Scientific Reports

https://doi.org/10.1038/s41598-026-50810-w

Article in Press

Evaluation of a behavioral intervention to support adolescents undergoing bariatric surgery using the reach, effectiveness, adoption, implementation, maintenance (RE-AIM) framework

Received: 10 November 2025

Accepted: 23 April 2026

Published online: 18 May 2026

Cite this article as: Allicock M.A., Francis J.M., Neti S. *et al.* Evaluation of a behavioral intervention to support adolescents undergoing bariatric surgery using the reach, effectiveness, adoption, implementation, maintenance (RE-AIM) framework. *Sci Rep* (2026). https://doi.org/10.1038/s41598-026-50810-w

Marlyn A. Allicock, Jackson M. Francis, Sitapriya Neti, Dhatri Polavarapu, Maral Misserian, M. Sunil Mathew, Alicia Wheelington, Rashon Braxton, Bethany R. Cartwright, Faisal G. Qureshi, Folefac Atem, Sarah E. Barlow & Sarah E. Messiah

Evaluation of a behavioral intervention to support adolescents undergoing bariatric surgery using the Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework

Authors: Marlyn A. Allicock, PhD, MPH[1], Jackson M. Francis, MPH[2], Sitapriya Neti,[2] MPH, Dhatri Polavarapu, MPH[1], Maral Misserian, PhD, MCN, RD[3], M. Sunil Mathew, MS[2], Alicia Wheelington, PhD[4,5], Rashon Braxton[1], Bethany R. Cartwright, MD, PhD[4,5,6], Faisal G. Qureshi, MD, MBA[4,7], Folefac Atem, PhD[1], Sarah E. Barlow, MD, MPH[4,5], Sarah E. Messiah, PhD, MPH, FTOS, FAHA[2,4,5]

[1]The University of Texas Health Science Center at Houston (UTHealth) School of Public Health, Dallas, TX, USA

[2]Child and Adolescent Population Health Program, Peter O'Donnell Jr. School of Public Health, University of Texas Southwestern Medical Center, Dallas, TX USA

[3]School of Allied Health Professions, University of Texas Southwestern Medical Center, Dallas, TX USA

[4]Children's Health System of Texas, Dallas, TX, USA

[5]Department of Pediatrics, University of Texas Southwestern Medical Center, Dallas, TX, USA

[6]Touchstone Diabetes Center, University of Texas Southwestern Medical Center, Dallas, TX, USA

[7]Department of Surgery, University of Texas Southwestern Medical Center, Dallas, TX, USA

Address correspondence to: Marlyn Allicock, The University of Texas Health Houston, School of Public Health, 2777 North Stemmons Freeway, Suite 8400, Dallas TX, 75207. [972-546-2932], marlyn.a.allicock@uth.tmc.edu.

Abstract:

Background. Severe obesity among adolescents in the United States is a major public health concern. While metabolic and bariatric surgery (MBS) is safe and effective for adolescents with severe obesity, no standardized lifestyle interventions are available to support MBS outcomes. TeenLyft, a 6-month behavioral support intervention adapted from the Diabetes Prevention Program, was provided to teens for peri-operative MBS care beginning four weeks before surgery. This study evaluated TeenLyft's efficacy on improving weight-related behaviors using the RE-AIM framework.

Methods. Adolescents aged 13–18 years were recruited from a single tertiary care center MBS program. Participants enrolled in TeenLyft received online educational videos. The five RE-AIM dimensions (*reach, effectiveness, adoption, implementation, and maintenance*) were assessed independently using a mixed-methods approach. Data sources included baseline (pre-surgery), 3- and 6-month post-MBS follow-up data on anthropometric measures and cardiometabolic biomarkers, interviews, and electronic health records. Quantitative data provided descriptive statistics, and paired t-tests assessed within-subject changes over time to evaluate effectiveness. Qualitative data were thematically analyzed.

Results. For *Reach*, 76 adolescents enrolled in TeenLyft, 47 of whom did not complete MBS, and 29 (38.1%) completed MBS, with participants indicating the program structure and suitability were reasons for enrollment. In terms of *Effectiveness (N=29),* older age was significantly associated with greater excess weight loss (EWL >50%: 16.8 ± 0.7 vs. 15.3 ± 1.1 years, p=0.0083), as was female sex (p=0.0062). As expected, weight and body mass index significantly decreased

from pre-surgery to six months post-MBS (136.1 kg to 95.7 kg, p=0.0001; BMI 48.3 to 33.3 kg/m², p=0.0001). Adolescents reported that the program supported their physical and emotional health and wanted more mental health-related content. *Adoption* was influenced by clinical staff involvement in recruitment, content development, and content alignment with adolescent needs. *Implementation* followed the outlined protocols with some additional adaptations to boost engagement via additional social media platforms. *Maintenance* showed most adolescents attended follow-up clinic visits at 6- and 12-month (83% and 67% respectively). Adolescents emphasized that the program provided education and skills to support post-operative weight management.

Conclusions. The RE-AIM framework suggested that TeenLyft was a successful approach for providing behavioral support pre and post-MBS. Additional benefits could be bolstered with support for mental health management.

Trial Registration. NCT05393570; Registered May 16, 2022

Keywords: MBS, metabolic and bariatric surgery, adolescents, behavioral support, weight management, RE-AIM framework

Contributions to the literature

- Guidance is needed for implementation strategies to support weight management for adolescents post-MBS
- We highlight adolescent behavioral support needs post-MBS
- The application of mixed methods to assess RE-AIM factors can inform practical strategies to enhance engagement in behavioral weight management

Introduction

Worldwide, the number of adolescents with severe obesity, defined as ≥120% of the 95th percentile of body mass index (BMI) adjusted for age and sex or a BMI >35 kg/m^2, is increasing (1-3). In the United States (US), it is the fastest-growing subcategory of obesity among adolescents (4). Severe obesity among adolescents is associated with numerous deleterious health and psychological effects, including risks for cardiometabolic, liver, and kidney disease, poor sleep quality, and mental health complications that result in lower quality of life (5-7). Metabolic and bariatric surgery (MBS) is safe and efficacious and has become an increasingly common method of weight management in adolescents who are experiencing severe obesity (8-10). Consequently, there has been an increased uptake of MBS procedures among US adolescents (11, 12).

Despite the effectiveness of MBS in promoting weight loss, the procedure alone does not adequately prevent weight regain and must be supported by lifestyle change. Studies show that adolescents have suboptimal postoperative adherence to behavioral and lifestyle recommendations (13). However, there is no standardized healthy lifestyle behavior intervention for adolescent MBS patients to address pre- and post-operative needs. Given the dearth of lifestyle interventions for adolescents pursuing MBS, it is important to understand not only the degree to which the intervention was effective, but also external indicators of success, such as implementation and maintenance, to help determine long-term potential for public health impact.

The RE-AIM framework (14) provides a systematic method to examine several dimensions of a program at the individual and organizational levels to assess the

feasibility of translating findings into practice. RE-AIM includes five dimensions: *Reach* focuses on the characteristics of organizations and participants willing to participate in the intervention, *Effectiveness* is an assessment of how well the intervention achieves intended outcomes, *Adoption* assesses setting level influences that affect program initiation, *Implementation* focuses on the extent that the intervention is delivered as intended, and *Maintenance* measures the extent to which an intervention is maintained at the organizational and individual level. By examining both the internal and external aspects of validity, we can understand how and why the intervention works and what aspects may need refinement.

The purpose of the current study was to leverage RE-AIM to thoroughly evaluate TeenLyft, a lifestyle support program for adolescents who complete MBS.

Methods

Program Overview

TeenLyft (Lifestyle support For Teens) is an intervention designed to provide lifestyle support for adolescents pre- and post-MBS. Currently, there is no standardized lifestyle intervention program targeting MBS adolescents. Therefore, with adolescent and parent input, we adapted the Diabetes Prevention Program Group Lifestyle Balance (DPP/GLB)(15-17), an evidence-based lifestyle intervention for adults with pre-diabetes and diabetes. Grounded in the Social Cognitive Theory (18), the educational modules addressed barriers and facilitators to intrapersonal constructs (e.g., quality of life, body image), interpersonal factors (e.g., sleep/sedentary behaviors, peer influence on weight loss after MBS), and community constructs (e.g., MBS support systems, food/activity environments to support MBS) and macro/policy level (e.g., media influences, environmental support

for post-MBS lifestyle). The program included four modules: Healthy Eating, Physical Activity, Stress Management, and Motivation, providing guidance about calorie management, healthy eating, physical activity, and managing setbacks to stay on track with weight loss, delivered via videos on the project's YouTube channel and Facebook. The narration for the videos was generated using ElevenLabs, an AI-based text-to-speech platform that produces natural-sounding voice output. To enhance variation and participant engagement, videos alternated between male and female voices. This proof-of-concept study aimed to enroll 20 participants who would complete MBS.

As illustrated in Figure 1, the program was designed to deliver video-based content to adolescents prescribed MBS across three stages: pre-operative, immediate pre-surgery, and post-operative. The pre-operative stage consisted of 38 videos intended for viewing during the month leading up to surgery. Two additional videos were intended to be viewed 48–72 hours before surgery. To bridge the transition between the pre- and post-surgery phases, we incorporated a module featuring a testimonial from an adolescent who had undergone MBS, offering participants a peer perspective into the surgical experience and postoperative life. The post-operative stage was structured as 12 module playlists, each including four videos to be completed over two weeks, totaling 48 videos across 24 weeks. In total, 86 videos were developed and disseminated. The videos range from approximately two to five minutes, with an average length of 1.97 minutes. Additionally, for the post-op stage, participants received an incentive kit two weeks after surgery containing a Fitbit, smart scale, water bottle, exercise bands, and dumbbells. Additional study details can be found elsewhere (19).

Participants

We used a quasi-experimental (non-randomized) prospective cohort study design to enroll adolescents who attended a multi-disciplinary weight loss surgery clinic at Children's Health System of Texas. Additionally, clinic staff provided MBS program patient lists available in EPIC. Adolescents were eligible if they were between 13 and 18 years of age, English or Spanish-speaking (all spoke English) and met the National Institute of Health criteria for MBS (10). Parents consented first, and adolescents assented after their parents gave permission. Completed informed consent and assent were via an online Qualtrics survey that collected demographic information and information about preferences for a weight management support program for the main study. Participants were enrolled from January 2023 to March 2024. Beyond the initial survey and interview at study initiation, surveys were also administered at 3- and 6-month post-surgery, while follow-up interviews were conducted at 6 weeks and 6 months post-surgery. All participants underwent Laparoscopic Sleeve Gastrectomy. All study procedures were approved by the institutional review boards at The University of Texas Health Science Center at Houston and The University of Texas Southwestern Medical Center

prior to parental consent (and participant assent, as applicable). All research was performed in accordance with the Declaration of Helsinki's guiding principles.

Design

We assessed each dimension of RE-AIM independently using a mixed-methods approach to allow for a comprehensive evaluation to support greater validity of inferences (20). Table 1 provides an overview of the variables assessed under each RE-AIM component, the data source, and data collection timeline. Quantitative surveys collected demographic, clinical, and social determinants of health variables using validated measures(21-24). Standard of care weight, body

mass index (raw, percentile, z-score), and cardiometabolic biomarkers (systolic and diastolic blood pressure, HbA1c, fasting glucose, and lipids) indicators were collected from the electronic health record. We used semi-structured interviews to query participants about RE-AIM elements using a researcher generated questionnaire to understand why participated, effectiveness of intervention, components and reasons for engagement, and impact of the intervention. Interviews lasted on average 30 minutes, transcribed verbatim and conducted via ZOOM or telephone trained study staff without a clinical relationship with the participant. Parents were not present during the interview.

For *Reach*, we refer to the number of participants who completed MBS, which was calculated by the number of those who consented and completed the study divided by the eligible participants receiving care at the clinic. We use qualitative data to further understand reasons for participation.

For *Effectiveness*, we evaluated the program on primary outcome measures, which included excess weight loss (EWL) defined as the intentional reduction of body weight by 10%(25), body mass index (raw, percentile, z-score), cardiometabolic biomarkers (systolic and diastolic blood pressure, HbA1c, and fasting glucose, and lipids). See outcomes paper for additional details (26). Furthermore, we assessed participants' perception of effective program elements to support weight management behavioral strategies, quality of life, and self-esteem in qualitative interviews.

Adoption refers to the successful recruitment of participants to the study. We assessed the percentage and characteristics of those who enrolled versus those retained at completion. At the clinic level, we report on the engagement of clinic staff

in recruitment, intervention development. Qualitative interviews provided information about engagement: how participants engaged, and whether they found it applicable for weight management.

Implementation assessed the extent to which the program was delivered as intended. At the program level, using study documentation, we examined the degree to which TeenLyft was delivered according to plan, adaptations made, and barriers and facilitators to implementation. Qualitative data describes adolescents' perception of the intervention and its delivery.

Maintenance (27) was an assessment of follow-up clinic visits related to weight management at 6- and 12-month post-surgery and qualitative responses regarding weight management behaviors maintained post-intervention.

Analysis

Quantitative. Descriptive statistics were calculated for all study variables. Effectiveness was analyzed using non-parametric tests to assess the association with excess weight loss at 6 months, specifically the Wilcoxon signed-rank test for continuous predictors and Fisher's exact test for categorical variables. Bivariate analyses were conducted to examine the associations between baseline characteristics and changes in weight and cardiometabolic biomarkers at 3- and 6-month post-surgery. A random effects analysis of variance (ANOVA) was used to compare these continuous outcomes across the three time points, as the assumption of normality was met. We applied Tukey's multiple comparison test for pairwise comparisons between time points. All analyses were performed using the SAS v. 9.4 software (SAS Institute, Cary, NC), and a two-tailed alpha level of 0.05 was used to determine statistical significance.

Qualitative. Transcribed qualitative interviews were reviewed and analyzed using NVivo 12.0 (QSR International, AUS). Our qualitative approach adhered to the guidelines of Consolidated Criteria for Reporting Qualitative Research (COREQ) (28). Three team members (DP, SN, JMF) conducted interview coding. Each coder began by coding three interviews independently to identify key concepts and create a preliminary code structure. Each transcript was reviewed by a secondary reviewer. After coding

the interviews, they performed thematic analysis. Utilizing the constant approach, our code structure was applied to all transcripts and adjusted as new concepts emerged (29, 30). The resulting themes were deemed "saturated" by the data analysts. Any discrepancies in coding were resolved by consensus among the research team.

Results

Reach

Quantitative. Of the 136 patients eligible for TeenLyft, 76 provided consent to participate. Forty-seven of these participants did not undergo MBS during the study period.

Among the 76 consenting participants, 73 fully completed the baseline enrollment survey, while 3 provided partial responses. Fourteen participants also completed the baseline qualitative interview. Among post-operative participants, 8 completed the 6-week interview, 11 completed the 3-month survey, and 9 completed the 6-month survey, with 6 interviews conducted at that time point.

There were no significant demographic differences between the 29 who completed and the 47 who enrolled but did not complete MBS. The final study

sample included 29 adolescents with a mean age of 15.9 years (SD = 1.1), with the majority (65.5%) aged 12–16 years. Females comprised 75.9% of the sample, which is expected as MBS completion skews female, as shown in many other studies (11).Racial/ethnic distribution included 44.8% Hispanic, 37.9% non-Hispanic Black, 13.8% non-Hispanic White, and 3.4% identifying as Other. Participants had a pre-MBS mean weight of 135.0 kg (SD = 22.1) and a mean BMI of 47.8 kg/m² (SD = 7.3), ranging from 36.9 to 62.4 kg/m².

Qualitative. In investigating the reasons for enrolling in TeenLyft, a common theme was a need for additional resources to support MBS. For example, one participant said,

> *"Mainly for my mental and physical health. I have a really bad mindset. Low motivation, and depression...I want to have a better mindset, like when I lose the weight from the surgery, and to feel better from that."* – Female, 16 years old.

Additionally, others pointed to the overall structure of the program as a reason for enrolling, while some were drawn by the incentives, such as fitness equipment. One participant said,

> "*I think the main reason I signed up was that I was going to get a scale, weights, bands, and the Fitbit because obtaining that isn't very easy here at my house. And receiving that was just the best thing since I use my weights a lot now and the bands to help my exercises, and I take my Fitbit with me wherever I go*." - Female, 17 years old.

Other participants joined for peer support or out of curiosity about the study's potential benefits. As one participant, an 18-year-old female, said, "*And I thought it*

would be a good opportunity to have a support group as I went through the process."

Effectiveness

Quantitative. Our results, reported in our outcomes paper (21), indicated that adolescents who achieved excess weight loss, greater than 50% (EWL >50%) were significantly older than those with EWL ≤50% (16.8 ± 0.7 years vs. 15.3 ± 1.1 years, p = 0.0083). Excess weight loss (EWL) (31) was calculated as the percentage of weight lost relative to excess body weight above the participant's ideal body weight. Sex distribution also showed a significant difference (p = 0.0062), with all males (100%) in the lower weight loss group (EWL ≤50%) and a more balanced distribution in the higher weight loss group (EWL >50%; 55.6% male, 44.4% female). Race/ethnicity differences approached statistical significance (p = 0.0649). The EWL >50% group had a higher proportion of Hispanic/Latino participants (77.8% vs. 58.3%). In comparison, the EWL ≤50% group included a notable proportion of non-Hispanic Black participants (33.3%) compared to none in the EWL >50% group. Pre-surgery BMI did not significantly differ between the groups (48.9 ± 7.6 vs. 44.1 ± 5.3, p = 0.1886).

Qualitative. Participants found that the program effectively supported their physical and emotional health. First, participants pointed out that the program videos helped them adjust their eating behaviors, increase physical activity, and maintain consistency in their self-care routines. The educational videos focused on mindful eating, motivation, and exercise were appreciated for their practicality and relatability by the participants. The videos emphasized healthier eating patterns, such as portion control, awareness of fullness, and nutrient tracking. One participant said,

> “Yeah. I feel like they [videos] help you. I really like them 'cause I think there was one about mindful eating. I feel like I used to be a very much on-the-go, taking on the go—and just eat whenever I had a break. But now, I'm taking the time… you listen to whenever you're full or satisfied. For me, that one helped me also shift a little mindset—where I would set aside that time for eating.” - Male, 17 years old.

A second benefit of the program related to the emotional aspects of weight management: reduced weight stigma and improved self-confidence. Participants spoke about breaking free from lifelong stigmas associated with obesity and gaining a sense of control over their lives.

> “Because I've lived my whole life, all these doctors, ‘Oh, you're overweight, you need to do this, you need to do that.’ So, this was kind of a way for me to break that cycle, and it kind of helped. Definitely just living a healthier life and not being suppressed by the fact that I was overweight.” - Female, 15 years old.

Many participants reported major improvements in self-image, confidence, and motivation, especially as they observed physical changes and received compliments from peers and family. One participant said,

> “Before the surgery, I was always super insecure about the way I look. I hated my face and my body. But now, after the surgery, I realized significant changes in my face. My cheeks are slimmer, and I get compliments from my family all the time that I look thinner and healthier.” – Female, 16 years old.

While some participants struggled with issues like loose skin or adapting to new food preferences, they believed they could overcome these challenges given

their positive outcomes, including significant weight loss and improved energy. Participants shared that others often didn't recognize them post-surgery due to significant physical changes, which boosted their confidence and validated their progress.

Several participants expressed a desire for more content focused on mental health and social support to improve program effectiveness. One participant pointed out,

> "I think there should be a lot more videos on mental health, because I think in this program, one thing that's not being done a lot is mental health. I think for the surgery, of course, they do check-in and they do that—the mental health and you get your psych eval. But I think after surgery, I don't think enough mental health check-ins are done, and I think that's important. Because I know body images and everything else, and support, and I know that's hard, because you lose friends, you lose family members, and relationships after the surgery, and you're fighting things after the surgery. So mental health—so, that would be good videos to add." - Female, 15 years old.

Adoption

Quantitative. The content received 1037 views across our online delivery platforms, 796 from YouTube and 241 from Facebook. We could not track the use of individual subjects. Our total content time was 76 minutes and 15 seconds. Overall, across the two platforms, the program videos were viewed for a total of 19 hours and 38 minutes: 6 hours and 31 minutes on YouTube, and 12 hours and 47 minutes on Facebook. The video with the longest view time from YouTube was the overview of bariatric surgery, and from Facebook, surgery from an adolescent's perspective.

Clinician support was crucial for both developing the TeenLyft program and recruiting and retaining study participants. The program depended on the expertise of a diverse team of clinical personnel, including physicians, a psychologist, a registered dietitian, and a social worker. These clinicians contributed in various ways: appearing in video content, helping with video development from initial concept to script writing and editing, providing potential participant lists, coordinating with the study team for in-person recruitment, and directly recruiting participants using study materials. Clinic staff played a vital role in retention by assisting study coordinators in planning participant calls and emails around post-operative follow-up appointments. While participants were in the clinic, staff would remind them about study surveys and interviews, prepare them for contact from study coordinators, and notify the coordinators so follow-up contact could be made soon after the visit.

Qualitative. Adolescents discussed the extent to which they participated in a program to indicate program components adopted. Reasons included that they found the content to be informative, relevant, and supportive of their MBS journey. Most participants said they engaged with the program content because it was accessible, informative, and supportive post-surgery. They integrated it into their daily lives, at school, work, or during downtime, using the videos for exercise guidance, stress management, motivational support, and nutritional education. Most participants appreciated that the videos were accessible, allowing them to watch at their own pace and return to specific content when needed. A participant said,

> *"I think being able to watch them on my own time. And, I know they would release every week. And I know a lot of my problems, it was pretty similar,*

like the weeks come out. So it was interesting to see the videos in relation to the problems that I was going through the surgery." - Female, 18 years old.

The program was described as relevant, easy to use, and emotionally supportive. Some participants noted that the videos helped them feel guided at times when they lacked clarity about what to eat or how to stay active post-surgery. One participant said,

"*I really liked the fitness videos because it helped me evaluate what I need to improve on in my exercises... I realized that I should have some high-intensity and weightlifting days instead of fully depending on walking and jogging*." - Female, 17 years old.

Multiple participants expressed that the materials aligned well with their needs and experiences. A participant expressed,

"*I think they're very helpful, especially when I'm in my free time and I'm not doing anything, and I want to learn or just have an opinion on something. I think the videos are great, honestly. I love to watch videos, so I think they're good*." - Female, 15 years old.

A few participants showed noncommittal engagement, often attributing their low involvement to forgetfulness or lack of prioritization. One participant said, "*Um, honestly, I just forgot about them*." – Female, 14 years old.

Some participants expressed a sense that they could have benefited more from the content had they engaged more actively with interactive videos, such as those incorporating questions at the end of the videos and opportunities for peer discussion. Participants also suggested engagement would be enhanced if the

program content included mental health videos, pre-surgical preparation, and peer support.

Implementation

Quantitative. Several modifications were implemented during delivery based on direct participant feedback to enhance feasibility and engagement. First, participants were granted access immediately upon providing consent instead of restricting access to pre-operative videos to the month before surgery. This change was made because surgery dates were often delayed for various reasons, and earlier access ensured that adolescents had greater exposure to the program. Second, while program content was initially delivered exclusively through Facebook, videos were later made available on YouTube, as many participants preferred this platform. Finally, to further promote engagement and video viewing, the team began using supplemental posts on Instagram and Facebook to draw participants' attention to our content.

Qualitative. Participants provided insight about how the program was implemented and whether it was acceptable and relevant for them. Feedback included comments on specific aspects such as content, delivery method, narrator voice, and video length. Overall, participants considered TeenLyft to be a useful and supportive tool that benefited them throughout their pre- and post-operative journeys. Participants especially liked the short video duration (about two to five minutes), the delivery via YouTube, and the sections on motivational and mental health content. The shorter videos helped keep their attention and made it easier to fit the program into their busy schedules, which was important since lack of time was the most common barrier to use. Participants generally had no preference for a male or female narrator, and they did not mind that the narrator's voice was AI-

generated. YouTube was preferred over Facebook because it was more familiar, easier to navigate, and more convenient for the participants. In contrast, Facebook was often seen as better suited for parents or older individuals. Many also described the program's content as positive and helpful for managing emotions, staying motivated, and coping with the challenges of such a major life change.

> "*I like the videos. I'm going to be honest. Like, I thought at first, it was going to be videos where it had a person just talking. But it actually…It gets my attention to actually look at it. Because it's a lot of cartoons…It's short and to the point, I can keep watching all those videos…They're not too long. They're not too short. They're kind of just right*." – Female, 18 years old.

Several ideas came up repeatedly regarding program improvements. Participants wanted more interactive elements, such as quizzes to review material, discussion prompts, the ability to use YouTube's comment sections, and live discussion sessions with other teens moderated by a study team or clinical care member. They also requested a wider variety of topics to avoid repetitive content, with additional emphasis on diet-related resources (e.g., recipe or cooking videos, tips for hunger control, and post-op adjustments) and more mental health support. Another highly suggested improvement was including relatable stories from other teens who have undergone MBS, which they felt would make the program more engaging and provide valuable, first-hand insight. While YouTube remained a favorite platform, many participants felt that adding delivery options through teen-friendly platforms such as TikTok or Instagram could help increase engagement. All participants responded positively when asked about creating a standalone app for the program. Overall, the program was implemented well and met participant

needs, but they offered clear and actionable suggestions for improving both its delivery and content.

> "*I feel like it's an easier way because I feel like everyone has a phone now, and they have YouTube. So I feel like it's easier to use YouTube...I feel like a lot of the teenagers have Instagram.* ***Maintenance***

Quantitative. We examined follow-up weight-management clinic visits and found that 24 (82.8%) out of the 29 surgery completers did follow-up visits at 6 months with the weight-management clinic, and 19 (65.52%) out of 29 did follow-up visits at 12 months. This is higher than the average clinic return rate at 6 months (66% %) and 12 months (63%) reported in other studies (32).

Qualitative. Participants discussed long-term post-operative weight loss, changes in behaviors or habits, and lessons or skills they had learned or were actively using to support lasting health improvements. Participants reflected on the physical, emotional, and lifestyle changes since surgery and the role the TeenLyft program played in helping them sustain these changes.

Many participants described meaningful progress following surgery, often noting significant weight loss, better overall health, and increased physical activity levels. For some, these changes led to dramatic improvements in self-esteem and self-image, while others described more modest shifts in how they viewed themselves, even with substantial physical transformation.

A common area of change involved dietary habits, with participants learning to manage portion sizes, adjust to new food textures, and maintain balanced nutrition. While many reported success, these adjustments were often described as an ongoing challenge that required conscious effort and persistence.

"*Obviously, before I was used to eating bigger portions and kind of not watching what I was eating. But now, I have to really watch how much I'm eating and how much water I intake, if I'm getting my protein, if I'm getting my vitamins, because I'll feel it, I won't feel energized, I'll feel tired…And that was the only thing that was kind of hard in the beginning because I'm so used to eating a lot of bread, a lot of pasta… So, I have to really pay attention to what foods I can cut out completely and just replace them with something maybe healthier*." - Female, 15 years old.

Participants discussed key motivators important for maintaining these lifestyle changes. Support from family and friends was frequently mentioned, with participants describing how positive feedback and encouragement boosted their confidence and helped them stay on track.

"*I think that a lot of my friends and family notice I lost weight…they're supportive of it, and the only thing that they care about is that I'm healthy*." - Female, 15 years old.

The TeenLyft program itself was also identified as a valuable source of reinforcement, which participants felt served to remind them of healthy practices and encouraged continued progress. Participants expressed that external social support and their internal motivations play an important role in sustaining the behaviors and habits needed for long-term success. Overall, participants shared that while maintaining lifestyle changes after MBS could be challenging, the combination of personal commitment, strong social support, and program resources was critical in helping them build and maintain healthier lives.

Discussion

We used the RE-AIM framework to evaluate the internal and external validity of our pilot TeenLyft program, designed for adolescents who undergo MBS. The evaluation identified areas of strength, as well as opportunities to improve program content and delivery in future studies.

Reach

We enrolled 55.0% of adolescents potentially eligible for TeenLyft within the clinic. Our pilot study aimed to recruit 20 participants who underwent MBS and was successful in recruiting beyond our goal, including capturing a diverse racial and ethnic sample. Although 76 adolescents consented and were in preparation for MBS, 39% completed MBS. At the intervention study clinic, an average of 10% of referred patients typically complete surgery.(33) Reasons for non-completion are not entirely clear, though likely contributors include not meeting pre-surgery weight loss goals, not clearing mental health screening requirements, or experiencing delays due to medical or logistical factors such as insurance coverage issues, differences in parent or child motivation, or typical attrition patterns commonly seen in clinical care following the initial visit (32). Other studies show that a majority of adolescents who are referred to MBS did not proceed with surgery (32). Reasons include patients not returning for a second surgical visit/consultation, non-adherence to clinical recommendations, insurance denials, and psychological contradiction (e.g., suicidal ideation)(32). Our recent work showed that MBS utilization among US adolescents increased by almost 15% from 2021 to 2023 (12) reflecting the growing acceptance of MBS among providers and patients. Our current study pointed out that adolescents recognized their need for MBS and the importance of having tools through TeenLyft to support their weight management. For those eligible for MBS, it

is essential to further understand how best to address barriers to MBS completion, given the rising need.

Effectiveness

Our study showed that older adolescents had greater excess weight loss compared to younger participants, and participants had significant reductions in weight, BMI, and select cardiometabolic risk factors by 6 months post-MBS (26). Adolescents emphasized that program content provided strategies to support weight management behaviors, improve their self-confidence, and reduce stigma. They viewed participation as a transformative experience that helped them reset their mindset and build better habits. However, some complained about loose skin and having to adapt to new foods as challenges. Excess skin after MBS is a common issue that has been reported among adolescents(34, 35) for which many are interested in seeking skin-reducing surgery (36). Additionally, the majority expressed the need for content that addresses mental health issues. Adolescents suggested that having mental health support information, strategies, and resources would be essential for long-term sustainability, particularly as they navigated post-surgical identity shifts. Adolescents who are eligible for MBS have a high burden of mental health problems compared to peers (37, 38). Although prospective studies show short-term improvements in mental health and quality of life after surgery for adolescents, these effects erode over time (38). Future behavioral interventions may benefit from incorporating education and resources to address mental health quality of life post-MBS, such as seeking appropriate care, navigating social and emotional situations during adjustment to post-surgery.

Adoption

At the clinic level, the involvement of the staff as partners to support the intervention development and delivery may have increased participant engagement in TeenLyft. The familiarity of clinic personnel represented in the videos served as an extension to the continuity of care before, during, and after MBS. The level of engagement at the participant level varied. While many participants integrated TeenLyft into their daily routines and reported strong benefits, others engaged inconsistently because they “forgot”. This suggests that clinic staff reminders for increasing program engagement may be important. Future program designs may benefit from incorporating participant feedback and features promoting interactivity. Engagement in digital interventions can best be improved through personalized feedback and reminders, peer support, and gamification(39). A standardized framework for measuring adherence can improve long-term engagement and effectiveness for better outcomes(40). These additions can address gaps in motivation and enhance long-term engagement of interventions among participants.

Implementation

Early in the implementation phase, adolescents communicated that Facebook was not their preferred platform. Due to this, we pivoted to delivering the program through a study YouTube channel, with structured playlists for each module. In our formative work (41) to develop TeenLyft, adolescents said their top three preferred modalities for program delivery were in-person support groups, live web-based support groups, and social media for both pre- and post-MBS. Adolescents preferred the use of TikTok or Instagram. While we began using Instagram for program reminders and general promotion to boost engagement, University restrictions for some social media platforms (e.g., TikTok) and budgetary constraints kept Facebook

and YouTube as the main delivery medium. The content developed was short (2-5 minutes) and well-received by participants, but the delivery mode needs to match the current platform adolescents use to increase engagement. Adolescent use of Facebook has declined from 71% reporting use in 2015 to 32% in 2024 (42). YouTube is the most used platform by 90% of adolescents (42). Adolescents suggested they would be more engaged through quizzes embedded in the videos, the use of peer mentors delivering content, and opportunities to discuss issues with other adolescents and clinic staff through the program.

Maintenance

This proof-of-concept study was limited to delivery of the program during the funded period. As such, for maintenance we were only able to assess long-term effects of the program outcomes(27) at the participant level and not at the setting level. Follow-up clinic visits declined from 86% at 3 months to 66% at 6 months. Typical baseline bariatric clinic follow-up rate at our intervention site at year is 40%.(32) While this is slightly higher than reported in other studies that had robust follow-up procedures (e.g., multiple contacts via email, certified letters, and electronic health record messages)(32), it is concerning as adolescents require monitoring for nutritional deficiencies after MBS completion. In our qualitative interviews, adolescents reported that they felt TeenLyft provided tools to continue their weight management, but additional mental health support was needed. They identified parents, family, and health care givers as important sources for long-term support. Parents have been recognized as an important source of support by adolescents before and after MBS, but adolescents have also described parents as a source of criticism and unhelpfulness (43, 44). Thus, intervention programs may need to help adolescents and parents determine how best to optimize support.

Health care providers are viewed by adolescents undergoing MBS as a source of support (43) and continue to provide guidance post-MBS through scheduled clinic visits. However, TeenLyft and interventions like it can help bridge the gap between the clinical and home environment.

Strengths and limitations

There are several strengths of this study. As others (35) have noted, there is limited data examining adolescent perspectives in the MBS process. We have included adolescents' qualitative assessments of TeenLyft to support their MBS journey. Our sample, though small, is racially and ethnically diverse. The increase in MBS utilization among adolescents is largely driven by utilization among non-Hispanic Black and Hispanic adolescents (11), who are included in our study. Examination through the application of the RE-AIM framework provides a strong assessment of program successes and challenges that can support a larger randomized trial.

There are some limitations of the study to be acknowledged. Our pilot study was implemented at one clinic, which limits generalizability. Our study was not designed to assess long-term maintenance. However, we have some patient-level perspectives regarding the potential for long-term gains.

Conclusion

This is the first study, to our knowledge, to deliver a behavioral intervention pre-to post-MBS among adolescents. Our findings show that TeenLyft can be added to MBS to support weight loss among adolescents. Recommendations to increase adolescent engagement and support weight management behaviors include mirroring delivery platforms used most by adolescents, addressing mental health

across all phases of the MBS process, providing peer role models, and leveraging parental and health care provider support.

Figure 1. TeenLyft Program Overview

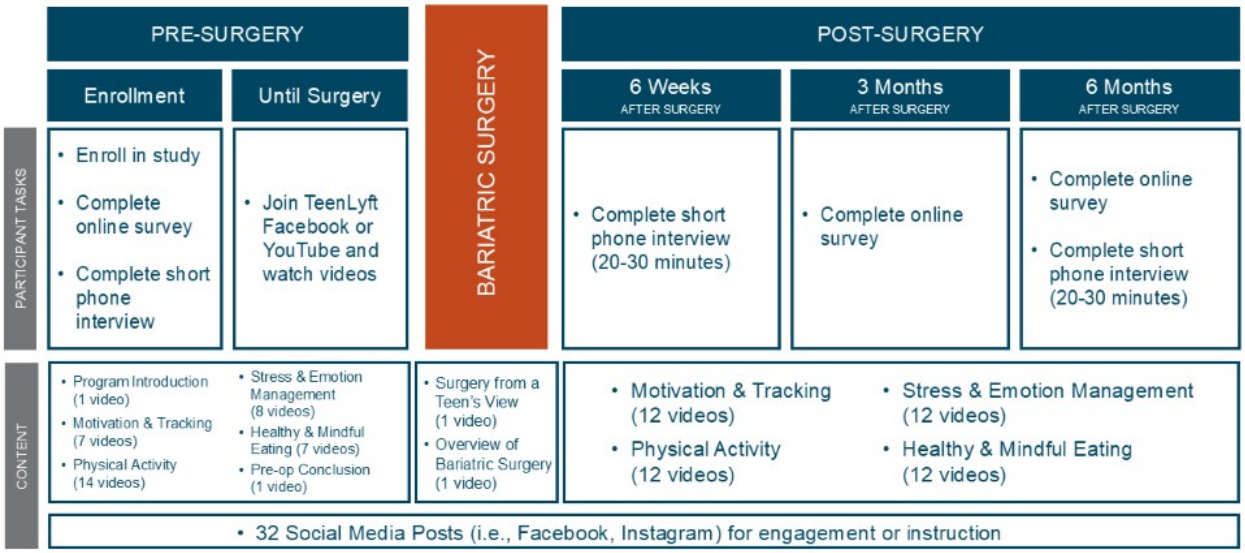

Table 1. RE-AIM Evaluation of TeenLyft

RE-AIM Construct	Measures	Data Sources	Timeline
Reach The number, proportion, and representativeness of adolescents who participated in TeenLyft	Eligibility criteria # adolescents consented # adolescents completed program #Exclusion	Clinic data (EHR) Consent forms Survey data Qualitative interviews	Pre-intervention
Effectiveness Impact of TeenLyft on excess weight loss, body mass index (raw, percentile, z-score), and cardiometabolic biomarkers (systolic and diastolic blood pressure, HbA1c, fasting glucose, and lipids).	Subjective and objective measures related to weight management Perception of program impact (positive or negative)	Survey data Qualitative interviews	Post-intervention
Adoption Willingness of stakeholders and target population to actively participate in the program	% Enrollment and retention of participants Characteristics of participants who enrolled vs loss to follow up Reasons for engagement Organizational level engagement (recruitment, intervention development)	Survey data Qualitative interviews	During intervention
Implementation e.g., the degree to which each program is implemented as intended)	Adherence and consistency to program delivery protocol # and type of adaptations made Barriers and facilitators to implementation % Components of program completed by participants	Program documentation Qualitative interviews	During intervention
Maintenance	Follow-up clinic visits for weight management	EHR data Qualitative interviews	Post-intervention

Sustainability of individual-level effects	□ Participant plans for behavior maintenance (strategies/facilitators, barriers		

References

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384(9945):766–81.
2. Azzopardi PS, Hearps SJC, Francis KL, Kennedy EC, Mokdad AH, Kassebaum NJ, et al. Progress in adolescent health and wellbeing: tracking 12 headline indicators for 195 countries and territories, 1990-2016. Lancet. 2019;393(10176):1101–18.
3. Skinner AC, Skelton JA. Prevalence and trends in obesity and severe obesity among children in the United States, 1999-2012. JAMA Pediatr. 2014;168(6):561–6.
4. Kumar S, Kelly AS. Review of Childhood Obesity: From Epidemiology, Etiology, and Comorbidities to Clinical Assessment and Treatment. Mayo Clin Proc. 2017;92(2):251–65.
5. Armstrong SC, Bolling CF, Michalsky MP, Reichard KW. Pediatric Metabolic and Bariatric Surgery: Evidence, Barriers, and Best Practices. Pediatrics. 2019;144(6).
6. Kelly AS, Barlow SE, Rao G, Inge TH, Hayman LL, Steinberger J, et al. Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American Heart Association. Circulation. 2013;128(15):1689–712.
7. Rank M, Siegrist M, Wilks DC, Langhof H, Wolfarth B, Haller B, et al. The cardio-metabolic risk of moderate and severe obesity in children and adolescents. J Pediatr. 2013;163(1):137–42.
8. Inge TH, Jenkins TM, Xanthakos SA, Dixon JB, Daniels SR, Zeller MH, et al. Long-term outcomes of bariatric surgery in adolescents with severe obesity (FABS-5+): a prospective follow-up analysis. Lancet Diabetes Endocrinol. 2017;5(3):165–73.
9. Wiggins T, Guidozzi N, Welbourn R, Ahmed AR, Markar SR. Association of bariatric surgery with all-cause mortality and incidence of obesity-related disease at a population level: A systematic review and meta-analysis. PLoS Med. 2020;17(7):e1003206.
10. Pratt JSA, Browne A, Browne NT, Bruzoni M, Cohen M, Desai A, et al. ASMBS pediatric metabolic and bariatric surgery guidelines, 2018. Surg Obes Relat Dis. 2018;14(7):882–901.
11. Messiah SE, Xie L, de la Cruz-Muñoz N, Lipshultz SE. Use of Metabolic and Bariatric Surgery Among US Youth. JAMA Pediatr. 2023;177(8):856–7.
12. Messiah SE, Ernest DK, Atem FD, Qureshi FG, Mathew MS, Francis JM, et al. Metabolic and Bariatric Surgery Utilization in the Era of Glucagon-Like Peptide-1 Receptor Agonists among Adolescents versus Adults. J Pediatr. 2025;282:114564.
13. Paulus GF, de Vaan LE, Verdam FJ, Bouvy ND, Ambergen TA, van Heurn LW. Bariatric surgery in morbidly obese adolescents: a systematic review and meta-analysis. Obes Surg. 2015;25(5):860–78.
14. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. Am J Public Health. 1999;89(9):1322–7.
15. US Department of Human and Health Services: Center for Disease Control and Prevention. What Is the National DPP? [August 21, 2025]. Available from: https://www.cdc.gov/diabetes-prevention/programs/what-is-the-national-dpp.html].

16. US Department of Human and Health Services: Center for Disease Control and Prevention. About the Lifestyle Change Program [Available from: [https://www.cdc.gov/diabetes-prevention/lifestyle-change-program/lifestyle-change-program-details.html.

17. Ackermann RT, Finch EA, Brizendine E, Zhou H, Marrero DG. Translating the Diabetes Prevention Program into the community. The DEPLOY Pilot Study. Am J Prev Med. 2008;35(4):357–63.
18. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, N.J: Prentice-Hall; 1986.
19. Misserian M, Wheelington A, King R, Francis J, Mathew MS, Allicock MA, et al. Adaptation of a standardized lifestyle intervention to maximize health outcomes in adolescent metabolic and bariatric surgery patients. J Transl Med. 2024;22(1):197.
20. Greene JC, Benjamin L, Goodyear L. The Merits of Mixing Methods in Evaluation. Evaluation: The International Journal of Theory, Research and Practice. 2001;7(1):25–44.
21. Williams S, Hill K, Mathew MS, Messiah SE. Disparities in Patient Family Social Determinants of Health in a Large Urban Pediatric Health System. J Pediatr Health Care. 2024;38(2):172–83.
22. Jetelina KK, Rodríguez P, Oke OK, Mathew MS, Schoppa S, Booker-Nubie Q, et al. Factors Influencing the Implementation of Social Determinants of Health Screening and Referral Processes in Pediatric Settings Serving Medically Complex Patients. Journal of Applied Research on Children: Informing Policy for Children at Risk. 2020.
23. US Department of Human and Health Services: Center for Disease Control and Prevention. Healthy People 2030 [Available from: https://health.gov/healthypeople/objectives-and-data/social-determinants-health.
24. Vartanian LR. Development and validation of a brief version of the Stigmatizing Situations Inventory. Obes Sci Pract. 2015;1(2):119–25.
25. Vani MF, Sabiston CM, Santa Mina D, Trinh L. "Your Body Is Not At All Where You Left It": Adolescent and Young Adult Cancer Survivors' Experiences Transitioning Back Into Physical Activity After Treatment. Qual Health Res. 2022;32(6):998–1013.
26. Messiah SE FJ, Atem FD, Mathew MS, Wheelington A, Misserian M, Neti S, Braxton R, Cartwright BR, Qureshi FG, Barlow SE, Allicock MA. . A Pilot Lifestyle Support Intervention Among Adolescent Metabolic and Bariatric Surgery Completers: Feasibility, Socio-demographic Characteristics, and Outcomes. . BMC Pediatrics. under review.
27. NIH. Measuring the Use of the RE-AIM Model Dimension Items Checklist http://cancercontrol.cancer.gov/IS/ 2012 [March 15, 2012]. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://re-aim.org/wp-content/uploads/2016/09/checklistdimensions.pdfhttp://cancercontrol.cancer.gov/IS/
28. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care. 2007;19(6):349–57.
29. Crabtree BR and Miller WL. Doing Qualitative Methods (Research Methods for Primary Care). Thousand Oaks, CA: Sage Publications; 1999.
30. Morse JM. The Significance of Saturation. Qualitative Health Research 1995;5(2):147–9.

31. Wing RR, Hill JO. Successful weight loss maintenance. Annu Rev Nutr. 2001;21:323–41.
32. Qureshi FG, Wiegand JG, O'Neill G, Allen B, Wools G, Klement J, et al. Longitudinal Outcomes in Adolescents After Referral for Metabolic and Bariatric Surgery. J Pediatr Gastroenterol Nutr. 2021;73(6):677–83.
33. Wheelington AaCM. Obesity severity among adolescents presenting for initial evaluation to an adolescent weight loss surgery program. The ASMBS Annual Meeting 2024; San Diego, CA2024.
34. Staalesen T, Olbers T, Dahlgren J, Fagevik Olsén M, Flodmark CE, Marcus C, et al. Development of excess skin and request for body-contouring surgery in postbariatric adolescents. Plast Reconstr Surg. 2014;134(4):627–36.
35. Heeren FAN, Ayzengart A, Menon S, Bernier AV, Cardel MI. Adolescent Bariatric Surgery: The Need for Tailored Educational Materials. Child Obes. 2024;20(4):221–6.
36. Derderian SC, Patten L, Kaizer AM, Inge TH, Jenkins TM, Michalsky MP, et al. Body contouring in adolescents after bariatric surgery. Surg Obes Relat Dis. 2020;16(1):137–42.
37. Järvholm K, Janson A, Peltonen M, Neovius M, Gronowitz E, Engström M, et al. Metabolic and bariatric surgery versus intensive non-surgical treatment for adolescents with severe obesity (AMOS2): a multicentre, randomised, controlled trial in Sweden. Lancet Child Adolesc Health. 2023;7(4):249–60.
38. Bruze G, Järvholm K, Norrbäck M, Ottosson J, Näslund I, Söderling J, et al. Mental health from 5 years before to 10 years after bariatric surgery in adolescents with severe obesity: a Swedish nationwide cohort study with matched population controls. Lancet Child Adolesc Health. 2024;8(2):135–46.
39. Saleem M, Kühne L, De Santis KK, Christianson L, Brand T, Busse H. Understanding Engagement Strategies in Digital Interventions for Mental Health Promotion: Scoping Review. JMIR Ment Health. 2021;8(12):e30000.
40. Winter N, Russell L, Ugalde A, White V, Livingston P. Engagement Strategies to Improve Adherence and Retention in Web-Based Mindfulness Programs: Systematic Review. J Med Internet Res. 2022;24(1):e30026.
41. Allicock MA, King R, Francis J, Mathew MS, Polavarapu D, Wheelington A, et al. Lifestyle intervention and support preferences to maximize health outcomes in adolescent bariatric surgery patients. J Clin Transl Sci. 2024;8(1):e127.
42. Faverio M. 10 facts about teens and social media 2025 [August 21, 2025]. Available from: https://www.pewresearch.org/short-reads/2025/07/10/10-facts-about-teens-and-social-media/.
43. Allicock MA, Francis JM, Braxton R, Polavarapu D, Misserian M, Mathew MS, et al. Motivators and Barriers to Seeking Metabolic and Bariatric Surgery Among Adolescents: A Qualitative Study. Obes Sci Pract. 2025;11(1):e70040.
44. Carroll C, Booth A, Cuevas DC. What matters to adolescents with obesity, and their caregivers, when considering bariatric surgery or weight loss devices? A qualitative evidence synthesis. Obes Rev. 2024;25(2):e13654.

Declarations

Ethics approval and consent to participate

All study procedures were approved by the institutional review boards at The University of Texas Health Science Center at Houston and The University of Texas Southwestern Medical Center. Informed written consent for adolescents to participate was obtained from parents and adolescents.

Consent for Publication: Not applicable

Availability of data and materials

The datasets generated during and/or analyzed during the current study are not publicly available due IRB data usage agreement, but are available from the corresponding author on reasonable request.

Competing Interests: The authors declared that they have no competing interests

Funding: All phases of this study were supported by NICHD grant R21HD105129.

Author Contributions

Drs. Marlyn Allicock and Sarah Messiah conceptualized and designed the study, drafted the initial manuscript, and critically reviewed and revised the manuscript.

Jackson Francis collected the data, conducted the qualitative analyses, and critically reviewed and revised the manuscript.

Rashon Braxton collected the data and critically reviewed and revised the manuscript.

Sitapriya Neti and Dhatri Polavarapu conducted qualitative analyses and critically reviewed and revised the manuscript.

Dr. Folefac Atem conducted quantitative analysis and critically reviewed and revised the manuscript.

Sunil Mathew designed the data collection instruments and critically reviewed and revised the manuscript.

Drs. Maral Misserian, Wheelington, Cartwright, Qureshi, and Barlow critically reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Acknowledgments: We thank the participants for their time and expertise.