# Reduction in Food Away from Home Is Associated with Improved Child Relative Weight and Body Composition Outcomes and This Relation Is Mediated by Changes in Diet Quality

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**ABSTRACT**

**Background** Reducing consumption of food away from home is often targeted during pediatric obesity treatment, given the associations with weight status and gain. However, the effects of this dietary change on weight loss are unknown.

**Objective** Our aim was to evaluate associations between changes in dietary factors and child anthropometric outcomes after treatment. It is hypothesized that reduced consumption of food away from home will be associated with improved dietary intake and greater reductions in anthropometric outcomes (standardized body mass index [BMI] and percent body fat), and the relationship between food away from home and anthropometric outcomes will be mediated by improved child dietary intake.

**Design** We conducted a longitudinal evaluation of associations between dietary changes and child anthropometric outcomes. Child diet (three 24-hour recalls) and anthropometric data were collected at baseline and 16 weeks.

**Participants/setting** Participants were 170 overweight and obese children ages 7 to 11 years who completed a 16-week family-based behavioral weight-loss treatment as part of a larger multi-site randomized controlled trial conducted in two cohorts between 2010 and 2011 (clinical research trial).

**Intervention** Dietary treatment targets during family-based behavioral weight-loss treatment included improving diet quality and reducing food away from home.

**Main outcome measures** The main outcome measures in this study were child relative weight (standardized BMI) and body composition (percent body fat).

**Statistical analyses** We performed *t* tests and bootstrapped single-mediation analyses adjusting for relevant covariates.

**Results** As hypothesized, decreased food away from home was associated with improved diet quality and greater reductions in standardized BMI ($P<0.05$) and percent body fat ($P<0.01$). Associations between food away from home and anthropometric outcomes were mediated by changes in diet quality. Specifically, change in total energy intake and added sugars mediated the association between change in food away from home and standardized BMI, and change in overall diet quality, fiber, added sugars, and added fats mediated the association between change in food away from home and percent body fat. Including physical activity as a covariate did not significantly impact these findings.

**Conclusions** These results suggest that reducing food away from home can be an important behavioral target for affecting positive changes in both diet quality and anthropometric outcomes during treatment.
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CHILDHOOD OVERWEIGHT AND OBESITY RATES IN the United States, estimated at 32.6% for children ages 6 to 11 years, have reached unprecedented levels.[1] To effectively intervene, it is important to identify specific behavioral changes associated with reductions in weight. One such behavioral target, recommended for childhood obesity interventions, is reducing the consumption of food away from home[2]; however, to our knowledge there have been no studies evaluating the impact of this change.

The link between consumption of food away from home and obesity is well documented. Overweight and obese children eat a higher proportion of meals away from home than their normal-weight counterparts,[3] and eating at least one meal per week away from home is associated with risk for obesity in children.[4] Prospectively, consuming a higher proportion of food away from home is associated with increases in child relative weight (ie, standardized body mass index [BMI]) over time,[5] and consuming breakfast away from home is associated with greater increases in BMI than consuming breakfast at home.[6] These associations are likely due to the energy-dense nature of food away from home.[7,8] Indeed, greater fast-food consumption among children is associated with higher energy intake and poorer diet quality,[9] and food away from home is typically served in larger portion sizes containing more calories than foods consumed at home.[4] However, no previous research has examined the effect of reducing consumption of food away from home on pediatric anthropometric outcomes.

The present study aims to evaluate the associations between change in consumption of food away from home and changes in relative weight, body composition, and diet quality after family-based behavioral weight-loss treatment, and to test the potential mediating role of changes in diet quality on the relationship between food away from home and changes in anthropometric outcomes (standardized BMI and percent body fat). It is hypothesized that reducing energy from food away from home will be associated with improved diet quality, reducing consumption of food away from home and improving diet quality will be associated with greater improvements in anthropometric outcomes, and the relationship between decreased consumption of food away from home and improvements in anthropometric outcomes will be mediated by improvements in diet quality.

## METHODS

### Procedure

The present study is a longitudinal evaluation of associations between dietary changes and child anthropometric outcomes. The data were collected as part of a larger multi-site (St Louis, MO, and Seattle, WA) randomized controlled trial examining the efficacy of different weight/behavioral maintenance programs after family-based behavioral weight-loss treatment. The present study examines only the family-based behavioral weight-loss treatment portion of the trial (conducted in 2 cohorts between 2010 and 2011), and all participants received the identical intervention, as randomization was conducted after family-based behavioral weight-loss treatment, when families entered the maintenance portion of the trial. A full description of the methods and procedures for the trial and associated treatment delivery is provided elsewhere.[10] In brief, family-based behavioral weight-loss treatment is a multi-component intervention that targets both dietary and physical activity modifications. Participants are encouraged to follow a low-energy-density diet by decreasing consumption of high-energy-dense and low-nutrient foods (eg, cookies, sugary drinks) and increasing consumption of low-energy-dense and high-nutrient foods (eg, fruits, vegetables, lean proteins), thereby improving diet quality. One mechanism for affecting these changes included in the present treatment is to decrease consumption of food away from home (ie, eat more foods prepared at home, and limit consumption of foods prepared outside of the home [eg, full-service restaurants, fast-food establishments, takeout foods, social or work gatherings]), and treatment content included strategies to help families establish healthy patterns for doing so (eg, planning home-cooked meals, simplifying food preparation, and creating grocery lists).

### Participants

Participants who entered the trial were 241 child–parent dyads. Participants were recruited in the St Louis, MO, and Seattle, WA, areas through local media outlets, schools, organizations, pediatrician referrals, weight-management clinics and word-of-mouth. Families were excluded from the trial if either the parent or child had an eating disorder, drug or alcohol dependence, or other mental illness diagnosis; low English comprehension; a physical illness or disability that prohibited following dietary recommendations or engaging in moderate to vigorous physical activity; or a medication that could affect weight. Children had a BMI ≥85th percentile for age and sex, were 7 to 11 years old, and had at least one parent with a BMI ≥25. Family-based behavioral weight-loss treatment completers with complete anthropometric and dietary data were included as part of this secondary analysis (n=170 for standardized BMI and n=113 for percent body fat). Participants included in the present analyses did not differ from those excluded on any demographic variables. Written informed consent and verbal assent were obtained from parents and children, respectively. Protocols were approved by the Institutional Review Boards at Washington University School of Medicine and Seattle Children's Research Institute.

### Measures

**Demographics.** At baseline, parents completed brief demographic questionnaires reporting child age, sex, and race/ethnicity. The Barratt Simplified Measure of Social Status (Barratt W, unpublished work, 2006), adapted from the Hollingshead Index of Social Status (Hollingshead AB, unpublished work, 1975), measured socioeconomic status. Higher values indicate higher socioeconomic status.

**Relative Weight.** Child weight and height were measured at baseline and after family-based behavioral weight-loss treatment. Weight and height measurements were taken in light clothing with shoes removed on a calibrated electronic scale and stadiometer. Child BMI was calculated and standardized according to age and sex based on Centers for Disease Control and Prevention growth curves[11] using the LMS method to calculate standardized BMI.

**Body Composition.** Children's percent body fat was assessed via whole-body dual-energy x-ray absorptiometry scans at baseline and post–family-based behavioral weight-loss treatment. Dual-energy x-ray absorptiometry is a noninvasive and brief procedure that provides a validated measure of fat and lean mass in children and adults.[12] The machines were regularly calibrated using phantoms of known composition, and the same machine was used within-site for all participants.

**Dietary Intake.** A registered dietitian nutritionist or trained bachelor-level nutritionist conducted three telephone-administered 24-hour dietary recalls at baseline

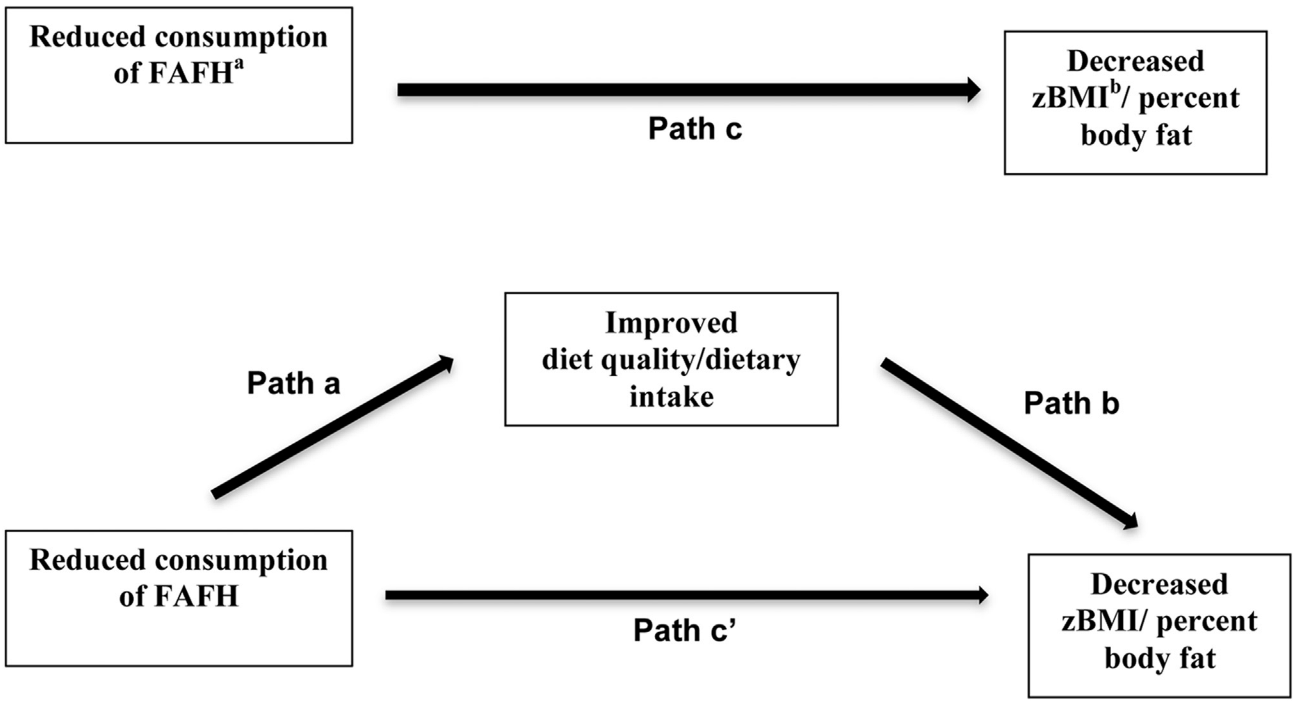


**Figure.** Proposed mediation model assessing whether changes in diet quality mediate the relationship between changes in energy from food prepared away from home and changes in anthropometric outcomes (standardized body mass index and percent body fat). Path c indicates the total effect of the association between reduced food away from home and the outcome variables when no mediator is included in the model. Path a indicates the relation between reduced consumption of food away from home on the mediator (changes in diet quality/dietary intake, included in separate single mediation models). Path b indicates the relation between the mediator and the outcome variable (change in anthropometric outcomes). Path c′ indicates the association between reduced food away from home and anthropometric changes when the mediator is included in the model. [a]FAFH=food away from home. [b]zBMI=standardized body mass index.

and post–family-based behavioral weight-loss treatment using the Nutrition Data System for Research (version 2009, Nutrition Coordinating Center, University of Minnesota). Interviews were conducted at both baseline and post–family-based behavioral weight-loss treatment on nonconsecutive days, including at least 1 weekday and 1 weekend day, following standard protocols using the multiple-pass method.[13] Parents completed the dietary recall for the child, but were assisted by the child if present. The 3-day mean for each nutrient/food group was computed for both time points. Mean energy intake was categorized as consumed at home or away from home. When there was a discrepancy between where the meal was prepared vs eaten, it was coded for where it was prepared (eg, if child ate a meal at home, but it was prepared at a restaurant it was coded as food away from home). The proportion of energy consumed from foods prepared away from home was calculated by dividing mean caloric intake consumed away from home by mean total caloric intake.

**Diet Quality.** Diet quality was assessed using the Healthy Eating Index-2005 (HEI-2005), a valid and reliable measure designed to assess adherence to the 2005 Dietary Guidelines for Americans from the US Department of Agriculture.[14] The scores range from 0 to 100, with a score of >80 indicating good diet quality. The HEI-2005 scores were calculated from the mean of the Nutrition Data System for Research data using the method described by Miller and colleagues,[15] with minor modifications for the "oils" category and "solid fats" component of the "Calories from Solid Fat, Alcohol, and Added Sugar" categories, as described by Wiltheiss and colleagues.[16]

**Physical Activity.** Child physical activity was assessed using an Actigraph accelerometer, which has been shown to be a reliable and valid measure of moderate-to-vigorous physical activity (MVPA) in children.[17,18] Children wore the Actigraph for 7 consecutive days, which is sufficient to obtain an assessment of habitual physical activity.[17,18] Age-specific cutoffs were used to determine minutes of MVPA (with 4 metabolic equivalents used as the criterion for moderate activity [a conservative criterion], and 6 and 9 metabolic equivalents for hard and very hard activity, respectively),[19] and minutes spent engaging in MVPA were averaged across the collected days.

## Statistical Analysis

For change variables, baseline values were subtracted from post–family-based behavioral weight-loss treatment values. Changes in nutrient/food group intake were previously reported from this trial.[20] Linear regressions were used to test associations among energy from food away from home, diet quality, nutrients/food groups, and anthropometric outcomes. Nutrients/food groups associated with standardized BMI change were identified in previous analyses and include total energy and percent energy from protein and fat.[20] Because the HEI-2005 components are energy-adjusted using a density approach (food group/nutrient per 1,000 kcal/day), the analyses did not control for change in total energy when examining associations with HEI-2005 scores.

Single mediation models based on the Preacher and Hayes method[21] were utilized to test the proposed mediation model (Figure). Separate models tested the mediating effects of change in HEI-2005 and each nutrient/food group that was significantly associated with change in energy from food away from home and standardized BMI (identified in previous analyses[20]) and percent body fat (identified in the present analyses). Covariates were decided a priori and included child age, race/ethnicity, sex, socioeconomic status, site, and baseline values of the independent, dependent, and mediation variables. To test whether physical activity influenced the hypothesized associations, additional analyses were conducted in the 129 subjects with complete dietary and physical activity data using change in minutes of MVPA as a covariate. Models for nutrients/food groups, excluding the macronutrients expressed as a percent of total energy, included change in total energy as a covariate. A bootstrapping procedure using 5,000 resamples was conducted to calculate the 95% CIs of each indirect effect. If the CI did not contain zero, the indirect effect was considered to be significant.[21] An $\alpha$ level of $P<0.05$ was set to determine significance. All analyses were conducted using SPSS software, version 19 (IBM SPSS).

## RESULTS

Participant characteristics and baseline and post–family-based behavioral weight-loss treatment anthropometrics and dietary intake are included in Table 1. Energy from food away from home and HEI-2005 scores significantly improved from baseline to post–family-based behavioral weight-loss treatment ($P<0.001$). Dietary changes that are associated with positive anthropometric outcomes are considered improvements.

### Associations between Consumption of Food Away from Home and Diet

Decreases in energy from food away from home consumption were associated with increased HEI-2005 scores ($\beta=-.345$, $P<0.001$), fiber ($\beta=-.481$, $P<0.001$), healthy fruits and vegetables ($\beta=-.366$, $P<0.001$), and percent energy from protein ($\beta=-.190$, $P<0.05$) and carbohydrates ($\beta=-.304$, $P<0.001$), and with decreased total energy ($\beta=.233$, $P<0.001$), added sugars ($\beta=.166$, $P<0.01$), added fats ($\beta=.206$, $P<0.001$), sugar-sweetened beverages ($\beta=.162$, $P<0.01$), and percent energy from fat ($\beta=.417$, $P<0.001$).

### Associations among Consumption of Food Away from Home, Diet, and Relative Weight/Body Composition

Decreased consumption of energy from food away from home and increased HEI-2005 scores were associated with decreased standardized BMI ($P<0.001$ and $P<0.05$, respectively). A similar pattern of results was evident for percent body fat ($P<0.01$). In addition, decreased total energy, percent energy from fat, added sugars, and added fats, and increased percent energy from protein, fiber, and healthy fruits and vegetables ($P<0.05$) were associated with greater decreases in percent body fat (Table 2). Results from these models did not change with the

**Table 1.** Baseline demographic characteristics, baseline and post-treatment dietary intake, and physical activity expenditure data for 170 children who completed family-based behavioral weight loss treatment

| | |
|---|---|
| **Race/ethnicity, n (%)** | |
| Non-Hispanic white | 107 (62.9) |
| Non-Hispanic black/African American | 29 (17.1) |
| Hispanic | 17 (10.0) |
| Other[a] | 17 (10.0) |
| **Sex, n (%)** | |
| Male | 66 (38.8) |
| Female | 104 (61.2) |
| **Child age at baseline, y, mean±SD[b]** | 9.4±1.2 |
| **Socioeconomic status, mean±SD, range** | 43.8±10.4, 10.0-65.0 |
| **Relative weight/body composition** | |
| Child zBMI[c] at baseline, mean±SD | 2.16±0.39 |
| Child zBMI post-FBT,[d] mean±SD | 1.87±0.56*** |
| Child percent body fat at baseline, mean±SD | 44.6±6.5 |
| Child percent body fat post-FBT, mean±SD | 40.8±8.0*** |
| **Diet** | |
| HEI-2005[e] score at baseline, mean±SD, range | 59.3±8.8, 40.6-90.0 |
| HEI-2005 score post-FBT, mean±SD, range | 74.5±9.8***, 48.8-95.4 |
| FAFH[f] baseline, mean±SD | 0.4±0.2 |
| FAFH post-FBT, mean±SD | 0.3±0.3*** |
| **Physical activity** | |
| MVPA,[g] baseline, min, mean±SD | 47.16±22.0 |
| MVPA post-FBT, min, mean±SD | 44.49±21.3 |

[a]Other races included American Indian or Alaskan Native, Asian, Native Hawaiian or other Pacific Islander, and "other" (self-reported).
[b]SD=standard deviation.
[c]zBMI=standardized body mass index.
[d]FBT=family-based behavioral weight-loss treatment.
[e]HEI-2005=Healthy Eating Index-2005.
[f]FAFH=energy from food prepared away from home.
[g]MVPA=moderate-to-vigorous physical activity.
***$P<0.001$, indicating a significant difference from baseline to post-FBT.

**Table 2.** Associations between change in proportion of energy consumed from food prepared away from home, diet quality, and change in child relative weight and body composition[a]

| Independent variable | B | β | P value |
|---|---|---|---|
| **Main outcome: change in zBMI[b] (n=170)[c]** | | | |
| Change in FAFH[d] | 0.269 | .273 | <0.001 |
| Change in HEI-2005[e] scores[f] | −0.004 | −.179 | 0.027 |
| **Main outcome: change in percent body fat (n=167)** | | | |
| Change in FAFH | 3.619 | .280 | 0.003 |
| Change in HEI-2005 scores | −0.070 | −.270 | 0.004 |
| Change in total energy, kcal | 0.002 | .249 | 0.042 |
| Change in protein, % total energy[f] | −0.241 | −.277 | 0.002 |
| Change in fat, % total energy[f] | 0.104 | .227 | 0.014 |
| Change in carbohydrates, % total energy[f] | −0.032 | −.072 | 0.437 |
| Change in fiber, g[f] | −0.145 | −.272 | 0.002 |
| Change in added sugars, g[f] | 0.037 | .422 | 0.004 |
| Change in healthy fruits and vegetables, servings/day[f] | −0.331 | −.213 | 0.011 |
| Change in added fats, servings/day[f] | 0.947 | .457 | 0.002 |
| Change in sugar-sweetened beverages, servings/day[f] | 1.113 | .241 | 0.122 |

[a]Linear regression models were adjusted for child age, race/ethnicity, sex; family socioeconomic status; study site; and baseline values of the independent and dependent variables.
[b]zBMI=standardized body mass index.
[c]Associations between nutrients/food groups and change in body mass index *z* score have been previously reported from this trial.[20]
[d]FAFH=energy from food prepared away from home.
[e]HEI-2005=Healthy Eating Index-2005.
[f]Model was also adjusted for change in total energy.

inclusion of MVPA as a covariate. To further explore the independent effect of HEI-2005 scores and anthropometric changes, changes in energy balance behaviors were included as covariates in these analyses. After controlling for change in energy balance behaviors (total energy intake and minutes of MVPA), change in HEI-2005 scores remained significantly associated with both standardized BMI ($P<0.05$) and percent body fat ($P<0.001$).

## Mediating Effects of Improved Diet

Mediation models testing the effects of dietary changes on the association between changes in consumption of energy from food away from home and anthropometric outcomes were conducted to explore changes that might explain the relationship between decreased energy from food away from home and anthropometric outcomes (Table 3). Change in total energy intake and added sugars mediated the relationship between changes in energy from food away from home and standardized BMI. Change in HEI-2005 scores, fiber, added fats, and added sugars mediated the relationship between consumption of energy from food away from home and percent body fat.

In the mediation models, the inclusion of MVPA as a covariate had a minor impact on the hypothesized associations with anthropometric outcomes. The mediation model testing change in total energy as a mediator for the association between change in food away from home and change in standardized BMI remained significant after controlling for change in physical activity (95% CI −0.1454 to −0.0229; 20.4% mediated); however, change in added sugars was no longer a significant mediator. Change in HEI-2005 scores and change in added sugars remained significant mediators for the association between change in food away from home and change in percent body fat (95% CI −2.6864 to −0.4275; 34.3% mediated); however, change in fiber and change in added fats were no longer significant.

## DISCUSSION

To maximize the efficacy of interventions for pediatric obesity, behavioral targets associated with changes in child anthropometric outcomes must be identified. The present results show that reduced consumption of food away from home was associated with reductions in child standardized BMI and percent body fat. The potential mechanism through which reducing food away from home is associated with improvements in anthropometric outcomes appears to be changes in diet quality. These results have potential implications for pediatric obesity interventions and suggest that reducing consumption of food away from home may be an important dietary target. Additional research is needed to identify the most effective strategies for reducing food away from home (eg, increased meal planning and preparation skills) and to determine the direct impact of reducing food away from home on anthropometric changes.

Previous research has examined the cross-sectional and longitudinal associations between consumption of food away from home and weight status and gain; however, to our knowledge the impact of reducing consumption of food away from home has not been examined. The results from the current study address this important gap in the literature by documenting the effect of this reduction on changes in anthropometric outcomes, including standardized BMI and percent body fat. At the start of treatment, participants ate approximately 40% of their energy from food away from home, higher than the national average of 35% for all children of this age group,[22] and reduced to slightly below the national average, 32%, by the end of family-based behavioral weight-loss treatment. As hypothesized, this reduction in energy from food away from home was associated with improvements in dietary intake and significant reductions in standardized BMI and percent body fat. Given the demonstrated importance of reducing energy from food away from home on anthropometric outcomes, it is also important to explore mechanisms by which reducing energy from food away from home can affect these changes. These results suggest that improvements in dietary intake mediate the associations with improved anthropometric outcomes. These findings support and extend previous findings that consumption of food away from home is

**Table 3.** Mediation models testing the mediating role of diet in the association between change in proportion of energy consumed from food prepared away from home and change in child relative weight and body composition[a]

| Mediator | Path a[b] | Path b[c] | Path c[d] | Path c′[e] | Indirect effects (95% CI)[f] | % Mediated[g] |
|---|---|---|---|---|---|---|
| **Main outcome: change in zBMI[h] (n=170)** | | | | | | |
| Change in HEI-2005[i] scores | 17.0478*** | −0.0018 | −0.2688*** | −0.2384** | −0.0304 (−0.0922 to 0.0240) | NS[j] |
| Change in total energy, kcal | −418.3565*** | 0.0001** | −0.2693*** | −0.2070** | −0.0623 (−0.1272 to −0.0230) | 23.1 |
| Change in protein, % total energy | 2.0151 | −0.0130** | −0.2465** | −0.2203** | −0.0263 (−0.0924 to 0.0031) | NS |
| Change in fat, % total energy | −10.7141*** | 0.0025 | −0.2345** | −0.2079* | −0.0266 (−0.0857 to 0.0320) | NS |
| Change in added sugars, g[k] | −25.7489*** | 0.0015 | −0.2463** | −0.2069 | −0.0395 (−0.1057 to −0.0031) | 16.0 |
| Change in healthy fruit and vegetables, servings/day[k] | 3.1064*** | −0.0066 | −0.2518** | −0.2312** | −0.0205 (−0.0698 to 0.0299) | NS |
| Change in sugar-sweetened beverages, servings/day[k] | −0.4533** | 0.0317 | −0.2482** | −0.2339** | −0.0144 (−0.0692 to 0.0301) | NS |
| **Main outcome: change in percent body fat (n=167)** | | | | | | |
| Change in HEI-2005 scores | 16.9791*** | −0.0499 | −3.6431** | −2.7967* | −0.8465 (−1.8405 to −0.1264) | 27.4 |
| Change in total energy, kcal | −407.7076*** | 0.0011 | −3.6428** | −3.2028* | −0.4400 (−1.2993 to 0.2006) | NS |
| Change in protein, % total energy | 1.9808 | −0.2224** | −3.6485** | −3.2079** | −0.4406 (−1.5044 to 0.0727) | NS |
| Change in fat, % total energy | −10.7296*** | 0.0693 | −3.5188** | −2.7755* | −0.7434 (−2.0360 to 0.1362) | NS |
| Change in fiber, g[k] | 11.7469*** | −0.1121* | −3.2730** | −1.9566 | −1.3164 (−2.7438 to −0.1525) | 40.2 |
| Change in added sugars, g[k] | −25.9139*** | 0.0281* | −3.6451** | −2.9161* | −0.7290 (−1.6676 to −0.1470) | 20.0 |
| Change in healthy fruits and vegetables servings/day[k] | 3.1932*** | −0.2250 | −3.6234** | −2.9050* | −0.7185 (−1.7704 to 0.0069) | NS |
| Change in added fats, servings/day[k] | −1.2909*** | 0.7342* | −3.7152** | −2.7675* | -0.9477 (−2.2453 to −0.1730) | 25.5 |

[a]Mediation models adjusted for child age, race/ethnicity, sex; family socioeconomic status; study site; and baseline values of the mediator, independent, and dependent variables. Unstandardized regression coefficients are reported for each path.
[b]Path a indicates the relation between reduced consumption of energy from food prepared away from home on the mediator.
[c]Path b indicates the relation between the mediator and the outcome variable.
[d]Path c indicates the total effect of the association between reduced energy from food prepared away from home and the outcome variables when no mediator is included in the model.
[e]Path c′ indicates the association between reduced energy from food prepared away from home and anthropometric changes when the mediator is included in the model.
[f]Bootstrap results for indirect effects with bias-corrected CIs set to 95% confidence (5,000 bootstrap resamples).
[g]% Mediated=[1−(C′/C)]×100.
[h]zBMI=standardized body mass index.
[i]HEI-2005=Healthy Eating Index-2005.
[j]Mediation model not significant.
[k]Model also adjusted for total energy change.
*$P<0.05$.
**$P<0.01$.
***$P<0.001$.

associated with poorer nutrition, specifically higher fat content and greater caloric intake.[4,8]

Interestingly, the mediation results differed for standardized BMI and percent body fat. Although improved HEI-2005 scores did not mediate the association between changes in energy from food away from home and standardized BMI as hypothesized, they significantly mediated reductions in percent body fat. In contrast, reduced total energy intake did not mediate the association between change in energy from food away from home and percent body fat, but significantly mediated changes in energy from food away from home and standardized BMI. It is possible that the significant association between changes in HEI-2005 and percent body fat might have occurred through another energy balance behavior, such as increases in physical activity. Indeed, increased physical activity has been associated with greater reductions in body fat, but not standardized BMI.[23] Research has also shown that food away from home is negatively,[24] and diet quality is positively,[25] associated with exercise in adults, which might suggest that children who increased HEI-2005 scores might also have increased their physical activity. To test this hypothesis, analyses were run in a subsample of subjects who had complete physical activity data (n=129) using the energy balance behaviors as covariates. After controlling for change in physical activity in the mediation model, the results strengthened, and *P* values for path b approached significance ($P$=0.08), suggesting that physical activity might be impacting the relationship between percent body fat and HEI-2005. It should be noted that a sizeable portion of the sample size failed to complete the physical activity data and, therefore, a loss of power occurred with its inclusion, these results should be interpreted with caution and additional research with larger sample sizes is needed to further explore this finding.

The results in the present study also indicate that improvement in diet quality, as measured by the HEI-2005, was independently associated with decreased child standardized BMI and percent body fat, and these results held when controlling for changes in total energy and MVPA, indicating that improvements in diet quality elicited positive changes in percent body fat, independent of changes in energy balance behaviors. Although the observed finding is novel and has implications for treatment, the current study was not designed to test these associations. Further research is needed to explore this finding and to examine the mechanisms by which improved diet quality is associated with greater changes in body composition, and the degree to which reducing food away from home facilitates improvements in diet quality.

Overall, our findings indicate that reducing food away from home is associated with improved diet quality, total energy intake, and weight loss. To achieve this target, interventions might focus on helping families increase at-home meal preparation by teaching skills and strategies to overcome barriers to engaging in this behavior (eg, help families learn how to plan meals, shop for groceries, prepare foods, identify ways to minimize costs, and time associated with preparing food at home).

There are limitations to this study. Consumption of food away from home and diet quality were measured at the same time point, which limits the ability to determine temporality for the observed associations. The present sample is both treatment seeking and treatment completing; they might have higher motivation for change than other populations, and these findings might not generalize to other populations. Also, the dietary data were obtained through self-report/parent report on child, allowing for the possibility of recall bias. However, this form of report has been validated and is considered the most accurate assessment method for children aged 4 to 11 years.[13] Strengths include a large sample size, 3 days of high-quality recall data that were averaged to provide a comprehensive evaluation of child diet, and high-quality body composition data.

## CONCLUSIONS

Limiting the amount of food consumed outside of the home at restaurants or fast-food venues is frequently recommended for weight management. The current study found evidence to support this recommendation and a potential mechanism for the effects. These results suggest that reducing consumption of food away from home can lead to improvements in diet quality and weight loss. Additional research is needed to replicate this finding, determine whether changes in food away from home cause improvements in diet quality and anthropometric outcomes—and mechanisms for this occurrence, and determine the most effective intervention strategies to achieve this target.

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### STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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