PROJECT MUSE®

Wearable Devices Decrease Attrition among Families Participating in an Obesity Intervention at a Federally Qualified Health Center

Juan C. Espinoza, Alexander M. Chen, Alexis Deavenport-Saman, Olga Solomon, Aric Ponce, Abu Sikder, Patricia Castillo, Cary Kreutzer, Larry Yin

Journal of Health Care for the Poor and Underserved, Volume 32, Number 2, May 2021 Supplement, pp. 13-24 (Article)

Published by Johns Hopkins University Press

DOI: <https://doi.org/10.1353/hpu.2021.0048>

➔ *For additional information about this article*

<https://muse.jhu.edu/article/789655>

Wearable Devices Decrease Attrition among Families Participating in an Obesity Intervention at a Federally Qualified Health Center

Juan C. Espinoza, MD*
Alexander M. Chen, MD*
Alexis Deavenport-Saman, DrPH
Olga Solomon, PhD
Aric Ponce, BA
Abu Sikder, BS
Patricia Castillo, MD
Cary Kreutzer, EdD, MPH, RDN
Larry Yin, MD, MSPH

Abstract: Background. Pediatric obesity interventions are time-intensive, reliant on parent engagement and affected by high attrition rates. We evaluated personal activity trackers (PAT) as an attrition intervention for Bodyworks (BW), a comprehensive family-based obesity intervention program in a federally qualified health center. **Methods.** Families enrolled in BW were recruited and randomized to either a control group (BW only) or intervention group (BW+PAT). Statistical analyses were conducted to examine differences between study arms in baseline characteristics and program completion. **Results.** One hundred and fifty-eight (158) families enrolled in the study. There were no significant differences between groups at baseline. There was a significant difference in program completion; the intervention group had a greater percent of completion than the control group (78.3% vs 62.1%), $p < .027$. **Conclusions.** Parents receiving a PATs demonstrated higher rates of program completion compared with controls. Personal activity trackers hold potential as a method to limit attrition and increase participation in obesity intervention programs.

Key words: Pediatrics, obesity, attrition interventions, wearable devices, federally qualified health center.

JUAN C. ESPINOZA, PATRICIA CASTILLO, and LARRY YIN are affiliated with Keck School of Medicine of the University of Southern California and the Division of General Pediatrics, Children's Hospital Los Angeles. **ALEXIS DEAVENPORT-SAMAN, OLGA SOLOMON, ARIC PONCE, and ABU SIKDER** are affiliated with the Division of General Pediatrics, Children's Hospital Los Angeles. **ALEXANDER M. CHEN** is affiliated with the Department of Family Medicine, University of Washington School of Medicine. **CARY KREUTZER** is affiliated with the University of Southern California Leonard Davis School of Gerontology. Please address all correspondence to: Juan Espinoza, Division of General Pediatrics, Children's Hospital Los Angeles, 4650 Sunset Boulevard, Mailstop #76, Los Angeles, CA 90027; Fax: (323) 361-4429; Phone: (323) 361-2721; Email: jespinoza@chla.usc.edu. *Juan C. Espinoza and Alexander M. Chen are co-lead authors.

Obesity affects 18.5% of U.S. children and adolescents, and costs an estimated \$14 billion per year.^{1,2} Childhood obesity remains the most significant risk factor for developing adult obesity and its associated morbidities.³ Children from ethnic minority and low-income backgrounds have a higher risk of obesity and related health problems.^{1,3} Children with obesity often struggle with weight loss interventions and may frequently have lower quality of life in terms of psychological and social health.⁴

Existing guidelines, expert opinion, and published literature support the use of comprehensive behavioral family lifestyle intervention (CBFLI) programs as tools to manage pediatric obesity.⁵⁻⁷ Comprehensive behavioral family lifestyle interventions address dietary intake, physical activity, and behavioral strategies for weight loss with a family-centered approach, involving the child and at least one caregiver. Parents are critical to the success of any pediatric weight loss intervention, serving as role models and stewards of the home environment, influencing the energy balance and dietary choices of their children.^{5,8} Parenting interventions in early childhood can decrease the risk of obesity later in life,^{9,10} and parent-targeted pediatric obesity interventions, using the Parents as Agents of Change framework (role-modeling), have demonstrated encouraging outcomes, including reduction in overweight⁸ and decreased program attrition.¹¹

The success of pediatric obesity programs is often undermined by high attrition rates. Nationwide, programs report rates of attrition as high as 83%.¹² Program attrition is associated with poor participant weight outcomes, reduced treatment effectiveness, and decreased provider cost effectiveness.¹³ Several factors have been identified as predictors of attrition, including being a Medicaid recipient, belonging to a racial or ethnic minority group, older child age, and self-reported depressive symptoms.¹⁴ Parents report logistical factors, lack of program fit, and child involvement as significant barriers to engaging with obesity programs.¹⁵ Little is known about interventions intended to improve parent and child completion of CBFLIs.

The impact of digital health interventions on engagement in adult weight loss programs is an emerging area of research. A systematic review found that small studies have shown at least some improvement in self-monitoring, sustained interest, and daily physical activity over the short term (<6 months) with the use of these tools.^{16,17} Tracking physical activity and digital health interventions have also been shown to increase program engagement, at least temporarily.¹⁶ Personal activity trackers (PATs), typically wrist or waist-worn devices that monitor daily steps walked and stairs climbed to calculate composite activity scores, automate and digitize tracking, providing feedback on activity, temporal trends, and more. Accelerometers have previously been used in studies to measure physical activity, but they are expensive and are not as accessible to families, particularly those of lower income.¹⁸ Personal activity trackers relieve the burden of manual tracking, and while they may not be as accurate in quantifying physical activity as research-grade accelerometers, they have been shown to be an easy and economical method to capture significant amounts of physical activity data.¹⁸ A meta-analysis of PATs in adults indicated that PATs have the potential to increase physical activity and may also provide information to health professionals to monitor progress and provide support.¹⁹

Personal activity trackers can facilitate key behavior change techniques, such as goal-setting, motivational interviewing, self-monitoring, coaching, and social support.²⁰

Figure 1.
Note: PAT=personal activity tracker.

Using the Parents as Agents of Change framework and Bandura's Social Cognitive Theory as models for parental participation in family-based obesity interventions, these behavior change techniques act upon the primary constructs of self-monitoring, modeling, and social support.²¹ These interventions result in increased CBFLI engagement and decreased attrition, which should in turn lead to increasing target behaviors (e.g., physical activity) and eventually improved weight outcomes. To date, few studies have evaluated the potential of digital health tools such as PATs to serve as attrition interventions for pediatric CFBLIs. The purpose of this study was to examine whether providing PATs to the parents of children enrolled in a CBFLI at a federally qualified health center (FQHC) increases program completion rates. Figure 1 shows the intervention's conceptual framework, which proposes how PATs may promote program engagement using Parents as Agents of Change via role-modeling and other behavior change constructs from various models as noted above. Here, we present the attendance and attrition outcomes from a randomized controlled trial.

Methods

Ethical approval and informed consent. The Institutional Review Board of Children's Hospital Los Angeles approved this study, IRB number CHLA-15-00269. This trial was registered with ClinicalTrials.gov NCT03215641. All participants provided written informed consent or assent, as appropriate for age.

Participants. We recruited families, consisting of at least one parent and child, enrolled in BW between August 2015 and December 2017. Families were eligible if the child was between 7–18 years of age, had a BMI $\geq$ 85th percentile for age and sex,²² and had been referred to BW by their pediatrician. Age restrictions were selected to exclude minors unable to meaningfully interact in the curriculum. A parent/caregiver was required to enroll with the child. Siblings were invited to participate to encourage

family attendance, however, they were not included in the study unless they met inclusion criteria. Parents self-selected into groups based on language preference (English or Spanish). Block randomization was used to assign whole language preference groups to either the intervention (BW+PAT) or control (BW only) arms of the study to ensure balanced allocation of groups and prevent in-group cross-contamination.

Intervention. *BodyWorks (BW).* BodyWorks has been adapted over the years to meet the needs of our low-income, primarily Medicaid, Latinx population. Each cycle of BW consisted of weekly, two-hour sessions for eight weeks offered in English or Spanish. Control and intervention participants received the same BW curriculum, which was tailored for age-appropriate delivery. Parents and children received separate curricula each week delivered by a trained multidisciplinary team of occupational therapists, registered dietitians, and pediatricians. Weekly sessions included anthropometric data collection, physician consultation, physical activity, and nutrition lessons. Children participated in separate groups based on their age and developmental level led by the occupational therapy staff overseeing the child portion of the program. Clinicians provided personalized weekly feedback, praised participants, asked participants to identify barriers, and used motivational interviewing techniques to help participants develop strategies to increase physical activity.

PAT intervention. All adults in the intervention arm, as well as children 13 years old or older, received Fitbit Flex (Fitbit Inc., San Francisco, CA) PATs. Children younger than 13 years old were not given a Fitbit or other PAT in accord with the Children's Online Privacy Protection Act (COPPA) at the time of the study, a U.S. federal law that prohibits the creation of online accounts for children younger than 13 years of age without parental consent.^{23,24} All participants were asked to not use any other PAT during the study. For BW+PAT participants, daily steps and daily active minutes data were downloaded from PATs, data were reviewed weekly with participants, and physical activity coaching provided. The PATs were returned at the end of each cycle. A more complete description of the study protocol has previously been published.²⁴

Outcomes. *Demographic characteristics.* Parents completed one demographic survey per family. Limited English proficiency (LEP) was defined as answering anything other than "very well" to the U.S. Census question on English language proficiency.²⁵ Percent of the federal poverty level (FPL) was calculated using self-reported total household income, household size, and the 2016 FPL guidelines for California.

Session attendance. Session attendance was examined among the families that enrolled in the program and attended at least one session. Differences were also examined between control and intervention groups.

Program completion. Meta-analyses of randomized controlled obesity intervention trials for children and adolescents have included four or more weeks as the basic threshold used in obesity interventions.^{26,27} We defined program completion, the primary study aim, as a family attending at least four of the seven sessions. The rates of program completion were calculated. A Fisher's exact test was conducted to examine differences in program completion between intervention and control groups.

PAT attitudes and perceptions. During the last session of BW, parents in the intervention group completed written surveys about their experiences using the Fitbit. The survey consisted of six five-point Likert scale items addressing 1) comfort, 2) ease of

use, 3) enjoyment of use, 4) motivational impact, 5) utility of feedback, and 6) desire to obtain a PAT in the future.

Technology access and preferences. Families completed a self-reported survey on their access to and use of technology, with a focus on smartphones, texting, and social media.

Statistical analysis. A population of 104 parent-child dyads (52 per group) was required for results with 80% power and .05 significance. We examined potential family-level demographic differences between the control and intervention groups at baseline. For family-level variables two-sided Fisher's exact tests were conducted. For the primary study aim, among all participants, one two-sided Fisher's exact test was conducted to examine control and intervention group differences in program completion. For PAT attitudes and perceptions, percentages were calculated.

Results

Participant demographic characteristics. There were 158 families who participated in the study. There were no significant demographic differences between study arms except LEP status. The majority of families identified as Hispanic, spoke Spanish, had LEP, had a household size of five or more members, and a household income of up to 200% of the federal poverty level (Table 1). All families had a female parent/caregiver participant; 14.4% also had a male parent/caregiver participant. All children spoke English.

Session attendance. Participants in the intervention arm attended more sessions than those in the control arm, $p = .031$, $SE = .34$ (Table 2).

Table 1.

SOCIODEMOGRAPHIC CHARACTERISTICS OF PARTICIPATING FAMILIES

Family level	Overall (N=158) n (%)	Intervention (n=92) n (%)	Control (n=66) n (%)	p value
Ethnicity				
Hispanic	148 (93.67)	88 (95.65)	60 (90.91)	.717
Non-Hispanic	8 (5.06)	4 (4.35)	4 (6.06)	
Limited English Proficiency				
No	45 (28.48)	21 (22.83)	24 (36.36)	.047
Yes	111 (70.25)	71 (77.17)	40 (60.61)	
Household income as %FPL				
Up to 200%	127 (80.38)	77 (83.70)	50 (75.76)	.999
Over 200%	10 (6.33)	6 (6.52)	4 (6.06)	
Household size				
1 to 4	71 (44.94)	42 (45.65)	29 (43.94)	.888
5 or more	81 (51.27)	47 (51.09)	34 (51.52)	

Table 2.
SESSION ATTENDANCE

Arm	Sessions attended, M	p-value	SE
Overall	4.7 ± .33		
Control	4.3 ± .55	.031	.34
Intervention	5.0 ± .4		

Table 3.
PROGRAM COMPLETION

	Enrolled, n	Completed, n	Rate	p-value
All participants	158	113	71.5%	
Control	66	41	62.1%	.027
Intervention	92	72	78.3%	
Subgroup analysis:				
All participants				
English	48	32	66.7%	.37
Spanish	110	81	73.6%	
English language group				
Control	22	13	59.1%	.31
Intervention	26	19	73.1%	
Spanish language group				
Control	44	28	63.6%	.052
Intervention	66	53	80.3%	

Program completion. Of the initial 158 families, 113 (71.5%) completed the program. The intervention arm had a higher completion rate than the control arm (78.3% vs. 62.1%, $p = .027$). There was no difference in completion rates by language group or within language groups (Table 3).

PAT attitudes and perceptions. Eighty-two of 146 participants the intervention arm completed the PAT attitudes and perceptions survey (Table 4). Respondents agreed or strongly agreed that Fitbit PATs were comfortable to wear, easy to charge, enjoyable to use, and that they motivated additional physical activity and provided data that enabled useful feedback. Some parents commented that using the PAT made them want to come back each week to see their progress and compare their results with those of other participants.

Technology access and preferences. Participants ($n=132$) accessed technology (except email) at similar or higher rates than the rest of the U.S. during the same time period (Table 5).^{28,29}

Table 4.**PAT (PERSONAL ACTIVITY TRACKER) ATTITUDES AND PERCEPTIONS**

Statement (n=82 respondents)	Agree or Strongly Agree, %	Neutral, %	Disagree, %
The Fitbit was comfortable to wear.	96.3	2.4	1.2
The Fitbit was easy to charge.	100.0	0	0
I enjoyed using the Fitbit.	96.3	3.7	0
I was motivated to do more activity by wearing the Fitbit.	96.3	3.7	0
The weekly Fitbit reports and feedback were useful for me.	98.8	1.2	0
I will consider getting my own Fitbit, or a similar device, in the future.	95.1	2.4	2.4

Discussion

Families in which parents/caregivers received PATs had a significantly greater rate of program completion compared with controls in this randomized controlled trial of 158 low-income, LEP, predominantly Latino families participating in the BW CBFLI pediatric obesity program. Results support the Parents as Agents of Change framework, where PATs increase family program participation by increasing parent/caregiver attendance and ultimately program completion consistent with Figure 1 and a previously outlined conceptual model.²⁴ These findings are important because they demonstrate that parents can be effective messengers of health information and partners in behavioral change.³⁰ The framework provides a strategy for influencing children's life-long eating and exercise behavior starting in childhood through influencing parents' behavior and practices.

Results from a systematic review indicated that consumer-based PATs can increase physical activity in terms of daily step count and moderate as well as vigorous physical activity.^{16,19} Self-monitoring increases physical activity in adults,¹⁷ a key component of BW and other obesity interventions.⁵ Beyond self-monitoring in BW sessions, PATs provide objective data that can be easily shared with clinicians to incorporate into personalized weekly physical activity feedback. Several families enjoyed competing to achieve the most steps per week, a gamification of the program that may have contributed to increased engagement and improved attendance. While there are no standardized instruments to measure the perception or impact of these devices on users, our PAT questionnaire showed that PAT devices were well received, and considered by almost all respondents to be comfortable and easy to use, and to motivate additional physical activity.

Limitations. This study has several important limitations. The sample size for English-preferring families was relatively small, making it difficult to do a meaningful subgroup analysis. The study setting and family-level demographics were homogeneous,

Table 5.**TECHNOLOGY ACCESS AND PREFERENCES**

Category	n	% ^a
Smartphones		
Have a smartphone	130	98%
Use text messaging	128	98%
Have unlimited data plan	110	86%
Email		
Have email	95	73%
Access emails with phone	87	82%
Access multiple times a week	97	92%
Social Media		
Use social media	97	75%
Access multiple times a week	93	82%
Platforms used:		
Facebook	93	45%
Whatsapp	60	29%
Google+	27	13%
Twitter	9	4%

Comparison with U.S. trends, 2015–2017

Characteristics	BW, %	U.S., %
Own a smartphone	98	64
iPhone	30	39
Android	64	58
Use text messaging	98	97
Have email	73	91
Access email from phone	82	88

Notes:

^aPercentage within a category are out of respondents reporting using a given technology.

BW=BodyWorks

representing mostly low-income, Latino, LEP families living in an urban environment, which may limit the generalizability of study findings to other populations. There was an inherent self-selection bias in both arms of the study; families were referred by their pediatrician to participate in an intensive, structured weight loss program, suggesting possible increased motivation. Whether these findings would translate to a less activated population remains to be seen. The definition of program completion used is somewhat arbitrary. Contact time and duration are important factors in obesity interventions, but there is no consensus on the ideal treatment dose.³¹ At least one study has found that as little as five to six contact hours and attending approximately 60% of sessions had a positive impact on obesity outcomes.³² This is comparable to our threshold of approximately 60% attendance and eight contact hours.

Data limitations also exist. We do not report PAT adherence in this study, which

would support a logical mechanism for the observed association. Additionally, we use program completion as a surrogate measure of engagement, but we do not measure child engagement directly with validated instruments such as the Patient Activation Measure (PAM) or the Patient Health Engagement (PHE) Scale.³³ Our future studies will include these and other psychosocial measures. Despite these limitations, the randomized study design strengthens causal inference that PATs may help to promote program completion. This study did not elucidate the mechanism by which PATs increase program completion, particularly in this low-income, primarily Latinx population. We are planning a qualitative study to explore this mechanism further.

Attendance and completion of CBFLIs is generally poor, and our findings may offer a new and low-cost strategy for improving program completion. Such programs, while effective, are demanding of both time and resources for participants and sponsoring institutions alike. Parents must adjust work schedules, arrange transportation, and commit to attending numerous weekly sessions alongside their children. Programs can cost upwards of \$2,000 per child, limiting their availability and accessibility by low-income families in disadvantaged settings.³⁴ Clinically, program attrition is related to poorer weight outcomes in addition to less development of nutrition and weight management strategies, though it is unclear which factor precedes, and causes, the other.¹³ Increases in physical activity by wearers of PATs decline over time, likely related to a novelty effect^{16,17}. Our results suggest a method of capitalizing on the short-term, novelty effect of PATs among parents to improve family CBFLI completion. Short-term, parent-targeted interventions may increase program completion and improve program access, which may lead to subsequent improvement in child health outcomes.

Conclusions. Our results suggest that the inclusion of PATs for parents/caregivers in a CBFLI pediatric obesity program increases completion among low-income Latino families, which may result in improved adoption of healthy lifestyle choices such as increased physical activity. Researchers should attempt to replicate these findings in different settings. Ongoing studies are needed to corroborate the study findings and determine if incorporation of parent/caregiver PATs into CBFLIs will affect long-term pediatric weight-related outcomes and adoption of healthy eating and exercise habits.

Acknowledgments

The authors would like to thank all the families who made this study possible. We would also like to acknowledge the valuable contributions of Lisa Lopez, Audrey Lai, Alex Wormuth, and Payal Shah. Research reported in this publication was supported by the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health (NIH) under Award Number R25DK096944, and the Academic Pediatric Association (APA). The content is solely the responsibility of the authors, and does not necessarily represent the official views of NIH or the APA.

References

1. Hales CM, Carroll MD, Fryar CD, et al. Prevalence of obesity among adults and youth: United States, 2015–2016. NCHS data brief. 2017 Oct;(288):1–8.
2. Trasande L, Chatterjee S. The impact of obesity on health service utilization and costs in childhood. *Obesity*. 2009;17(9):1749–54.

- <https://doi.org/10.1038/oby.2009.67>
PMid:19300433
3. Singh GK, Siahpush M, Kogan MD. Rising social inequalities in US childhood obesity, 2003–2007. *Ann Epidemiol.* 2010 Jan;20(1):40–52.
<https://doi.org/10.1016/j.annepidem.2009.09.008>
PMid:20006275
 4. Buttitta M, Iliescu C, Rousseau A, et al. Quality of life in overweight and obese children and adolescents: a literature review. *Qual Life Res.* 2014 May 19;23(4):1117–39.
<https://doi.org/10.1007/s11136-013-0568-5>
PMid:24249217
 5. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics.* 2007 Dec;120(Suppl 4):S164–92.
<https://doi.org/10.1542/peds.2007-2329C>
PMid:18055651
 6. Janicke DM, Steele RG, Gayes LA, et al. Systematic review and meta-analysis of comprehensive behavioral family lifestyle interventions addressing pediatric obesity. *J Pediatr Psychol.* 2014 Sep;39(8):809–25. Epub 2014 May 13.
<https://doi.org/10.1093/jpepsy/jsu023>
PMid:24824614
 7. Whitlock EP, O'Connor EA, Williams SB, et al. Effectiveness of weight management interventions in children: a targeted systematic review for the USPSTF. *Pediatrics.* 2010 Feb;125(2):e396–418.
<https://doi.org/10.1542/peds.2009-1955>
PMid:20083531
 8. Golan M, Crow S. Targeting parents exclusively in the treatment of childhood obesity: long-term results. *Obesity Researc.* 2004;12(2):357–61.
<https://doi.org/10.1038/oby.2004.45>
PMid:14981230
 9. Brotman LM, Dawson-McClure S, Huang K-Y, et al. Early childhood family intervention and long-term obesity prevention among high-risk minority youth. *Pediatrics.* 2012;129(3):e621–8.
<https://doi.org/10.1542/peds.2011-1568>
PMid:22311988 PMCID:PMC3289522
 10. Brown T, Moore TH, Hooper L, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev.* 2019 Jul 23;7(7):CD001871.
<https://doi.org/10.1002/14651858.CD001871.pub4>
PMid:31332776 PMCID:PMC6646867
 11. Spence ND, Newton AS, Keaschuk RA, et al. Predictors of short- and long-term attrition from the parents as agents of change randomized controlled trial for managing pediatric obesity. *J Pediatr Health Care.* 2017 May–Jun;31(3):293–301.
<https://doi.org/10.1016/j.pedhc.2016.09.003>
PMid:27743908
 12. Dhaliwal J, Nosworthy NM, Holt NL, et al. Attrition and the management of pediatric obesity: an integrative review. *Child Obes.* 2014 Dec;10(6):461–73.
<https://doi.org/10.1089/chi.2014.0060>
PMid:25496035
 13. Miller BML, Brennan L. Measuring and reporting attrition from obesity treatment

- programs: a call to action! *Obes Res Clin Pract*. 2015 May-Jun;9(3):187–202. Epub 2014 Oct 5.
<https://doi.org/10.1016/j.orcp.2014.08.007>
PMid:25293585
14. Zeller M, Kirk S, Claytor R, et al. Predictors of attrition from a pediatric weight management program. *J Pediatr*. 2004 Apr;144(4):466–70.
<https://doi.org/10.1016/j.jpeds.2003.12.031>
PMid:15069394
15. Kwitowski M, Bean MK, Mazzeo SE. An exploration of factors influencing attrition from a pediatric weight management intervention. *Obes Res Clin Pract*. 2017 Mar-Apr;11(2):233–40.
<https://doi.org/10.1016/j.orcp.2016.08.002>
PMid:27544283 PMCID:PMC5315693
16. Afshin A, Babalola D, Mclean M, et al. Information technology and lifestyle: a systematic evaluation of internet and mobile interventions for improving diet, physical activity, obesity, tobacco, and alcohol use. *J Am Heart Assoc*. 2016 Aug 31;5(9):e003058.
<https://doi.org/10.1161/JAHA.115.003058>
17. Lewis ZH, Lyons EJ, Jarvis JM, et al. Using an electronic activity monitor system as an intervention modality: a systematic review. *BMC Public Health*. 2015 Jun 24;15(1):585.
<https://doi.org/10.1186/s12889-015-1947-3>
PMid:26104189 PMCID:PMC4479243
18. Lee J-M, Kim Y, Welk GJ. Validity of consumer-based physical activity monitors. *Med Sci Sports Exerc*. 2014 Sep;46(9):1840–8.
<https://doi.org/10.1249/MSS.0000000000000287>
PMid:24777201
19. Brickwood K-J, Watson G, O'Brien J, et al. Consumer-based wearable activity trackers increase physical activity participation: systematic review and meta-analysis. *JMIR Mhealth and Uhealth*. 2019 Apr 12;7(4):e11819.
<https://doi.org/10.2196/11819>
PMid:30977740 PMCID:PMC6484266
20. Michie S, Richardson M, Johnston M, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med*. 2013 Aug;46(1):81–95.
<https://doi.org/10.1007/s12160-013-9486-6>
PMid:23512568
21. Tougas ME, Hayden JA, McGrath PJ, et al. A systematic review exploring the social cognitive theory of self-regulation as a framework for chronic health condition interventions. *PLoS ONE*. 2015 Aug 7;10(8):e0134977.
<https://doi.org/10.1371/journal.pone.0134977>
PMid:26252889 PMCID:PMC4529200
22. Centers for Disease Control and Prevention (CDC). Clinical growth charts. Atlanta, GA: CDC, 2017. Available at: https://www.cdc.gov/growthcharts/clinical_charts.htm.
23. Fitbit. Terms of service. San Francisco, CA: Fitbit, 2018. Available at: <https://www.fitbit.com/legal/terms-of-service>.
24. Espinoza J, Chen A, Orozco J, et al. Effect of personal activity trackers on weight loss in families enrolled in a comprehensive behavioral family-lifestyle intervention program in the federally qualified health center setting: a randomized controlled trial. *Contemp Clin Trials Commun*. 2017 Sep;7:86–94. Epub 2017 Jun 15.

- <https://doi.org/10.1016/j.conctc.2017.06.004>
PMid:29308436 PMCID:PMC5753795
25. Karliner LS, Napoles-Springer AM, Schillinger D, et al. Identification of limited English proficient patients in clinical care. *J Gen Intern Med*. 2008 Oct;23(10):1555–60. Epub 2008 Jul 10.
<https://doi.org/10.1007/s11606-008-0693-y>
PMid:18618200 PMCID:PMC2533382
26. Knowlden AP, Sharma M, Cottrell RR, et al. Impact evaluation of enabling mothers to prevent pediatric obesity through web-based education and reciprocal determinism (EMPOWER) randomized control trial. *Health Educ Behav*. 2015 Apr;42(2):171–84. Epub 2014 Aug 26.
<https://doi.org/10.1177/1090198114547816>
PMid:25161168
27. Kelley GA, Kelley KS, Pate RR. Exercise and BMI in overweight and obese children and adolescents: a systematic review and trial sequential meta-analysis. *Biomed Res Int*. 2015;2015:704539. Epub 2015 Oct 22.
<https://doi.org/10.1155/2015/704539>
PMid:26579538 PMCID:PMC4633529
28. Smith A. U.S. smartphone use in 2015. Washington, DC: Pew Research Center, 2015. Available at: <https://www.pewresearch.org/internet/2015/04/01/us-smartphone-use-in-2015/>.
29. Kantar. Android vs. iOS—smartphone OS sales market share evolution. London: Kantar, 2020. Available at: <https://www.kantarworldpanel.com/smartphone-os-market-share/>.
30. Epstein LH, Quattrin T. Ideas for next-generation treatments of adolescent obesity. *JAMA Pediatr*. 2020 Jun 1;174(6):527–8.
<https://doi.org/10.1001/jamapediatrics.2020.0034>
PMid:32202598
31. Heerman WJ, JaKa MM, Berge JM, et al. The dose of behavioral interventions to prevent and treat childhood obesity: a systematic review and meta-regression. *Int J Behav Nutr Phys Act*. 2017 Nov 15;14(1):157.
<https://doi.org/10.1186/s12966-017-0615-7>
PMid:29141651 PMCID:PMC5688650
32. Heerman WJ, Sommer EC, Qi A, et al. Evaluating dose delivered of a behavioral intervention for childhood obesity prevention: a secondary analysis. *BMC Public Health*. 2020 Jun 8;20(1):885.
<https://doi.org/10.1186/s12889-020-09020-w>
PMid:32513226 PMCID:PMC7281919
33. Graffigna G, Barello S, Bonanomi A, et al. Measuring patient engagement: development and psychometric properties of the patient health engagement (PHE) scale. *Front Psychol*. 2015 Mar 27;6:274.
<https://doi.org/10.3389/fpsyg.2015.00274>
PMCID:PMC4376060
34. Wright DR, Taveras EM, Gillman MW, et al. The cost of a primary care-based childhood obesity prevention intervention. *BMC Health Serv Res*. 2014 Jan 29;14:44.
<https://doi.org/10.1186/1472-6963-14-44>
PMid:24472122 PMCID:PMC3912346