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Results of a 2-year randomized, controlled obesity prevention trial: Effects on diet, activity and sleep behaviors in an at-risk young adult population

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Abstract

Excess weight gain tends to occur in young adulthood. However, research examining effective weight-related interventions for this age group has been limited. As one of seven trials in the EARLY Trials consortium (Early Adult Reduction of weight through LifestYle intervention), the CHOICES Study (Choosing Healthy Options in College Environments and Settings) tested effects of a technology-integrated, young adult weight gain prevention intervention. It was a randomized controlled trial with assessments at baseline (2011) and 4-, 12- and 24-months post-intervention initiation and included 441 participants (ages 18-35) who were students at three Minnesota community colleges. The 24-month intervention included a 1-credit academic course and social networking and support online intervention. This analysis examined effects on 12 secondary behavioral outcomes across three domains: diet (fast food, sugary beverages, breakfast, at-home meal preparation), physical activity/screen time (minutes and energy expenditure in leisure time physical activity, television viewing, leisure time computer use) and sleep (hours of sleep, time required to fall asleep, days not getting enough rest, difficulty staying awake). The intervention resulted in significant reductions in fast food (p=0.007) but increases in difficulty staying awake (p=0.015). There was limited evidence of other behavior changes at 4 months (0.05<p<0.1) in the expected direction but differences by treatment condition dissipated over time. Analyses examining summary treatment effects (i.e., modeling effects on all behavioral outcomes simultaneously) indicated significant overall effects (p=0.014), largely driven by 4-month results

(p=0.005). Additional research is needed to understand effective obesity prevention among young adults, particularly when addressing multiple weight-related outcomes.

Introduction

Obesity is a public health concern,[1, 2] and young adults (e.g., ages 18–35) are especially at risk for unhealthy weight gain.[3, 4] The young adult years represent a critical transition period when many young people move out of their family's home, relocate, and establish independent lifestyles. These transition years may also involve other landmark life events, like entering post-secondary education, beginning new jobs, shifting social networks, and childbearing. Despite the importance of this age, research examining effective weight gain prevention strategies for young adults has been limited.[3, 4]

There is a particular need for research in at-risk young adult populations, including those in understudied and non-traditional post-secondary settings, like 2-year community colleges.[5, 6] Nearly 8 million young adults in the U.S. attend 2-year community and technical colleges. These institutions serve a large proportion of students from lower-income and/or minority communities.[7] Previous research has demonstrated that, compared to their counterparts attending 4-year universities, 2-year college students are at significantly greater risk for adverse weight-related factors, including overweight/obesity, physical inactivity, excessive television viewing, and high intakes of soda and fast food.[6] To our knowledge, there have been no randomized controlled weight gain prevention trials conducted on 2-year college campuses; thus this represents an important setting for future research, partnership and outreach.

Several recent reviews [4, 8-10] have identified a limited number of interventions addressing young adult weight gain prevention, with very few specifically addressing at-risk or underserved populations. Many of these studies yielded favorable short-term effects on weight status and/or body composition, but were small-scale pilot studies and lacked data from fully powered randomized trials. Other young adult interventions targeting specific weight-related behaviors, including 19 interventions focusing exclusively on diet-related factors and 7 focusing on physical activity only, have yielded encouraging findings for dietary behaviors, but mixed results for physical activity.[4] This literature thus suggests behavioral interventions targeting young adults may yield a more consistent impact on some types of weight-related behaviors versus others. In addition, some behaviors related to weight have been poorly examined in intervention studies. Specifically, numerous studies show inverse associations between short sleep duration and obesity, particularly among young people.[11-18] but weight gain prevention studies attempting to intervene on sleep remain relatively rare.

The need for targeting multiple weight-related behaviors within an intervention is also important because weight behaviors cluster together,[19, 20] and interventions targeting multiple behaviors may have a greater public health impact than those focusing on singular behavioral targets, particularly given that behavior change, even in the absence of weight change, may have beneficial health effects.[21, 22] However, to date, few young adults obesity prevention studies have used a multiple behavior approach. One study conducted on 13 large

university campuses used online mini-educational lessons to promote a non-diet approach to healthy weight maintenance; the 10-week intervention focused on eating, physical activity and stress and also included sleep content.[23] Overall, the intervention did not have an impact on BMI or weight status, but did yield small, immediate post-intervention improvements in diet, activity and sleep. Another 12-week study of 155 university students evaluated a multiple component intervention requiring participants to complete a contract identifying at least one behavior to improve in the next week (e.g., physical activity, alcohol misuse, sleep) in addition to behavioral self-monitoring; intervention results indicated favorable changes across several health behaviors.[24] More research using multiple behavior intervention approaches is needed, particularly to understand the possible impact of interventions that are sustained for longer durations. Furthermore, interventions utilizing innovative technologies, such as social networking technologies, may be particularly relevant to young adults; to date, early work on such technologies has shown mixed effects on various behavioral outcomes but may have a high degree of relevance to this age group, particularly as the field advances.[25, 26]

To address these gaps in the literature, the Choosing Healthy Options in College Environments and Settings (CHOICES) Study was designed to test an intervention to reduce unhealthy weight gain among 2-year college students;[27] body mass index (BMI) was the primary outcome of the CHOICES study. This study was one of seven randomized, controlled trials funded as part of the EARLY Trials consortium (Early Adult Reduction of weight through LifestYle intervention, earlytrials.org). The purpose of this paper is to describe the impact of the CHOICES intervention on weight-related behaviors intervened upon and assessed as secondary outcomes including dietary, physical activity/screen time and sleep behaviors.

Methods

The CHOICES Study

The CHOICES Study had a randomized, controlled, parallel-group design with a 1:1 randomization ratio. The study tested a 24-month active intervention to prevent excess weight gain in participants 18-35 years of age, including 441 participants from three community colleges in the Twin Cities area of Minnesota (2011-2014).[27] Eligibility requirements were: being 18-35 years old; BMI=20-34.9kg/m^2; and planning to be in the geographic area for 2 years. Original study eligibility requirements were BMI=20-29.9kg/m^2; due to challenging participant enrollment in this population and initial interest from students with BMI 30kg/m^2, investigators expanded the BMI inclusion criteria to 20-34.9kg/m^2 after enrollment began. This change brought CHOICES into alignment with inclusion criteria for other EARLY trials. Individuals with BMI 35kg/m^2 were ineligible because (a) CHOICES was a weight gain prevention trial and (b) individuals with BMI 35kg/m^2 have different intervention needs for weight loss.[28, 29]

Additional EARLY trial criteria excluded participants with significant health problems that are described elsewhere.[27, 30] Study protocols were approved by the University of Minnesota Institutional Review Board.

Intervention and control conditions

The CHOICES intervention consisted of two overlapping components: an academic course and a social network and support website. The intervention focused on several content areas, including diet/nutrition, physical activity, screen time, and sleep. These areas and the intervention-targeted behaviors were identified from previous evidence of leading contributors to weight gain and formative research with 2-year college students.[6, 31, 32] Intervention development was informed by ecological theories of health behavior, social cognitive theory, and social network theory, suggesting weight-related behaviors are influenced by various personal and socio-environmental factors.[27] More detail on the CHOICES intervention is available elsewhere.[27]

Students randomized to the intervention condition participated in a one-credit course offered through the college in which they were enrolled. The course was developed and delivered by CHOICES research staff and focused on eating, activity, sleep habits, and stress management as mechanisms for maintaining and/or achieving a healthy weight. Participants chose between three course sections (online, face-to-face, or hybrid) to meet scheduling needs and learning preferences.

In addition to the course, students randomized to the intervention participated in a social networking and support website, introduced as part of the course and continued as the primary intervention channel for 20 months. The website was password-protected and open only to intervention participants and a limited number of their invited guests. It was designed to reinforce, inform and encourage exchange and support between participants. Students were encouraged to track their weight and up to 10 weight-related behaviors (i.e., sugary beverages, fast food, fruits/vegetables or breakfast consumption; eating mindfully; TV/ movie viewing; computer and internet use, physical activity, sleep duration or stress management) on the website. Trained interventionists primarily interacted with participants through the website, but occasionally used texting and telephone calls to offer encouragement and help problem solve. The website included articles, recipes, quizzes, videos and ways to accumulate points for prizes.

Students randomized to the control condition received health assessments per the study measurement schedule as well as basic health promotion information on a quarterly basis. Students in the control condition were not allowed to enroll in the course and were not granted access to the website. Figure 1 summarizes the study design and activities included in intervention and control conditions.

Blocked randomization was determined using computer-generated randomization. Following baseline measures, the team blocked students on college, weight status and gender, and randomly assigned participants within block into the intervention or control condition. The randomization sequence was generated by the study programmer. Participants were enrolled and notified of randomization assignment by the study coordinator.

Evaluation

Outcome evaluation measures were collected at baseline and 4-, 12- and 24-months post intervention initiation. These included measures of demographic characteristics (e.g.,

gender, race/ethnicity, education, participant income, relationship status), weight-related behaviors (e.g., diet, physical activity, media use), and other related factors. Self-reported income did not include income from other family members, but rather only income from the individual participant. Participants received $100 in gift cards for participating in each outcome assessment.

In this analysis we focused on secondary intervention outcomes in three behavioral domains: dietary factors, physical activity/screen time and sleep. Behavioral outcomes were self-reported by participants at the four measurement time points, and were assessed via survey items included as common elements across all seven EARLY Trials. Objectively assessed height and weight were documented by trained data collectors; these details and results of the primary outcome evaluation are reported elsewhere.[33] (Lytle et al, under review)

Outcome measures

Eating behaviors targeted by the intervention and assessed included: fast food purchasing, sugary beverage and breakfast consumption and frequency of home meal preparation.[33] To assess fast food, participants were asked: "Over the past 30 days, how many times did you buy food at a fast food restaurant, such as McDonald's, Burger King, Arby's, Wendy's, Hardee's, Taco Bell, Taco Johns, Chipotle, KFC, Pizza Hut, Panera, Quiznos, Noodles & Company, Bruegger's Bagels?"[34] Four questions selected from the National Cancer Institute's Diet History Questionnaire (DHQ)[35] asked about past 30-day consumption of soda/pop, fruit drinks, sports drinks and energy drinks. As in the DHQ, two additional questions were included to quantify how often soda/pop and/or fruit drink consumption was diet/sugar-free. Finally, breakfast was assessed by asking "in a typical week, how many times do you eat breakfast?," and home food preparation was assessed via a summary score of responses to three items: "over the past week, how many times did you eat the following meals that were prepared in your home or the place where you live" (breakfast, lunch, dinner; days/week).

Physical activity/screen time behaviors included: energy expenditure for leisure time physical activity (LTPA), total LTPA in minutes, television viewing and leisure time computer use. The Paffenbarger Questionnaire[36] was used to estimate calories expended in leisure activity based on number of stairs climbed and blocks walked, amount of time spent doing light (5 kcal/min), medium (7.5 kcal/min), and high (10 kcal/min) intensity activity, and weekly minutes of LTPA (excluding flights of stairs). Television and leisure time computer use were assessed using weekday and weekend specific items from the CARDIA Study (http://www.cardia.dopm.uab.edu). Daily hours were reported in response to the questions: "on a typical [weekday/weekend day] how much time do you spend sitting while watching TV (including videos on VCR/DVDs)" and "sitting while using the computer for non-work/non-school activities or playing video games."

Finally, four outcomes were used to assess sleep. Daily hours of sleep were calculated based on two items, "What time do you usually go to bed in the evening (turn out the lights in order to go to sleep)?" and "What time do you usually get out of bed in the morning?".[37] Participants were also asked, "on average, how often has it taken you more than 30 minutes to fall asleep after lights out?," "during the past 30 days, for about how many days have you

felt you did not get enough rest or sleep?," and "in the past week, how many days have you had trouble staying awake while driving, eating meals, in class or engaging in social activity?." These items were adapted from the Pittsburgh Sleep Quality Index.[38]

Sample size determination

Sample size was calculated based on power to detect changes in the primary outcome, change in BMI. A sample size of 441 participants provided power to detect <3% change in BMI between treatment conditions using a 2-sided test at 5% Type I error rate with greater than 80% power, an ICC of 0.005, and dropout rate of 20%.

Statistical Analysis

Summary statistics were calculated for overall descriptive and demographic characteristics of the sample, comparing characteristics of the intervention and control condition, as well as the characteristics of those completing 24-month assessments versus those who did not. Behavioral outcomes distributions were examined and transformed, when necessary. This involved log-transformation of several outcomes, and square-root transformation when zeros were present in the data. In some cases, it was not possible to approximate a Gaussian distribution through transformations; thus, three variables (eating breakfast, trouble staying awake, and trouble falling asleep) were dichotomized, and logistic regression was used.

Second, repeated measures analysis was used to examine possible different trajectories over four time periods by condition (3 degrees of freedom (Df) test). Models were adjusted for age, sex, racial category, parental education level, data collection wave, and intervention course section with school as a random effect. Also included were tests (1 Df, each) for differences at each time point, and tests for net differences from baseline per ensuing time period.

Finally, to give a comprehensive view of the intervention, as well as to reflect the flexible structure of allowing participants to select any targeted behavior(s) on which to focus during the intervention (which they could also change throughout the intervention), additional analyses were conducted. To examine summary treatment effects both within and across the three domains (diet, physical activity/screen time, and sleep), the four target behavioral outcomes in each domain were analyzed as repeated outcomes on the same underlying complex, as well as by all twelve outcomes per student marking a global complex of healthy life-style behaviors. In these hierarchical mixed models,[39] the input variables were standardized and modeled as repeated measures using compound symmetry as the covariance matrix.

Results

The average age of participants was 22.8 years. A majority of the sample was female (67.6%), white (72.6%), with an income <$12,000 (66.2%). Approximately 16% of the sample was Black/African American and 7.6% were Hispanic. The only marginally significant sociodemographic or behavioral difference between the intervention and control conditions was for percent of participants identifying as white (intervention: 76.3%, control: 68.7%, p=0.07). (Table 1)

There were no sociodemographic differences between those retained in the study and those who were lost to follow-up, ineligible and/or dropped out, with the exception of race; more non-white than white participants were lost by the 24-month follow-up (p=0.03) (data not shown). In addition, there was no differential retention by eating, activity and/or sleep-related outcomes, except for sugary beverage consumption; those who were lost by the 24-month follow-up reported higher baseline sugary beverage consumption versus those retained (p=0.001) (data not shown).

During the course of the trial, 23 serious adverse events were reported by participants across both conditions. Only one was determined to be possibly, though not probably, related to study participation. All adverse events were reviewed by the study's Data Safety Monitoring Board.

Behavior change over time by treatment group is presented in Table 2. At 24-months, results suggest that the intervention resulted in decreases in fast food consumption (p=0.007) but increases in difficulty staying awake during more than 2 days in the past week (p=0.015), compared to the control condition. In addition, differences in days in the past month not getting enough rest was marginally significant between treatment groups at 24-months (p=0.061). For the 4-month follow-up assessment period only, several behaviors also yielded intervention effects of borderline significance (0.05<p<0.10) in the expected direction including: fast food, breakfast, meals prepared at home; only one yielded statistically significance differences at the p<0.05 level (days in the past month not getting enough rest). Few differences were observed at 12- and 24-month follow-up time points.

Further analyses examined summary treatment effects, both within and across diet, physical activity/screen time and sleep domains, and represent the composite effect of the intervention on multiple behavioral outcomes, considered simultaneously in a hierarchical mixed model (Table 3). When simultaneously examining the intervention effect on all four dietary factors (fast food, sugary beverages, breakfast, home meal preparation), the overall effect was associated with a p-value of 0.082, with time-specific effects also estimated for 4-month (p=0.038), 12-months (p=0.752) and 24-months (p=0.406). Summary level treatment effects were not statistically significant within physical activity/screen time or sleep domains. However, the overall intervention effect was significant when examining all 12 behavioral outcomes simultaneously (p=0.014). These overall effects appear to be primarily driven by effects at the 4-month time point (p=0.005).

Discussion

To our knowledge, this study is the first large-scale, randomized, controlled trial of its kind to evaluate a weight gain prevention intervention among young adults attending two-year community colleges. The intervention appeared to be effective in reducing consumption of fast food and but may not have been entirely beneficial for sleep. These effects were seen at 24 months after adjusting for covariates. In addition, at 4 months, which corresponds to immediately after the required one-credit course, marginal effects (p<0.10), in the expected direction were seen for fast food consumption, eating breakfast, and preparing meals at home, and significant effects (p=0.019) were seen at 4 months for the number of days in the

past month that participants reported not getting enough rest. Interestingly, further ad hoc analyses examining intervention effects on multiple behavioral outcomes simultaneously indicated statistically significant differences between intervention and control groups. These effects were significant for the 24-month intervention overall and appeared to be largely driven by differences at the 4-month assessment period.

These results run parallel to those from other weight management trials yielding some short-term effects that are not sustained over time.[8] CHOICES included an active 24-month intervention, which is much longer than other interventions reported to date with the young adult age group.[4] Process evaluation showed that engagement was high during the first intervention phase (i.e., including the CHOICES course and initial months of website utilization).[40] However, consistent with other trials using similar intervention platforms,[41-43] engagement declined thereafter. After the first 4 months of the intervention, process results indicate that 30-40% of participants continued to engage in the CHOICES website. Overall, previous research has shown that participant engagement is particularly challenging among the young adult age group.[44]

The results of the summary treatment effects analysis are notable, given they take into account simultaneous behavior change across multiple domains. Importantly, they also reflect the flexible structure of the CHOICES intervention, which allowed participants to select any targeted behavior(s) on which to focus (and which they could change at any time throughout the 24-month intervention). Formative research contributing to the development and refinement of the intervention indicated that providing flexibility and choice to young adult participants was critical.[31] As a result, CHOICES was designed with multiple options for participants regarding modes of intervention delivery, mechanisms for communication, behavioral targets for goal setting and various other factors. Study process evaluation results indicated a high degree of participant satisfaction, likely because of this design feature.[40]

These issues of flexibility and choice, however, present challenges for traditional statistical models and examination of intervention effects. For example, participants were not consistently focusing on the same behaviors at the same time. Since behavioral targets were self-selected, some individuals only focused on a subset of behaviors throughout the 24-month intervention. The study, however, was not powered to examine differences between small groups of participants that selected common behavioral targets at various times during the intervention. Thus, a more comprehensive approach was needed to simultaneously examine intervention effects on numerous weight-related behavioral outcomes of interest. To our knowledge, this is a relatively novel method for examining intervention effects in a trial that targeted multiple behaviors and has not been widely utilized in the literature to date.

Limitations of this research include insufficient statistical power to detect behavioral changes across participant sub-groups, self-reported assessments of behavioral outcomes (which include a notable degree of bias and error) and limited external validity since this study occurred in one metropolitan area. These results may not be generalizable to community colleges across various regions of the U.S. In addition, our sample is limited in racial/ethnic diversity, and thus results cannot be generalized across all racial/ethnic groups. Future research would benefit from studies powered to examine the effect of multiple

behavior change strategies on weight gain prevention (rather that being powered only by a weight-related outcome, such as BMI) and by studying similar intervention approaches in more diverse populations. Finding affordable and acceptable objective measures of weight-related behaviors, especially diet, screen time and sleep, remain a significant challenge for population-based intervention research.

Conclusions

Few weight gain prevention interventions to date have focused on this age group.[4] Large-scale, randomized controlled trials addressing the needs of at-risk or underserved young adults and targeting an array of weight-related behaviors are particularly lacking. CHOICES was centered on a multi-dimensional intervention design including both online and in-person delivery components,[27] and it was informed by a multifaceted formative research phase that included a range of key stakeholders and students.[31] With obesity risk in young adults a national concern and the paucity of work among two-year colleges students, more work in this area is needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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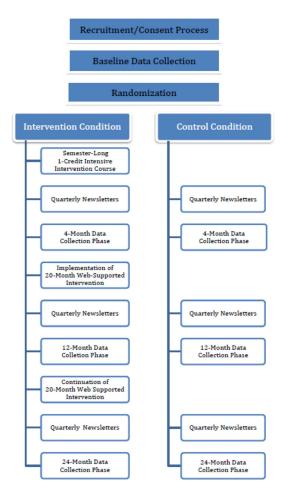
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Highlights

- Few randomized controlled obesity prevention trials have targeted young adults.

- The CHOICES intervention had limited impact on individual weight-related behaviors.

- Effects were significant when examining 12 behavioral outcomes simultaneously.

- Effects observed 4 months post intervention initiation were not evident by 1 year.

- Obesity research is needed to address multiple behavioral outcomes in young adults.

Figure 1.
Study Design, Measurement Periods and Intervention Elements: The CHOICES Study

Table 1

Sample characteristics at baseline: The CHOICES Study.

	Total (n=441)	Intervention (224)	Control (n=217)	P-value[1]
Gender, Female (%)	67.6	67.0	68.2	0.78
Race/ethnicity				
White (%)	72.6	76.3	68.7	0.07
Hispanic or Latino origin (%)	7.5	7.6	7.4	0.93
Current relationship status				
Single or casually dating (%)	54.6	53.8	53.3	0.75
Age at randomization, years	22.8	22.9	22.8	0.84
Income				
Less than $12,000 (%)	66.2	67.9	64.5	0.46
Dietary factors				
Fast food (times/week)	1.7	1.7	1.8	0.45
Sugary beverages (times/day)	0.9	0.8	1.0	0.13
Breakfast 5-7 days/week (%)	51.5	51.8	51.2	0.89
Weekly meals prepared at home (total)	13.5	13.5	13.4	0.86
Activity				
Energy expenditure: Leisure time physical activity (kcals)	2076.2	2169.3	1979.2	0.51
Leisure time physical activity (weekly minutes)	270.8	295.5	245.5	0.20
Television (hours/day)	1.5	1.6	1.5	0.58
Leisure-time computer use (hours/week)	1.2	1.2	1.2	0.63
Sleep				
Total daily sleep (hours)	8.4	8.4	8.3	0.36
Days/month not getting enough rest	9.1	9.4	8.8	0.37
Difficulty staying awake >2 days/week (%)	7.7	6.2	9.2	0.24
30 minutes to fall asleep 3-7 nights/week (%)	28.8	32.1	25.4	0.11

Table 2

Treatment effects on secondary weight-related outcome variables: The CHOICES Study.

Domain	Outcome	Analysis using available data								Overall Effect
		Baseline		4 months		12 months		24 months		P(df=3)
		N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	
Dietary factors										
	Fast food (times/week)									
	Intervention (I)	212	1.6 (0.2)	194	1.3 (0.1)	188	1.5 (0.2)	179	1.3 (0.1)	0.007
	Control (C)	209	1.9 (0.2)	194	1.9 (0.1)	184	1.4 (0.2)	174	1.4 (0.1)	
	I-C difference		−0.3		−0.6		0.1		−0.1	
	p-net		—		0.059		0.157		0.504	
	Sugary beverages (times/day)									
	Intervention	212	0.7 (0.1)	194	0.7 (0.1)	188	0.6 (0.1)	179	0.6 (0.1)	0.608
	Control	209	0.8 (0.1)	194	0.7 (0.1)	184	0.6 (0.1)	174	0.7 (0.1)	
	I-C difference		−0.1		0.00		0.0		−0.1	
	p-net		—		0.652		0.254		0.890	
	Eat breakfast 5-7 days/week									
	Intervention	212	50.9% (3.8)	194	56.7% (3.9)	188	59.3% (4.0)	179	62.5% (4.2)	0.299
	Control	209	54.1% (3.9)	194	49.9% (4.0)	184	57.6% (4.1)	174	59.5% (4.2)	
	I-C difference		−3.2%		6.8%		1.7%		3.0%	
	p-net		—		0.057		0.413		0.318	
	Weekly meals prepared at home (total)									
	Intervention	211	13.3 (0.4)	194	13.2 (0.4)	188	13.2 (0.4)	179	13.9 (0.4)	0.284
	Control	209	13.7 (0.4)	193	12.7 (0.4)	184	13.3 (0.4)	174	13.6 (0.4)	
	I-C difference		−0.4		−0.5		−0.1		0.3	
	p-net		—		0.070		0.591		0.257	
Physical activity and screen time										
	Energy expenditure for leisure time physical activity (weekly kcals)									
	Intervention	212	2289.0 (216.2)	194	2128.7 (178.3)	188	1712.9 (171.9)	179	1700.3 (166.8)	0.343
	Control	208	1989.8 (218.2)	194	1750.6 (178.4)	184	1659.8 (173.3)	173	1766.8 (167.5)	
	I-C difference		299.2		378.1		53.1		−66.5	
	p-net		—		0.083		0.277		0.726	

Domain	Outcome		Baseline		Analysis using available data						Overall Effect
					4 months		12 months		24 months		P(df=3)
		N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)		
	Leisure time physical activity (minutes)										
	Intervention	212	310.0 (29.3)	194	282.2 (24.5)	188	234.9 (21.8)	178	212.5 (21.9)		0.538
	Control	209	245.4 (29.5)	192	208.5 (24.6)	183	202.5 (22.1)	174	220.7 (21.9)		
	I-C difference		64.6		73.7		32.4		−8.2		
	p-net		—		0.165		0.733		0.622		
	Television (hours/day)										
	Intervention	212	1.5 (0.1)	194	1.4 (0.1)	188	1.4 (0.1)	179	1.3 (0.1)		0.570
	Control	209	1.5 (0.1)	194	1.5 (0.1)	184	1.3 (0.1)	173	1.2 (0.1)		
	I-C difference		0.0		−0.1		0.1		0.1		
	p-net		—		0.470		0.584		0.574		
	Leisure-time computer use (hours/day)										
	Intervention	212	1.2 (0.1)	194	1.3 (0.1)	188	1.2 (0.1)	179	1.2 (0.1)		0.605
	Control	209	1.3 (0.1)	194	1.3 (0.1)	184	1.2 (0.1)	174	1.1 (0.1)		
	I-C difference		−0.1		0.0		0.0		0.1		
	p-net		—		0.404		0.499		0.182		
Sleep	**Total daily sleep (hours)**										
	Intervention	210	8.4 (0.1)	194	8.2 (0.1)	188	8.3 (0.1)	179	8.4 (0.1)		0.126
	Control	209	8.3 (0.1)	194	8.3 (0.1)	184	8.3 (0.1)	174	8.1 (0.1)		
	I-C difference		0.1		−0.1		0.0		0.3		
	p-net		—		0.245		0.438		0.155		
	Days in the past month not getting enough rest										
	Intervention	212	7.4 (0.5)	194	6.5 (0.6)	188	6.3 (0.6)	179	5.8 (0.5)		0.061
	Control	208	7.4 (0.6)	194	8.2 (0.6)	184	6.4 (0.6)	174	6.6 (0.6)		
	I-C difference		0.0		−1.7		−0.1		−0.8		
	p-net		—		0.019		0.951		0.313		
	Difficulty staying awake during more than 2 days in the past week										
	Intervention	212	5.0% (1.5)	194	4.3% (1.3)	188	8.4% (1.9)	179	9.5% (2.1)		0.015

Domain	Outcome		Analysis using available data									Overall Effect
			Baseline	**4 months**		**12 months**		**24 months**				**P(df=3)**
		N	**Mean (SE)**	**N**	**Mean (SE)**	**N**	**Mean (SE)**	**N**	**Mean (SE)**			
	Control	209	11.2% (2.5)	194	17.4% (3.1)	184	12.6% (2.8)	174	10.8% (2.6)			
	I-C difference		−6.2%		−13.1%		−4.2%		−1.3%			
	p-net		—		0.190		0.408		0.139			
Takes 30+ minutes to fall asleep on 3-7 nights/week												
	Intervention	212	29.2% (3.5)	194	25.8% (3.4)	188	26.1% (3.3)	179	27.7% (3.5)			0.369
	Control	209	25.8% (3.5)	194	23.6% (3.4)	184	30.1% (3.7)	174	23.8% (3.6)			
	I-C difference		3.4%		2.2%		−4.0%		3.9%			
	p-net		—		0.837		0.171		0.911			

Models adjusted for sex, racial category, cohort, the maximum education of parents of the respondent (as a measure of socio-economic status), and included school as a random effect. All estimates (including I-C difference estimates) are subject to a small degree of rounding error.

Table 3

Summary treatment effects on secondary weight-related outcomes by domain: The CHOICES Study.

Domain		Baseline	Analysis using available data			Overall Effect
		Mean (SE)	4 month Mean (SE)	12 month Mean (SE)	24 moth Mean (SE)	P(df=3)
Dietary factors	Intervention-Control difference	--	0.13 (0.6)	−0.02 (0.06)	0.05 (0.06)	0.082
	p-net	—	0.038	0.752	0.406	
Physical activity and screen time	Intervention-Control difference	--	0.10 (0.06)	0.03 (0.07)	−0.02 (0.07)	0.263
	p-net	—	0.109	0.700	0.769	
Sleep	Intervention-Control difference	--	0.09 (0.07)	−0.004 (0.07)	0.02 (0.07)	0.483
	p-net	—	0.182	0.958	0.824	
TOTAL	Intervention-Control difference	--	0.11 (0.04)	0.002 (0.04)	0.02 (0.04)	0.014
	p-net	—	0.005	0.966	0.681	

NOTE: Models adjusted for sex, racial category, cohort, the maximum education of parents of the respondent (as a measure of socioeconomic status), and intervention course section and included school as a random effect. Dietary results included 4 variables modeled simultaneously: frequency of consuming fast food, sugary beverages, eating breakfast and meals at home. Physical activity and screen time included: energy expenditure and time spent in leisure time physical activity, hours of television viewing and leisure-time computer use. Sleep included: total hours, days in the past month not getting enough rest, difficulty staying awake more than two days in the past month and taking 30+ minutes to fall asleep on 3–7 nights/week. Total effects represent the results of all 12 behavioral variables modeled simultaneously across the three domains (diet, physical activity/screen time and sleep).