



Study design and rationale for TEENS+REACH: Evaluating ripple effects of a family-based lifestyle intervention to untreated family members

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ABSTRACT

Background: Understanding the effects of family-based lifestyle intervention beyond the treated adolescent is important, given that obesity is a familial disease and there are likely bidirectional relations between an adolescent's treatment success and broader household changes. However, it is unknown if recommended household-wide changes are adopted or if untreated family members experience weight-related benefits.

Methods: TEENS + REACH leverages our ongoing randomized clinical trial of TEENS+, a family-based lifestyle intervention for adolescents with obesity, to determine: 1) if household-wide changes to the shared home environment are implemented, 2) if ripple effects to untreated family members are observed, and 3) whether these changes are predictive of adolescents' weight management success. TEENS + REACH will expand trial assessments to include comprehensive assessments of the shared home feeding, weight, and physical activity environment of the target adolescents. Specifically, we will enroll untreated children (8–17yrs) and caregivers living in the same household as the target parent/adolescent dyad (N = 60 families). At 0, 2, 4 (primary endpoint), and 8-months, the target parent/adolescent dyad and other untreated children and caregivers in the home will complete anthropometric assessments.

Discussion: Results will determine the familial reach of TEENS+ and reveal potential mediators of treatment response, which can inform future efforts to optimize family-based lifestyle interventions.

Trial registration: TEENS + REACH was retrospectively registered in [Clinicaltrials.gov](https://clinicaltrials.gov) March 22, 2023 (NCT05780970) as an observational study ancillary to the TEENS + clinical trial, registered February 22, 2019 (NCT03851796).

1. Background

Over one-third of U.S. children have overweight (body mass index [BMI] ≥ 85 th and < 95 th %ile) or obesity (BMI ≥ 95 th %ile). Among adolescents (12–19yrs) $> 25\%$ have obesity and 8.4% have severe obesity, the highest prevalence among any pediatric age group [1–3]. Clinical practice guidelines uniformly cite family-based lifestyle intervention (FBLI) as the gold standard for treating adolescent obesity [4–6]. This

approach includes making household-wide changes to the home environment, thus has potential to benefit non-targeted family members. Yet, within adolescent obesity treatments, it is unknown if household-wide changes are implemented, if non-targeted family members experience weight-related benefits, or whether these broader family-level changes impact adolescent outcomes. Typical weight losses observed in adolescent obesity treatment are modest [7], with a lack of evidence regarding the optimal family-based approach during this

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distinct developmental period [8,9]. Thus, identification of strategies to enhance adolescent weight loss, while also improving family-wide outcomes, is urgently needed. Via R01HD095910, we are testing the comparative efficacy of two approaches for involving parents in adolescent obesity treatment (TEENS+) [10]: parent skills training (Parents as Coaches [PAC]) or parent behavioral weight loss (Parent Weight Loss [PWL]). PAC provides training and skills to help parents support their adolescents' weight management efforts, focusing on role modeling, authoritative parenting, and establishing a healthy home environment. PWL provides parents with their own behavioral weight loss program, which occurs parallel to their adolescents' treatment—both parent approaches yielded reductions in adolescent BMI in the pilot trial [11]. This ancillary study leverages this randomized clinical trial (RCT) to determine the familial reach of TEENS+ and identify potential mediators of treatment response to target directly in future iterations of FBLLI.

Adolescence is a complex developmental period, characterized by rapid psychological and physical changes, normative shifts in family dynamics, and an elevated importance of peers [12]. Yet despite increased autonomy over their eating patterns, adolescents are still largely influenced by their family environments, with the most proximal influences on adolescent weight-related behaviors occurring at the individual, family, and household levels [13]. For example, the majority of adolescents' calories are consumed at home [14,15]; most adolescents eat ≥ 5 meals/week with their family [16]; family meals positively impact adolescent health [17,18]; parent feeding behaviors influence adolescent eating habits and weight [19]; and eating and weight patterns in families are related [20–22]. Thus, FBLLI to treat adolescent obesity includes parents and emphasizes use of consistent feeding strategies, modifying the home food environment, and making family-wide dietary changes—regardless of family members' weight status—to support adolescent weight loss. Evidence in this area is mixed—for example, a recent systematic review identified that these strategies are components of treatments that yielded significant adolescent weight losses; however, these same strategies are also components of treatments that did *not* yield significant adolescent outcomes [8]. Moreover, there is a clear lack of evidence about *whether* treatments were implemented at the household level, or which family-level factors yield more favorable adolescent outcomes, as assessments overwhelmingly focus on the identified adolescent. Other than our pilot trial [11], to our knowledge, no studies have addressed the optimal way to harness family-level factors in adolescent obesity treatment [9]. To address this gap, this study will conduct a comprehensive assessment of family-level changes made within our FBLLI, TEENS+, and examine their relation to adolescent weight outcomes.

There is extensive theoretical [23,24] and empirical [20–22,25] support for the interdependence of family eating and weight behaviors. Thus, behavioral weight loss treatment can potentially leverage familial social and environmental factors to enhance outcomes and reach. Within adult behavioral weight loss, Gorin et al. demonstrated that untreated partners in the same household made dietary (although not physical activity) modifications and lost clinically significant amounts of weight, providing evidence of a ripple effect [26]. These outcomes are driven primarily by changes in the shared food environment. Moreover, weight loss in treated and untreated adults is linked, suggesting that individuals are likely to do better if their untreated partner also has success [27]. Similarly, within FBLLI for 8–12yr olds with overweight [28,29], untreated siblings reduced percent overweight. Moreover, weight loss in treated and untreated siblings was related, with better generalization of treatment effects to older siblings and those in larger families and with sex concordance [28]. Although not directly assessed, the treatment's focus on changing the shared family environment, including healthy eating for all family members, was implicated as the likely mechanism. However, no studies have evaluated if ripple effects occur within FBLLI for adolescent obesity and generalizability across age groups cannot be assumed given the unique (and unclear) role of the family in treatment

during this developmental period.

Changes in the home food environment is an identified mechanism for weight change among younger children [30] and also appears to be associated with adolescent dietary [31,32] and weight [33] outcomes. Although cross-sectional studies consistently identify the home food environment as a robust correlate of adolescent dietary intake [34,35], conclusions regarding the home environment as a mechanism for adolescent weight outcomes are limited by a lack of longitudinal data and prior studies' narrow assessment of home food availability, which does not consider the broader feeding culture or other family members' behaviors. This limits the ability to optimize the role of the family in FBLLI for adolescents with obesity. Thus, the objective of this study is to examine an expanded assessment of the shared home environment, including weight changes of untreated family members, to identify if family-level changes were implemented in TEENS+, and examine their relations to adolescent weight outcomes.

2. Methods

2.1. Study aims

The TEENS + RCT is evaluating two approaches to involving parents in FBLLI to treat adolescent obesity [10] (R01HD095910). As previously described [10], all adolescents participate in TEENS+, our 4-month empirically supported behavioral weight loss treatment. Parents are randomized to either 1) parent skills training (Parents as Coaches; PAC) or 2) concurrent parent BWL (Parent Weight Loss; PWL). This ancillary study, TEENS + REACH, will leverage TEENS + to greatly expand our assessment of the shared home environment of the target adolescents. Specifically, we will enroll untreated children (8–17yrs) and caregivers living in the same household as the target parent/adolescent dyad. At 0, 2, 4 (primary endpoint), and 8-months, the target parent/adolescent dyad, and *untreated* children and caregivers will complete anthropometric assessments, and measures of the shared home feeding and weight-related environment will be conducted. TEENS + REACH has three aims and corresponding hypotheses:

1. To determine if family-level changes to the shared home environment are implemented in the TEENS + intervention. Specifically, we will examine 0–4 m changes in: 1) home food availability (digital images and self-report), 2) the home exercise and electronic media environment (digital images and self-report), 3) caregiver (untreated and treated) feeding behaviors regarding both targeted and non-targeted children, and 4) family mealtime routines (i.e., frequency and importance of family meals and media use at meals). Interactions with TEENS + intervention group will be explored. *We hypothesize that statistically significant family-level changes to the shared home environment will be observed.*
2. To determine if weight changes are observed among untreated family members of TEENS + participants. We will examine 0–4 m changes in untreated children's zBMI and caregivers' % weight loss. Child/caregiver sex and TEENS + intervention group will be explored as potential moderators. *We hypothesize that statistically significant weight losses (zBMI and % weight loss) will be observed among untreated family members.*
3. To examine the associations between 0 and 4 m household changes assessed in Aims 1 and 2 and target adolescent weight loss (ΔBMI_{0-4m}) and maintenance (ΔBMI_{4-8m}). Interactions with TEENS + intervention group will be explored. We will also create a novel composite variable depicting family-wide ΔzBMI and explore how family-wide ΔzBMI_{0-4m} relates to adolescent weight loss (ΔBMI_{0-4m}) and maintenance (ΔBMI_{4-8m}). *We hypothesize that greater household changes will predict greater adolescent weight loss and maintenance.*

Results will inform a conceptual model regarding family-level influences on adolescent weight outcomes to guide the execution of a

subsequent FBFI designed to optimize both familial reach and adolescent weight outcomes.

2.2. Study setting

The site for this study is a pediatric obesity clinical research center at an academic medical center in central Virginia.

2.3. Study population

TEENS + REACH will enroll eligible untreated family members from $N = 60$ TEENS + families (30 per treatment group) to complete assessments only. Based on family density in the parent trial, we anticipate enrolling approximately 80 untreated children and 60 untreated caregivers.

2.4. Recruitment and screening

Participants in the main TEENS + trial will be recruited in waves, to yield approximately 30 parent/adolescent dyads per cohort. Recruitment strategies are substantiated by our formative work, including through outreach to pediatricians [64–66]. Interested families complete eligibility screening (which will include household density) via telephone or a secure website. Eligibility will be reviewed in a follow-up telephone call, during which TEENS + REACH will be introduced. Eligible families complete an orientation (in person or zoom) in which TEENS + procedures will be detailed, eligibility confirmed, informed consent/assent obtained, and detailed assessment instructions provided. Eligibility and enrollment procedures for untreated family members will also be described. A separate consent/assent process will occur for these individuals, which will occur at a separate zoom or in-person visit. Families who decline/are ineligible for TEENS + REACH will proceed with the main trial. To enhance recruitment and retention, families will receive payment (\$20 [0-months], \$25 [2-months], \$40 [4-months], \$60 [8-months]) for completion of each untreated family member's assessments. The primary parent/adolescent dyad will receive payment for completion of the TEENS + trial assessments, with additional compensation (\$20 [0-months], \$20 [2-months], \$25 [4-months], \$30 [8-months]) for completion of the TEENS + REACH measures. The incentive structure was determined based on estimated time to complete measures, using a graduated approach.

2.5. Eligibility criteria

The primary parent/adolescent dyad must be enrolled in the TEENS + trial for untreated family members to be potentially eligible for TEENS + REACH, an ancillary study.

Primary Adolescent and Parent Inclusion Criteria for the TEENS + Trial. Male and female adolescents with overweight or obesity (BMI ≥ 85 th percentile for age and sex assigned at birth according to the CDC Growth Charts) between the age of 12–16yrs will be eligible for participation in TEENS+. The adolescent must reside with the primary participating parent (or legal guardian; ≥ 18 yrs), who has a BMI ≥ 25 kg/m² and is also willing to participate in the study protocol. See Bean et al. [10] for complete TEENS + eligibility criteria.

Untreated Family Member Inclusion/Exclusion Criteria. All untreated children (8–17yrs) and untreated adult caregivers (≥ 18 yrs) primarily living in the same household as the primary parent/adolescent dyad will be eligible. Thus, more than one untreated child and/or caregiver could potentially be eligible within a family. Recognizing the non-traditional family structure of our diverse sample, both familial and non-familial individuals will be eligible. Adults must be identified as a significant caregiver in the household, and thus could potentially include older siblings (≥ 18 yrs), grandparents, aunts/uncles, step-parents, or other related or non-related individuals. Individuals temporarily (<1yr) living in the participating family's home will be

ineligible. Although we anticipate that most family members will have overweight or obesity (based on familial patterns of obesity, our formative data that 69% of siblings and 91% of parents had overweight or obesity, and weight patterns within social networks), overweight is not an inclusion criterion (consistent with prior studies [26,28]). Further, given that the primary adolescent and parent have overweight or obesity, all family members living in the household are at greater risk for obesity. Moreover, the premise behind a family-based approach is that positive feeding practices and healthy eating should be applied to all family members, regardless of weight status. However, children (BMI < 5th percentile) and adults (BMI < 18.5 kg/m²) with underweight will be ineligible, as weight gain would be clinically appropriate. We will also exclude untreated caregivers and children under the following conditions: 1) non-English speaking; 2) medical condition(s) that may be associated with unintentional weight change or significant disruption to eating behaviors (e.g., hypothalamic injury, Prader-Willi, G-tube placement, or malignancy); 3) clinically significant eating disorder; 4) is prescribed a medically-supervised/prescribed diet; or 5) psychiatric, cognitive, physical or developmental conditions that would impair the individual's ability to complete assessments.

2.6. Intervention overview

The parent and adolescent interventions include 16 weekly group sessions, led by trained, supervised lifestyle coaches, masked to study hypotheses. Our interventions capitalize on social learning and emphasize interactions among personal, environmental, and behavioral factors [24]. Core behavioral weight loss strategies [36,37] are integrated into all sessions (e.g., goal-setting, self-monitoring, problem solving, contingency management, stimulus control, dealing with setbacks, maintenance, and relapse prevention). TEENS+ was designed to be an in-person treatment, yet due to COVID-19 was modified for remote delivery (via Zoom, with live group, individual, and exercise sessions). Untreated family members will participate in assessments only, drawing from cohorts conducted remotely. Only the participating parent/adolescent dyad will participate in TEENS+, previously described in greater detail [10], and described below briefly.

TEENS + Adolescent Intervention. All adolescents participate in TEENS+, which was informed by prior research [11,38–42]. Adolescents are in same-sex groups, according to their parents' treatment. Adolescents receive personalized dietary and physical activity goals and are taught strategies to achieve these goals to yield safe, sustainable weight loss. The TEENS + dietary intervention [43] was designed to create a caloric deficit via adding low calorie, nutrient-dense foods ("Go Foods") while remaining within a prescribed calorie range. The TEENS + physical activity intervention includes personalized progressions to achieve ≥ 1 hr/day of moderate physical activity, with supervised exercise sessions ≥ 1 x/week. Weight is assessed weekly and personalized feedback provided in a self-regulation framework to assist adolescents in recognizing the relation between their behaviors and weight change, to reinforce successes and guide modifications.

Parent Interventions. Parents participate in their assigned, intervention (PAC/PWL), matched on contact. Key similarities make these treatments particularly well-suited to respond to our study question. Specifically, both treatments 1) target families as a strategy to impact adolescent weight loss, 2) emphasize the importance of making changes to the shared home environment, 3) teach strategies to execute these changes, including via personalized feedback reports (at 0, 2, 4-months) based on the Home Food Inventory [44], and 4) promote shared engagement in behavior change for parents and adolescents.

Parents as Coaches (PAC). PAC focuses on parent skills training to support their adolescents' weight management, and is informed by our pilot [11] and previous research supporting this authoritative approach to FBFI [45,46]. PAC teaches positive reinforcement principles to promote behavior change, and emphasizes parents' roles as important models of health behaviors and the importance of setting up the home

environment to facilitate their adolescents’ successful goal attainment.

Parent Weight Loss (PWL). PWL is an adult behavioral weight loss program, concurrent, yet independent from their adolescents. PWL is informed by our pilot [11] and is based on the premise that adolescents whose parents lose weight within FBLLI yield superior weight losses [47, 48]. The goal is to produce parent weight losses of 5–7%, via personalized dietary and physical activity goals. PWL includes specific content focused on navigating financial, environmental, social, and emotional barriers to weight management, including applying stimulus control strategies to cue healthy behaviors (and remove unhealthy cues) from their home environments. It is emphasized that parents’ concurrent engagement in shared behavioral weight management behaviors should be helpful for their adolescent.

2.7. Measures

All measures are appropriate for our population and will be administered by masked assessors at 0, 2, 4, and 8 months. Surveys will be completed online via REDCap [49,50]. Based on COVID-19 protocols and participant preferences, both remote and in-person protocols will be applied. Table 1 details the source of data from each respondent for this study.

2.8. Physical measures

All treated and untreated participants will have their height and weight assessed after a 12-h fast using a precision stadiometer and digital scale, respectively. All measurements will be rounded to the nearest 0.1 cm and 0.1 kg. BMI (kg/m²) will be calculated. BMI percentile (children only) and z-scores will be calculated using Epi-info [51]. As described in French et al. [52], we will create a composite variable depicting family-wide zBMI at 0, 4, and 8-months. For those ≥20yrs, zBMI will be calculated using sex and 5yr age group values from NHANES [53].

2.9. Environmental measures

Shared Home Environment-Food. The primary parent will complete assessments of the shared home food environment using the Home Food Inventory [44] (HFI). The HFI documents the presence of healthy/unhealthy foods in their home. The *obesogenic food environment score* will be calculated. Parents will also be instructed to take *digital images* (tablets provided) of their home food environment, following detailed protocols that include taking images of all locations where food and/or beverages are present. Images will be coded to identify each item’s 1) visibility and 2) location. These data will be examined in conjunction with HFI scores to further characterize the home environment.

Shared Home Environment-Physical Activity. The primary parent will complete the Exercise Environment Questionnaire (EEQ) [54] to document the presence of home exercise equipment. A *shared home*

exercise environment score will be calculated. Parents will take *digital images* of their home exercise environment, which will be subsequently coded to identify each item’s 1) visibility and 2) location.

Shared Home Environment- Electronics. The primary parent will complete the Home Electronics Equipment Scale [55] (HEE; also enhanced with *digital images*) to indicate the number and type of electronics available in the home, as well as which are available in each child’s bedroom (including portable electronics).

Family Mealtime Environment. Both primary and untreated parents will complete measures of family mealtime. The mealtime environment will be assessed using Family Eating and Activity in Teens (F-EAT) [56] items, including: *frequency of family meals* (“During the past 7 days, how many times did all, or most, of your family living in your house eat a meal together?”); *importance of family meals* (mean of 4 items, e.g., “In our family, children are expected to be home for dinner”); *frequency of child (and parent) media use at meals* (composite score of 5 items assessing: watching TV, talking on the phone, listening to music with headphones, playing hand-held games, or text messaging); and *parent limit setting on media use at meals* (i.e., “Do you set limits on your child’s media use [e.g., TV] at family meals?”).

Child Feeding. The primary parent will complete the Child Feeding Questionnaire (CFQ) [57,58] regarding the primary (treated) adolescent and untreated child(ren). Untreated parents will also complete the CFQ regarding the primary adolescent. Both primary and untreated parents will complete the CFQ because there are limited data regarding the generalization of feeding behaviors across parents and children within a household, with unknown relations to adolescent weight outcomes [56, 59]. Thus, we will calculate targeted and nontargeted parent feeding practices.

Demographics. Untreated parents will report age, gender, sex, race, ethnicity, education, and relation to the primary participating adolescent at baseline. The primary participating parent will report these variables for themselves, their adolescent, and each untreated child participant. Household income, insurance status, food insecurity (18-item US Household Food Security Survey) [60] and family density and structure will be assessed at 0, 4, and 8 months.

2.10. Quality control

Masked assessors will complete rigorous training including: 1) review of the operations manuals, 2) observing the research coordinator conduct assessments, 3) supervised practice, and 4) mock assessments. We modified TEENS + protocols for use with children across the age-span (8–17yrs) based on the NHANES anthropometry manual [61]. Assessors will be trained to code images following detailed protocols to establish interrater reliabilities (intraclass correlations) ≥0.80, consistent with our prior experience developing and using detailed coding systems [40,62–66]. Study initiation will proceed once the PI confirms protocol adherence.

Table 1
Source of data from each respondent in TEENS + REACH.

Measure	Treated Parent/Caregiver		Treated Adolescent	Untreated Caregivers		Untreated Child(ren)
	TEENS+	TEENS + REACH	TEENS+	TEENS + REACH		TEENS + REACH
Demographics	✓		✓	✓		✓
Anthropometrics	✓		✓	✓		✓
Family Mealtime Environment		✓		✓		
CFQ ^a (re: treated adolescent)	✓			✓		
CFQ ^a (re: untreated child[ren])		✓				
Home Food Inventory	✓					
+digital images		✓				
Home Exercise Environment	✓					
+digital images		✓				
Home Electronic Environment (+digital images)		✓				

^a CFQ = Child Feeding Questionnaire.

2.11. Statistical analyses

2.11.1. Power analyses

Power analyses were conducted to detect significant differences in 0–4 month change over time (within-subjects factor) using G*power, with one group. Effect sizes were derived from the TEENS pilot [11], fitting 2 models to these data using HFI as the primary outcome of interest: model 1 included a fixed effect of time and a random effect for subject to accommodate within-subject correlation (nesting); model 2 was the same, with the addition of fixed effects for covariates: cohort, age, sex, race, baseline BMI, and family density. From these models the intra-cluster correlation (ICC) and f effect size for ΔHFI_{0-4m} post-hoc calculation was calculated. In model 1, the $\text{ICC}=.60$ and $f=.57$; in model 2 with the additional covariates, the $\text{ICC}=.60$ and $f=.59$. With these estimates, power is $>90\%$ based on a projected $N = 60$ families and 10% attrition at 4 months. Acknowledging that these observed effect sizes are large, further calculations (i.e., for the HFI and/or other outcomes of interest) indicate that if $\text{ICCs} \geq 0.475$ and the effect size is reduced to $f=.20$, we would still have $>80\%$ power with this sample size; power remains $>80\%$ if the $\text{ICCs} \geq 0.175$ and $f=.25$. We also have 80% power to evaluate exploratory 2-group moderators with a medium effect size, $f = 0.25$, and an $\text{ICC} \geq 0.20$.

2.11.2. Analyses

Descriptives and graphical techniques will examine all variables prior to hypothesis testing, as appropriate based on variable type, and transformations will be considered. Preliminary analyses will identify potential covariates to include in each model (i.e., sex, race/ethnicity, family density, food security, child/parent weight status), using Pearson's correlations, chi-square, and ANOVAs, based on variable type. Variables significantly associated with outcomes of interest will be retained as covariates in the final models, as appropriate. We will correct for multiple testing using the false discovery rate procedure [67]. Analyses will be conducted with SAS v9.4 and Mplus.

To assess 0–4 month changes in the shared home environment, we will apply linear mixed models, which allow a variety of longitudinal covariance structures to be modeled and all available data to be used. For the outcome variables (HFI, EEQ, HEE, CFQ [treated and untreated parent report], F-EAT [treated and untreated parent report], and untreated child [zBMI] and parent [% weight loss] changes), we will fit mixed models with 1 within-subjects factor (time with 4 levels, 0, 2, 4, 8 months), with a post-hoc comparison of 0–4-month change. If > 1 child per family participates, we will account for nesting within family by including a random effect for subject nested within family. Sibling age will be included as a covariate in all models. If significant, follow-up analyses will explore age as a potential moderator. Sibling/parent sex and TEENS + intervention group [PAC/PWL]) will be evaluated as potential moderators, as appropriate. Agreement between the targeted and untreated parent F-EAT and CFQ with regard to the target adolescent, and targeted parent agreement on the CFQ across children in a household, will be measured with concordance correlation coefficients.

We will evaluate whether adolescent weight loss (ΔBMI_{0-4m}) and maintenance (ΔBMI_{4-8m}) are associated with the significant family environment variables and weight changes using linear models. Interactions with TEENS + intervention group will be explored. Lastly, we will explore how family-wide ΔzBMI relates to adolescent weight outcomes. Mean family-wide ΔzBMI_{0-4m} and ΔzBMI_{4-8m} will be determined using all participants except treated adolescents. Linear regression models will examine relations between family-wide ΔzBMI_{0-4m} and adolescent weight loss (ΔBMI_{0-4m}) and maintenance (ΔBMI_{4-8m}). Will also explore how family-wide ΔzBMI_{4-8m} (in maintenance) relates to adolescent weight loss maintenance (ΔBMI_{4-8m}).

3. Discussion

TEENS + REACH is an ancillary study to TEENS + RCT and is

designed to examine the influence FBLI on untreated household members residing in the same home environment with treated adolescents and parents. Adolescence is the last opportunity for family-based obesity treatment, yet it is unknown how best to harness family-level factors to optimize outcomes. TEENS + REACH will leverage an ongoing RCT that is uniquely positioned to address this gap: both TEENS + PAC and TEENS + PWL yield adolescent weight loss and positively impact the shared food environment, with potential to effect change in both adolescents and untreated family members via these environmental changes. We will examine the familial reach of TEENS+, including assessment of the shared home environment and untreated family members' weight change, and examine their relations to adolescent weight outcomes.

Adolescent obesity treatment is delivered at the *family* level; yet assessments are conducted at the *individual* level. TEENS + REACH aligns intervention and assessment targets to advance treatment paradigms to be consistent with the conceptualization of obesity as a familial disease. Findings will reveal potential mediators to target directly in future FBLIs to yield greater adolescent weight loss and familial reach, enhancing their clinical and public health impact. Given the lack of empirical support for specific family-level targets within adolescent obesity treatment, and unique considerations regarding the role of the family during the developmental period, this line of inquiry has the potential to significantly transform clinical practice guidelines and enhance the public health impact of FBLI via improving adolescent – and other family members' – weight outcomes.

Ethics approval and consent to participate

All materials, consent and assent forms, and protocols have been approved by the institution's IRB. All methods are carried out in accordance with relevant guidelines and regulations. Only parent(s)/guardian(s) are able to initiate the study screening process. Parents provide their verbal consent prior to beginning the screening. Any untreated caregivers are invited to complete separate eligibility screening. Written informed consent and assent are obtained from the parent(s) (or guardian) and the potential child participants, respectively, prior to study participation; untreated caregivers participate in a separate consent process. The consent/assent forms include an age-appropriate description of the study in layman's terms, potential risks and benefits, alternative procedures (in this case, the alternative is to choose not to participate in the study), and investigator/IRB contact information. Following eligibility screening, copies of consent/assent documents are provided to interested parents for review with their children and other family members at home, prior to formal consent/assent procedures. Formal consent/assent procedures are conducted either in person or via zoom as part of either one-on-one or group orientation sessions; parents and children participate in consent/assent procedures together. Specifically, the PI, study coordinator, or other trained staff explain the research protocol and review parental consent/child assent documents. During the assent process, it is emphasized to children (as appropriate based on age) that their participation is voluntary. Study staff require that age-appropriate children (~age 8 and older) verbalize clear assent to participate and children and parents are encouraged to ask questions before signing the consent/assent documents. Families meet individually with study staff to discuss additional questions prior to completing consent/assent procedures. Participants are provided as much time as they need to make their decision about study participation. Parents are provided with a copy of the signed/dated consent/assent documents, which include contact information for the PI and for the VCU Office of Research Subjects Protection.

Consent for publication

Not applicable.

Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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CRedit authorship contribution statement

Kristal Lyn Brown: Conceptualization, Writing – original draft, Writing – review & editing. **Jessica Gokee LaRose:** Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Hollie A. Raynor:** Conceptualization, Funding acquisition, Investigation, Writing – review & editing. **Amy A. Gorin:** Funding acquisition, Investigation, Writing – review & editing. **Laura M. Thornton:** Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Sarah Farthing:** Project administration, Writing – review & editing. **Kristina Tatum:** Project administration, Writing – review & editing. **Melanie K. Bean:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Not applicable

List of abbreviations

CDC	Centers for Disease Control and Prevention
CFQ	Child Feeding Questionnaire
EEQ	Exercise Environment Questionnaire
FBLI	Family-based Lifestyle Intervention
F-EAT	Family Eating and Activity in Teens
HEE	Home Electronics Equipment
HFI	Home Food Inventory
NHANES	National Health and Nutrition Examination Survey
PAC	Parents as Coaches
PWL	Parent Weight Loss
RCT	Randomized Clinical Trial

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