no competing interests directly related to this work.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration

and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Human Rights: The research protocol for this study was submitted to Temple University's Institutional Review Board (IRB) but was not considered research involving human subjects as defined by DHHS or FDA regulations, since it was a program evaluation designed to modify or improve the Game on Philly intervention. Consequently, IRB approval and consent was deemed not applicable and waived. Therefore, this article does not contain any studies with human participants performed by any of the authors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Study registration: This study was not formally registered.

Analytic plan registration: The analysis plan was not formally pre-registered.

Data Availability

Availability of data: De-identified data from this study are not available in a public archive. De-identified data from this study will be available (as allowable according to institutional IRB standards) by emailing the corresponding author.

Availability of analytic code: Analytic code used to conduct the analyses presented in this study are not available in a public archive. They may be available by emailed the corresponding author.

Availability of materials: Materials used to conduct the study are not publicly available.

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