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Weight Gain Reduction Among 2-Year College Students: The CHOICES RCT

Leslie A. Lytle, PhD[1], **Melissa N. Laska, PhD**[2], **Jennifer A. Linde, PhD**[2], **Stacey G. Moe, MPH**[2], **Marilyn S. Nanney, PhD**[3], **Peter J. Hannan, MStat**[2], and **Darin J. Erickson, PhD**[2]

[1]Department of Health Behavior, University of North Carolina, Chapel Hill, North Carolina

[2]Division of Epidemiology, University of Minnesota, Minneapolis, Minnesota

[3]Department of Family Medicine and Community Health, University of Minnesota, Minneapolis, Minnesota

Abstract

Introduction—The young adult years have been recognized as an influential period for excess weight gain. Non-traditional students and those attending 2-year community colleges are at particularly high risk for a range of adverse weight-related outcomes.

Design—Choosing Healthy Options in College Environments and Settings was an RCT with students randomly assigned into a control or intervention condition after baseline assessment. The study was designed to evaluate if a 24-month weight gain prevention intervention reduces the expected increase in BMI and overweight prevalence in young adults attending 2-year colleges. Two cohorts were recruited, corresponding to the fall and spring semesters. Data collection occurred at four time points for each cohort, with baseline occurring in fall 2011 for Cohort 1 and spring 2012 for Cohort 2. The 24-month follow-up occurred in fall 2013 for Cohort 1 and spring 2014 for Cohort 2. Data analysis occurred in 2015–2016.

Setting/participants—This research was conducted with 441 students from three community colleges in Minnesota.

Intervention—The 24-month intervention began with a 1-credit college course on healthy weight behaviors. A social networking and social support website was introduced as part of the course and participation encouraged for the duration of the trial.

Address correspondence to: Leslie A. Lytle, PhD, Professor and Chair, Department of Health Behavior, Gillings School of Global Public Health, Campus Box 7440, University of North Carolina, Chapel Hill NC 27599-7440. llytle@email.unc.edu.

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Author contributions: Leslie Lytle, PhD, the principal investigator of the study, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis; study concept and design: Lytle and Laska; acquisition of data: Lytle and Moe; analysis and interpretation of data: Lytle, Laska, Hannan, and Erickson; drafting of the manuscript: Lytle; critical revision of the manuscript for important intellectual content: Lytle, Laska, Linde, Moe, Nanney, and Hannan; statistical analysis: Hannan and Erickson; administrative, technical, or material support: Moe; obtained funding: Lytle; and study supervision: Lytle, Laska, and Moe.

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Main outcome measures—Changes in BMI, weight, body fat percentage, waist circumference, and weight status were assessed.

Results—Retention of the cohorts at 24 months was 83.4%. There was not a statistically significant difference in BMI between conditions at the end of the trial. However, there was a statically significant difference in the prevalence of overweight/obesity between treatment conditions at 24 months. Also, participants randomized to the intervention who were overweight or obese at baseline were more than three times as likely to transition to a healthy weight by the end of the trial as compared with control students.

Conclusions—The intervention was not successful in achieving BMI differences between treatment groups. However, an 8% reduction in the prevalence of overweight and obesity over time may have population-level significance.

INTRODUCTION

Obesity is a major public health priority.[1,2] The young adult years in particular (e.g., age 18–35 years) have been recognized as an influential period for excess weight gain and unhealthy weight-related behaviors.[3,4] National Health and Nutrition Examination Survey data indicate that 67.1% of men aged 20–39 years and 55.8% of women aged 20–39 years were overweight or obese in 2010–2011.[5] Furthermore, approximately 5.5 million Americans are obese by the time they reach their third decade of life.[6] At-risk young adult populations, such as non-traditional students and those attending 2-year community colleges, are at particularly high risk for a range of adverse weight-related outcomes.[7,8] In a study of more than 16,000 students attending 27 post-secondary campuses in Minnesota, Laska and colleagues[8] found that students enrolled in 2-year colleges, particularly women, had a higher prevalence of overweight and obesity, lower levels of physical activity, more TV viewing, and higher intakes of soda and fast food compared with students attending 4-year colleges. Disparities persisted even after accounting for a range of sociodemographic factors known to differ between these 2-year and 4-year college students.

The importance of helping individuals maintain a heathy weight is paramount. Recent research shows that once individuals gain weight, losing weight and maintaining that weight loss is extremely difficult.[9] Strategies that help individuals maintain a healthy weight, especially during high-risk life stages such as young adulthood, are likely the most effective approach for reducing obesity-related morbidity and mortality.

Despite the importance of this life stage and preventing unhealthy weight gain, scholarly work testing effective weight-related health promotion strategies for young adults is just emerging.[3,4,10] Several recent systematic scientific literature reviews focusing on interventions to prevent overweight and obesity in young adults have identified major gaps in the literature. For example, Partridge et al.[10] identified 21 RCTs published between 1980 and 2014 that utilized lifestyle interventions for weight loss or weight gain prevention in young adults examining BMI or weight change as their primary outcome. More than half of the studies were effective in the short term for reducing BMI or weight; however, only one of the five studies that looked at maintenance saw an effect at follow-up.[10] The nascent nature of the field is also reflected in limited external validity, interventions of very short

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duration, and lack of long-term follow-up. Furthermore, none of the studies reviewed were conducted in the 2-year college setting.[4,10]

The use of technology to successfully engage participants in weight-related interventions has been identified as a priority area for future research with the young adult age group.[4,11] Technology-based eHealth strategies have been shown to be successful in the promotion of a wide range of healthy behaviors in other age groups and populations.[12–19] However, in the review by Partridge and colleagues,[10] only 29% of the interventions with young adults used any kind of technology. Of six studies that used some technology,[20–24] three[20,22,23] saw no intervention effects, two[24] saw effects for a difference in body weight but not BMI, and only one[21] saw a significant intervention effect for BMI.

To advance the field, the National Heart, Lung, and Blood Institute of NIH funded the EARLY consortium (www.earlytrials.org). This collaboration consisted of seven research sites charged with conducting technology-based intervention trials to test innovative behavioral or environmental approaches for weight control in young adults at high risk for weight gain[11,25] (RFA-HL-08-007). The Choosing Healthy Options in College Environments and Settings (CHOICES) study was one of seven trials funded through the consortium, and tested the effectiveness of a 24-month intervention to reduce unhealthy weight gain in 2-year community college students.[26] This manuscript describes the main results of the CHOICES study.

The primary hypothesis tested in CHOICES was that students randomized to an intervention condition would experience a smaller increase in BMI after a 24-month intervention as compared with students randomized to a control condition. A secondary hypothesis was that the intervention would result in significantly lower prevalence of overweight and obesity in students randomized to the intervention condition as compared with those randomized to the control condition.

METHODS

Study Design

The study design was an RCT, recruiting 441 students from three 2-year colleges to participate in a 24-month intervention to help students maintain or achieve a healthy weight. After consenting and baseline assessments, students were randomized to the intervention or control condition. Students randomized to the intervention condition received a 24-month intervention. Students randomized to the control condition received health assessments with their measurement visits as well as basic health promotion information on a quarterly basis.[27] Data for the study were collected at baseline (2011/2012), 4 months (2012), 12 months (2013), and 24 months (2014) post-randomization.

Three 2-year colleges in the Twin Cities, Minnesota metropolitan area agreed to participate in the study by committing to help with recruitment and retention activities, provide a space for measurement visits on campus, and to offer the 1-credit course to students randomized to the intervention. CHOICES study staff recruited students to participate in the study with help from the administrative offices at the colleges using a variety of approaches.[28] Two

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cohorts of students were recruited to participate in the study with a cohort beginning at both the fall and spring semester to be coincident with the offering of the intervention course. Details on recruitment and retention are available elsewhere.[28]

Students who expressed an interest in the study were prescreened for their eligibility. The main eligibility requirements included: (1) being aged 18–35 years; (2) having a BMI between 20 and 34.9 kg/m^2; and (3) planning to live in the geographic area for at least 2 years. A BMI of ≥20 was chosen as the lower cut point to help guard against unhealthy weight loss. Once students met the prescreening criteria, they were asked to provide informed consent that included an agreement to comply with their random assignment into the intervention or control condition and, if randomized into the intervention condition, to participate in the CHOICES intervention. A final screening occurred when baseline measures were taken including assessment of height and weight by study staff; interested students not meeting the BMI criteria were excluded from the study at that time. Following baseline measures students were blocked by college, weight status, and gender, and then randomly assigned within block to the intervention or control condition. The data management team used a random allocation sequence to assign participants to either condition.

Students who consented to participate in the study were provided up to $100 for each measurement visit, for a maximum potential compensation of $400. Participants also received results from their health assessments, and, if randomized to the intervention, had fees for the 1-credit class paid by the research grant and were given full access to the CHOICES study website. The IRB: Human Subjects Committee at the University of Minnesota approved all protocol for the CHOICES study.

The intervention and conceptual model guiding the intervention are described in detail elsewhere.[26] Briefly, students randomized to the intervention condition were required to enroll in a 1-credit, semester-long academic course at their college, designed and taught by CHOICES study staff. The course was based on the Sleep, Eat, and Exercise course[29] from the Rothenberger Institute at the University of Minnesota (www.ri.umn.edu/) that focuses on behaviors related to healthy weight maintenance (diet, physical activity, stress management, and sleep). Students could choose to enroll in an online, face-to-face, or hybrid version of the course. A social network website designed for the CHOICES study was introduced in the course and encouraged self-monitoring, goal setting, and interaction around the same health behaviors taught in the course. In addition to being able to self-monitor and set goals for ten unique behaviors (including sleep, stress management, screen time, eating breakfast, fruits, vegetables, sugar-sweetened beverage and fast food intake, physical activity, mindful eating) and weight, the website also included a discussion forum for students to engage with each other on a variety of topics, an “Ask the Expert” section where students could ask confidential questions about a personal challenge or health issue, and a hot topics page where news articles were posted. Incentives in the form of points for participation were provided and could be redeemed for a variety of wellness-related products such as yoga mats and cooking utensils. These incentives and periodic encouragement via e-mail from intervention staff were used to encourage students to participate in the website during the 24-month intervention period.

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Measures

Assessments included a measurement visit at the participant's college where height, weight, waist circumference, and body fat were assessed by trained study staff and where participants completed a paper/pencil survey. Anthropometric measurements were assessed by trained and certified data collectors following the protocol established for all of the EARLY trials.[25] The protocol included assessing height using a calibrated stadiometer graduated in cm and assessing weight using a calibrated digital scale that measured weight to the nearest 0.1 kg. Height and weight were assessed at each measurement period and used to calculate BMI. Waist circumference was taken and recorded to the nearest 0.1 cm using a Gullick tape measure. Proportion of body fat was assessed using a Tanita Scale measuring bioelectrical impedance (TBF-300A) and blood pressure was assessed using the Critikon Dinamap 8100 monitor. The CHOICES survey asked respondents to report their demographic characteristics (including sex, age, race/ethnicity, household education, and income), behavioral patterns, and other psychosocial and affective characteristics. Students were also asked to complete two dietary recalls online using the Automated Self-Administered 24-hour dietary recall system.[30] In addition to baseline assessments, there was an attempt to follow and assess all participants at 4 months (at the end of the 1-credit college course) and again at 12 and 24 months.

Statistical Analysis

Descriptive statistics were used to describe the demographic characteristics and weight-related variables of the baseline sample. The primary outcome analysis used hierarchical linear models having repeated measures of the outcome regressed on experimental condition, adjusted for baseline age (linear), sex, race, and household education level (all categorical) as well as recruitment cohort (two levels: fall semester, spring semester) and college (three levels). Residuals were correlated using a Toeplitz pattern to account for correlation due to repeated measurement of the same individuals over time. The four continuously distributed outcomes (BMI, weight, waist circumference, body fat percentage) were modeled using linear regression and the single categorical outcome (overweight/obese: BMI ≥25, BMI <25) used logistic regression. The overall intervention effect was tested using a 3-df **time** (four levels: 0, 4, 12, and 24) × **condition** (two levels: intervention, control) interaction, with 1-df planned contrasts used to test net differences (intervention minus control at 4 months, 12 months, or 24 months vs intervention minus control at baseline). Although few data were missing, a series of 100 imputations using a very full imputer's model were run and analyzed using the same models. The results were very consistent and analyses of available data only are presented here. To examine longitudinal transitions between healthy weight (BMI <25 kg/m^2) and overweight (BMI ≥25 kg/m^2) or vice versa over the course of the study, the data were separated by baseline weight status, and analyzed using logistic models as before (but without repeated measures), providing adjusted probabilities for transition between categories of weight status by randomization status. All analyses were conducted using SAS, version 9.3 and occurred in 2014–2015.

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RESULTS

A total of 441 students participated in baseline measurement and were randomized to conditions. Figure 1 shows the CONSORT diagram tracking those initially expressing interest in the study to the data available at the final 24-month assessment. Of the 962 individuals who expressed interest in the study, 519 were determined to be ineligible at the initial contact, pre-screening assessment, or baseline visit. The most frequent reasons for ineligibility were: (1) age out of range; (2) not attending a participating 2-year college; or (3) BMI out of range. Of the remaining 443 individuals, two dropped out prior to randomization.

Table 1 shows the demographic characteristics of the total sample at baseline and by treatment condition, those remaining at 24 months, and those lost to attrition. The baseline sample was primarily female (67.6%) and white (72.6%) with a mean age of 22.7 years. Approximately two thirds of the sample had a yearly income <$12,000. Mean BMI for the total sample was 25.4 kg/m^2 and fewer than half (46.7%) of the baseline sample were overweight or obese (BMI ≥25). Nearly one third were overweight (32.9%) and 14% were obese (data not shown).[31] There were no statistically significant differences ($p \leq 0.05$) by treatment condition for any of these characteristics post-randomization. At the 24-month measurement period, 368 participants were assessed and height and weight were available on 366 participants, resulting in a retention rate of 83.4%.[28] There were statistically significant differences ($p \leq 0.05$) between the sample retained for the entire 24 months and the sample lost to follow-up by race/ethnicity (with those lost to follow-up more likely to be non-white) and by income (with those lost to follow-up more likely to have a higher income or report they didn't know their income). There was no differential dropout by treatment condition with the exception of sex. Women in the intervention condition were slightly more likely to drop out as compared with women in the control condition ($p=0.05$, data not shown).[28]

Table 2 shows the adjusted mean values and SEs for BMI, weight in kg, waist circumference, body fat percentage, and prevalence of overweight and obesity by condition at each of the four measurement periods, adjusting for demographic characteristics and controlling for college and cohort as fixed effects. The net difference between conditions over the 24-month period is presented with the *p*-value for the adjusted model; the net difference accounts for the differences in outcomes by condition at baseline as well as any differences in baseline covariates related to the outcomes by condition. There were no statistically significant differences by treatment condition for BMI, weight, waist circumference, or body fat percentage. The prevalence of overweight or obesity was significantly lower in the intervention condition as compared with the control condition at 24 months (net difference, 8.3%; $p=0.049$). By the end of the intervention, 46.5% of the intervention participants were overweight or obese as compared with 57.6% of those in the control group.

After running the analysis for the primary and secondary outcomes, several additional analyses were run to try to better understand why no differences in BMI were seen by treatment group whereas differences in prevalence of overweight/obesity were seen. It was

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hypothesized that the inability to see differences in BMI at 24 months between treatment groups might be caused by outliers in BMI shift: Because only small changes in BMI were expected in this weight gain prevention study, large weight changes in either group might have affected mean BMI.

Therefore, the distribution of weight change across the sample was examined and those with very large shifts in weight between the baseline and the 24-month measurement period (a change of >15% body weight) were considered to be outliers. Thirty-two participants (18 from intervention and 14 from control) gained >15% and four participants (two from each condition) lost >15% of their body weight between baseline and 24 months across the two conditions. These 36 cases were eliminated from the data and the primary analysis was re-run on the reduced sample; no significant differences between treatment conditions at any time point were found (p=0.38 at 4 months; p=0.45 at 12 months; p=0.82 at 24 months).

Another approach recommended by Stevens et al.[32] was considered, which involved looking at differences by condition in those who maintained their weight, gained weight, and lost weight between baseline and the 24 month period; a 3% difference from baseline was considered a change and weight stability of <3% gain or loss was considered maintenance. The transition between those categories by treatment condition was examined using chi-square analysis. Across the entire sample, more than half (53.6%) gained weight and 20% lost weight during the trial. At the end of the trial, 21.4% of intervention participants lost weight versus 18.4% of those in the control condition and 54.6% of those in the intervention condition gained weight as compared to 52.5% of those in the control condition. When comparisons of weight change categories were examined by the treatment condition, there were no significant intervention effects (p=0.52).

Finally, as exploratory analyses, the effectiveness of the intervention to help college students identified as overweight or obese lose weight and to help healthy weight students maintain a healthy weight was examined by evaluating the transition between weight categories by treatment condition. Consistent with the primary and secondary analyses, these exploratory analyses were adjusted for age, sex, race, and household education and included college and cohort as fixed effects. At baseline, 90 participants randomized to the intervention condition and 82 individuals randomized to the control condition were overweight or obese (BMI ≥25 kg/m^2). At 24 months, nearly 14% of the intervention participants who started the trial as overweight or obese transitioned into a healthy weight (BMI <25 kg/m^2) whereas only 4% of participants in the control condition who started overweight or obese transitioned into a healthy weight category; the difference by treatment condition was statistically significant (p=0.02). In addition, at baseline, 97 participants from each treatment condition started at a healthy weight. Nearly 24% of those randomized to the control condition transitioned from being a healthy weight to overweight or obese by the end of the trial whereas 17% of those randomized to the intervention condition transitioned to the overweight or obese category; the difference by condition was not statistically significant (p=0.24).

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DISCUSSION

This study was one of the first weight gain prevention trials in young adults to test an intervention of 24-month duration and the only one to date to be conducted with 2-year college students.[10,23] The CHOICES study did not yield a significant treatment effect for BMI at 24 months. Results from CHOICES were similar to other weight management trials in young adults; very few positive long-term results in obesity prevention interventions in young adults have been realized.[10]

Technology-based interventions hold some hope for increasing the reach of interventions as well as providing a platform that might be particularly engaging to young adults.[12–19] But, results using technology as a weight management intervention strategy have been mixed and those of long duration often find that engagement in technology decreases over time. A review of web-based behavior change interventions[13] showed that attracting and maintaining participants' attention in a web-based intervention is quite challenging.

Engagement was examined as an issue in the CHOICES outcomes. Overall, engagement in the 1-credit course was very good,[34] where fewer than 15% dropped out of the course before the end of the semester and the vast majority of students (69%–100%) completed all of the activities required in the course (i.e., setting goals and completing homework activities). In the face-to-face course, attendance was high with nearly 80% attending all classes; reported satisfaction with the course was also very high. Continued engagement with the social networking website was more problematic. At the beginning of the intervention, at least 50%–60% of participants logged in and self-monitored their weight at least once a month; but by the end of the 24 months, those rates had fallen to only about 30% regularly logging their weight.[34] Despite the drop off in engagement, at the end of the 24-month intervention, 91.5% of intervention participants reported being somewhat or very satisfied with the intervention and 94% said that they would recommend it to others.[34] Similarly, the Cell phone intervention for you (CITY) trial[33] (one of the seven EARLY Trials[25]) was an RCT of a behavioral weight loss intervention in young adults that used cell phones and apps as their intervention platform in their 24 month intervention. Engagement with the CITY cell phone app dropped from nearly five times per day in the first 6 months of the intervention down to less than once a day by the end of the trial. Although technology-based interventions are appealing because of their reach and cost effectiveness, sustaining young adults' engagement in health promotion activities using technology is very challenging as their social media options are vast, technologically very sophisticated, and highly competitive for their time.

The CHOICES study did result in a significant difference in change in the prevalence of overweight/obesity by condition as observed by the widening gap in prevalence beginning at the 4-month assessment period and reaching a statistically significant difference of more than 8% by the final assessment period. In addition, participants randomized to the intervention condition with a BMI of ≥25 kg/m^2 at baseline were more than three times as likely as their control counterparts to transition to a healthy weight by the 24-month period. Therefore, the CHOICES intervention appeared to be effective as an obesity treatment program for participants starting the trial overweight or obese. CHOICES' apparent success as a weight loss intervention may be because the students who were the heaviest were more

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motivated and ready to make the behavioral changes recommended and reinforced through the intervention.

An intervention's effect on both change in BMI and prevalence of overweight is rarely examined in weight loss or weight gain prevention studies. None of the articles included in the review by Partridge and colleagues[10] of weight gain prevention studies of young adults evaluated change in the prevalence of overweight or obesity by treatment condition. However, both BMI and prevalence change were examined in Bright Start, a weight gain prevention trial conducted with American Indian children, and a similar pattern of outcomes was seen.[35] Although the Bright Start intervention did not result in a statistically significant change in mean levels of BMI, BMI-Z, skinfolds, or body fat percentage, the intervention resulted in a 10% lower prevalence of overweight and obesity in the intervention as compared with the control condition.[35]

Prevalence of overweight and obesity is directly linked to population-level health outcomes. The HEALTHY study, a multisite school-based study designed to mitigate risk for Type 2 diabetes, examined cardiometabolic risk associated with shifts in weight category. The study found that a shift from a healthy weight category to an overweight or obese category during adolescence was associated with clinically meaningful changes in cardiometabolic risk, including glucose, insulin, systolic and diastolic blood pressure, and lipids.[36] In addition, the Coronary Artery Risk Development in Young Adults study, a prospective, epidemiologic investigation of the determinants and evolution of cardiovascular disease in young adults, showed that participants who were classified at baseline as overweight or above based on a BMI of ≥25 kg/m^2 had statistically significantly greater risk for coronary artery calcification at the 15-year follow-up visit as compared with those entering young adulthood at a healthier weight.[37]

Limitations

There are limitations to this research. Although this study was conducted in the community as an effectiveness trial, additional research with other young adults in 2-year community colleges is warranted. Tracking the cohort over time would be desirable to determine if the difference in prevalence rates by condition persists and to evaluate if the delay in the onset of overweight or obesity carries with it health benefits. Because of sample size constraints, the categories of overweight and obesity were combined. Additional insights might be gleaned from examining intervention impact and transitions between three categories of weight status. Sample size constraints also limit the inferences that can be made on the exploratory analysis that considers the intervention's impact on students entering the trial overweight or obese.

CONCLUSIONS

In spite of these limitations, this is an important study with significant findings. A reduction in the prevalence of overweight and obesity in young adults may positively impact chronic disease risk in clinically relevant ways.[37–40] The intervention also appears to have helped overweight students transition into a healthy weight. Finally, the intervention was designed with reach and ease of dissemination in mind. A weight management course offered through

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colleges and a web-based intervention represent useful public health approaches to reduce the burden of obesity in young adults.

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REFERENCES

1. Flegal KM, Kruszon-Moran D, Carroll MD, Fryar CD, Ogden CL. Trends in Obesity Among Adults in the United States, 2005 to 2014. JAMA. 2016; 315(21):2284–2291. http://dx.doi.org/10.1001/jama.2016.6458. [PubMed: 27272580]
2. Ogden CL, Carroll MD, Lawman HG, et al. Trends in Obesity Prevalence Among Children and Adolescents in the United States, 1988–1994 Through 2013–2014. JAMA. 2016; 315(21):2292–2299. http://dx.doi.org/10.1001/jama.2016.6361. [PubMed: 27272581]
3. Nelson MC, Story M, Larson NI, Neumark-Sztainer D, Lytle LA. Emerging adulthood and college-aged youth: An overlooked age for weight-related behavior change. Obesity (Silver Spring). 2008; 16(10):2205–2211. http://dx.doi.org/10.1038/oby.2008.365. [PubMed: 18719665]
4. Laska MN, Pelletier JE, Larson NI, Story M. Interventions for weight gain prevention during the transition to young adulthood: a review of the literature. J Adoles Health. 2012; 50(4):324–333. http://dx.doi.org/10.1016/j.jadohealth.2012.01.016.
5. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of Obesity and Trends in the Distribution of Body Mass Index Among U.S. Adults, 1999–2010. JAMA. 2012; 307(5):491–497. http://dx.doi.org/10.1001/jama.2012.39. [PubMed: 22253363]
6. Gordon-Larsen P, The NS, Adair LS. Longitudinal trends in obesity in the United States from adolescence to the third decade of life. Obesity (Silver Spring). 2010; 18(9):1801–1804. http://dx.doi.org/10.1038/oby.2009.451. [PubMed: 20035278]
7. Nelson MC, Larson NI, Barr-Anderson D, Neumark-Sztainer D, Story M. Disparities in Dietary Intake, Meal Patterning, and Home Food Environments Among Young Adult Nonstudents and 2- and 4-Year College Students. Am J Public Health. 2009; 99(7):1216–1219. http://dx.doi.org/10.2105/AJPH.2008.147454. [PubMed: 19443824]
8. Laska M, Pasch K, Lust K, Story M, Ehlinger E. The differential prevalence of obesity and related behaviors in two- vs. four-year colleges. Obesity (Silver Spring). 2011; 19(2):453–456. http://dx.doi.org/10.1038/oby.2010.262. [PubMed: 20966910]
9. Fothergill E, Guo J, Howard L, et al. Persistent metabolic adaptation 6 years after "The Biggest Loser" competition. Obesity (Silver Spring). 2016; 24(8):1612–1619. http://dx.doi.org/10.1002/oby.21538. [PubMed: 27136388]
10. Partridge SRJS, McGeechan K, Bauman A, Allman-Farinelli M. Poor quality of external validity reporting limits generalizability of overweight and/or obesity lifestyle prevention interventions in young adults: a systematic review. Obes Rev. 2015; 16(1):13–31. http://dx.doi.org/10.1111/obr.12233. [PubMed: 25407633]

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11. Loria CM, Signore C, Arteaga SS. The need for targeted weight-control approaches in young women and men. Am J Prev Med. 2010; 38(2):233–235. http://dx.doi.org/10.1016/j.amepre.2009.11.001. [PubMed: 20117581]
12. Neve M, Morgan PJ, Jones PR, Collins CE. Effectiveness of web-based interventions in achieving weight loss and weight loss maintenance in overweight and obese adults: a systematic review with meta-analysis. Obes Rev. 2010; 11(4):306–321. http://dx.doi.org/10.1111/j.1467-789X.2009.00646.x. [PubMed: 19754633]
13. Wantland DJ, Portillo CJ, Holzemer WL, Slaughter R, McGhee EM. The effectiveness of Web-based vs. non-Web-based interventions: a meta-analysis of behavioral change outcomes. J Med Internet Res. 2004; 6(4):e40. http://dx.doi.org/10.2196/jmir.6.4.e40. [PubMed: 15631964]
14. Lustria ML, Cortese J, Noar SM, Glueckauf RL. Computer-tailored health interventions delivered over the Web: review and analysis of key components. Patient Educ Couns. 2009; 74(2):156–173. http://dx.doi.org/10.1016/j.pec.2008.08.023. [PubMed: 18947966]
15. Khaylis A, Yiaslas T, Bergstrom J, Gore-Felton C. A review of efficacious technology-based weight-loss interventions: five key components. Telemed J E Health. 2010; 16(9):931–938. http://dx.doi.org/10.1089/tmj.2010.0065. [PubMed: 21091286]
16. Tate DF, Jackvony EH, Wing RR. Effects of Internet behavioral counseling on weight loss in adults at risk for Type 2 diabetes: A randomized trial. JAMA. 2003; 289(14):1833–1836. http://dx.doi.org/10.1001/jama.289.14.1833. [PubMed: 12684363]
17. Tate DF, Wing RR, Winett RA. Using Internet technology to deliver a behavioral weight loss program. JAMA. 2001; 285(9):1172–1177. http://dx.doi.org/10.1001/jama.285.9.1172. [PubMed: 11231746]
18. Bennett GG, Glasgow RE. The delivery of public health interventions via the Internet: actualizing their potential. Annu Rev Public Health. 2009; 30:273–292. http://dx.doi.org/10.1146/annurev.publhealth.031308.100235. [PubMed: 19296777]
19. Chou WY, Prestin A, Lyons C, Wen KY. Web 2.0 for health promotion: reviewing the current evidence. Am J Public Health. 2013; 103(1):e9–e18. http://dx.doi.org/10.2105/AJPH.2012.301071.
20. Dennis EA, Potter KL, Estabrooks PA, Davy BM. Weight Gain Prevention for College Freshmen: Comparing Two Social Cognitive Theory-Based Interventions with and without Explicit Self-Regulation Training. J Obes. 2012; 2012:803769. http://dx.doi.org/10.1155/2012/803769. [PubMed: 22778919]
21. Gow RW, Trace SE, Mazzeo SE. Preventing weight gain in first year college students: an online intervention to prevent the "freshman fifteen". Eat Behav. 2010; 11(1):33–39. http://dx.doi.org/10.1016/j.eatbeh.2009.08.005. [PubMed: 19962118]
22. Greene GW, White AA, Hoerr SL, et al. Impact of an online healthful eating and physical activity program for college students. Am J Health Promot. 2012; 27(2):e47–e58. http://dx.doi.org/10.4278/ajhp.110606-QUAN-239. [PubMed: 23113786]
23. Hebden L, Cook A, van der Ploeg HP, King L, Bauman A, Allman-Farinelli M. A mobile health intervention for weight management among young adults: a pilot randomised controlled trial. J Hum Nutr Diet. 2014; 27(4):322–332. http://dx.doi.org/10.1111/jhn.12155. [PubMed: 23992038]
24. Levitsky DA, Garay J, Nausbaum M, Neighbors L, Dellavalle DM. Monitoring weight daily blocks the freshman weight gain: a model for combating the epidemic of obesity. Int J Obes (Lond). 2006; 30(6):1003–1010. http://dx.doi.org/10.1038/sj.ijo.0803221. [PubMed: 16446748]
25. Lytle L, Svetkey L, Patrick K, et al. The EARLY trials: a consortium of studies targeting weight control in young adults. Transl Behav Med. 2014; 4(3):304–313. http://dx.doi.org/10.1007/s13142-014-0252-5. [PubMed: 25264469]
26. Lytle LA, Moe SG, Nanney MS, Laska MN, Linde JA. Designing a Weight Gain Prevention Trial for Young Adults: The CHOICES Study. Am J Health Ed. 2014; 45(2):67–75. http://dx.doi.org/10.1080/19325037.2013.875962.
27. Healthy You. Feature on The Nation's Health website. http://thenationshealth.aphapublications.org/site/misc/HealthyYou.xhtml.

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28. Moe SG, Lytle LA, Nanney MS, Linde JA, Laska MN. Recruiting and retaining young adults in a weight gain prevention trial: Lessons learned from the CHOICES study. Clin Trials. 2016; 13(2): 205–213. http://dx.doi.org/10.1177/1740774515605084. [PubMed: 26378096]
29. Kjolhaug J. Sleep, Eat, and Exercise. [Accessed 2013] Published 2011; www.ri.umn.edu/Courses/Sleep-Eat-Exercise.php.
30. Subar AF, Kirkpatrick SI, Mittl B, et al. The Automated Self-Administered 24-hour dietary recall (ASA24): a resource for researchers, clinicians, and educators from the National Cancer Institute. J Acad Nutr Diet. 2012; 112(8):1134–1137. http://dx.doi.org/10.1016/j.jand.2012.04.016. [PubMed: 22704899]
31. Nanney MS, Lytle LA, Farbakhsh K, et al. Weight and Weight-Related Behaviors Among 2-Year College Students. J Am Coll Health. 2015; 63(4):221–229. http://dx.doi.org/10.1080/07448481.2015.1015022. [PubMed: 25692380]
32. Stevens J, Truesdale KP, McClain JE, Cai J. The definition of weight maintenance. Int J Obes (Lond). 2006; 30(3):391–399. http://dx.doi.org/10.1038/sj.ijo.0803175. [PubMed: 16302013]
33. Svetkey LP, Batch BC, Lin PH, et al. Cell phone intervention for you (CITY): A randomized, controlled trial of behavioral weight loss intervention for young adults using mobile technology. Obesity (Silver Spring). 2015; 23(11):2133–2141. http://dx.doi.org/10.1002/oby.21226. [PubMed: 26530929]
34. Laska MN, Sevcik SM, Moe SG, et al. A 2-year young adult obesity prevention trial in the U.S.: Process evaluation results. Health Promot Int. 2015 Jun 30. In press. Online.
35. Story M, Hannan PJ, Fulkerson JA, et al. Bright Start: Description and main outcomes from a group-randomized obesity prevention trial in American Indian children. Obesity (Silver Spring). 2012; 20(11):2241–2249. http://dx.doi.org/10.1038/oby.2012.89. [PubMed: 22513491]
36. Marcus MD, Foster GD, El Ghormli L, et al. Shifts in BMI category and associated cardiometabolic risk: prospective results from HEALTHY study. Pediatrics. 2012; 129(4):e983–e991. http://dx.doi.org/10.1542/peds.2011-2696. [PubMed: 22430457]
37. Loria CM, Liu K, Lewis CE, et al. Early adult risk factor levels and subsequent coronary artery calcification: the CARDIA Study. J Am Coll Cardiol. 2007; 49(20):2013–2020. http://dx.doi.org/10.1016/j.jacc.2007.03.009. [PubMed: 17512357]
38. Truesdale KP, Stevens J, Cai J. Nine-year changes in cardiovascular disease risk factors with weight maintenance in the atherosclerosis risk in communities cohort. Am J Epidemiol. 2007; 165(8):890–900. http://dx.doi.org/10.1093/aje/kwk072. [PubMed: 17259640]
39. Truesdale KP, Stevens J, Cai J. The effect of weight history on glucose and lipids: the Atherosclerosis Risk in Communities Study. Am J Epidemiol. 2005; 161(12):1133–1143. http://dx.doi.org/10.1093/aje/kwi151. [PubMed: 15937022]
40. Truesdale KP, Stevens J, Cai J. Effect of 3-year weight history on blood pressure: the atherosclerosis risk in communities study. Obesity (Silver Spring). 2008; 16(5):1112–1119. http://dx.doi.org/10.1038/oby.2008.27. [PubMed: 18277386]

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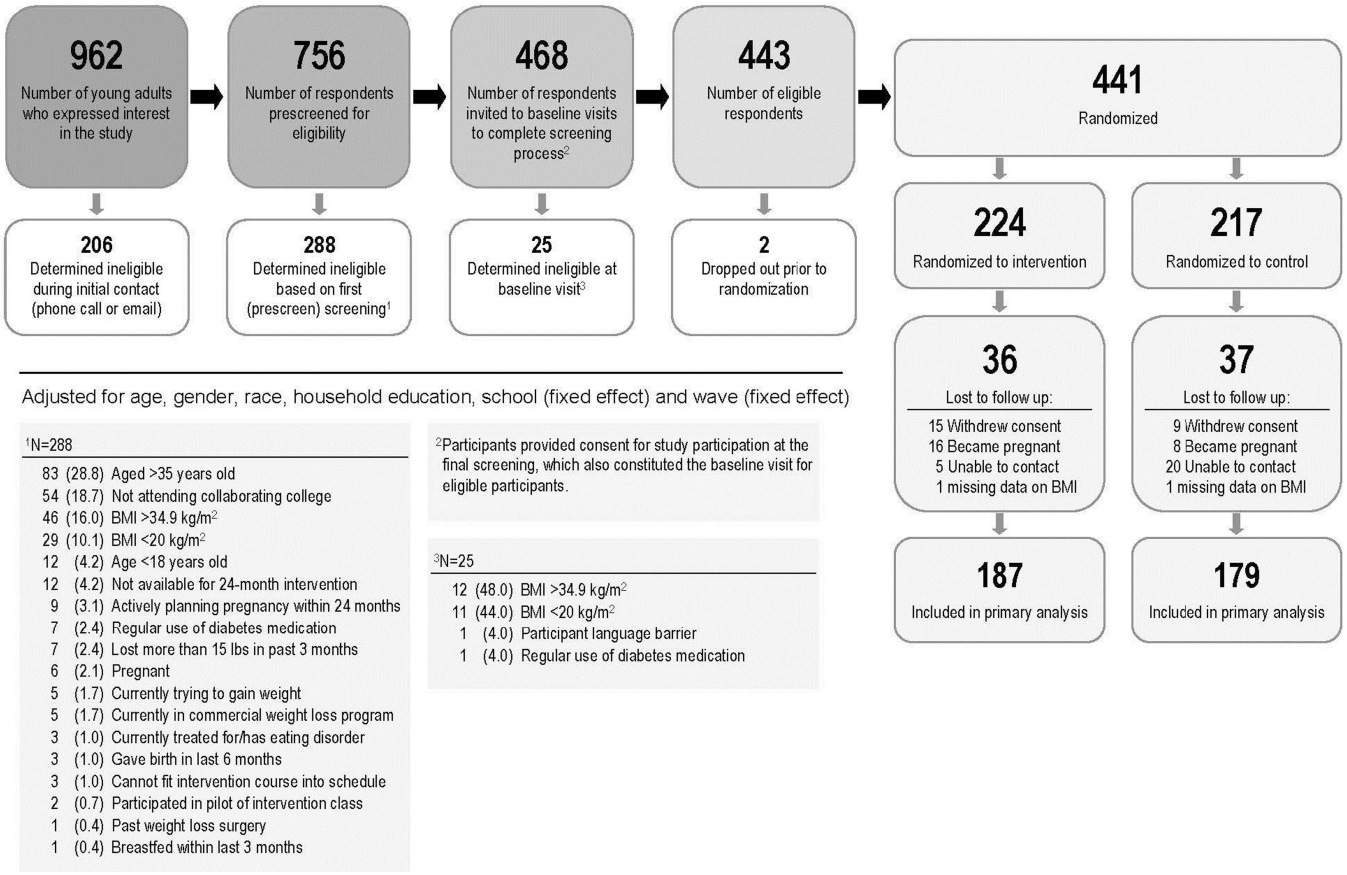

Figure 1.
CONSORT diagram. Flow of participants through the CHOICES Study.

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Table 1

CHOICES Sample Characteristics at Baseline and at Follow-up[a]

	Baseline				Follow-up status		
Characteristic	**Total (n=441)**	**Control (n=217)**	**Intervention (n=224)**	***p*-value[b]**	**Retained for 24-month follow-up assessment (n=366)**	**Lost to follow-up, withdrawn and/or ineligible at 24 months (n=75)**	***p*-value[c]**
Randomization to intervention	50.8				51.1	49.3	0.781
Sex, Female	67.6	68.2	67.0	0.78	66.7	72.0	0.369
Race/ethnicity							
White vs. non-white	72.6	68.7	76.3	0.07	75.4	58.7	**0.003**
Hispanic or Latino origin	7.5	7.4	7.6	0.93	7.7	6.7	0.768
Current relationship status							
Single or casually dating	54.6	55.3	53.8	0.75	54.4	54.7	0.963
Age at randomization, years	22.7 (5.0)	22.8 (5.0)	22.9 (5.0)	0.84	22.8 (5.1)	22.5 (4.7)	0.640
Your income							
Less than $12,000	66.2	64.5	67.9		68.0	57.3	
$12,000 or more	27.0	28.1	25.9	0.74	26.2	30.7	
Don t'know	6.8	7.4	6.3		5.7	12.0	**0.033**
Parental education							
Post graduate	15.2	16.3	14.3	0.84	15.3	14.7	
Graduate	31.5	30.4	32.6		33.1	24.0	
Vocational/some college	26.1	25.8	26.3		25.1	30.7	
High school, GED or less	22.7	24.0	21.4		22.4	24.0	
Missing	4.5	3.7	5.4		4.1	6.7	0.502
BMI	25.4 (3.8)	25.4 (3.8)	25.4 (3.8)	0.95	25.3 (3.7)	25.8 (4.1)	0.293
Percent body fat	27.0 (8.7)	27.1 (8.7)	26.8 (8.8)	0.78	26.6 (8.9)	28.6 (7.9)	0.056
Waist circumference, cm (3 missing)	88.5 (10.0)	88.2 (9.9)	88.8 (10.1)	0.52	88.3 (9.8)	89.8 (10.9)	0.256
Weight, kg	72.0 (13.9)	72.0 (14.1)	72.0 (13.8)	0.97	71.7 (13.3)	73.3 (16.7)	0.436
Weight status							
Overweight/Obese, BMI ≥25	46.7	47.0	46.4	0.90	47.0	45.3	0.793

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Note: Boldface indicates statistical significance ($p<0.05$).

[a] Percent occurrence of dichotomies or mean (SD) for continuous characteristics

[b] Comparison tested between treatment condition

[c] Comparison tested between responders at 24 months and non-responders

GED, General Educational Development test

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Table 2

Adjusted Mean (SE) of BMI, Weight, Waist Circumference, Body Fat, and Proportion Overweight/Obese by Condition[a]

Outcome	Analysis using available data								Net diff[b]
	Base		4 months		12 months		24 months		(*p*-value)
	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	
BMI									
Intervention (I)	224	25.2 (0.273)	205	25.5 (0.273)	197	25.5 (0.274)	187	26.0 (0.280)	0.092
Control (C)	217	25.4 (0.275)	201	25.6 (0.274)	190	25.7 (0.276)	179	26.2 (0.283)	*p*=0.699
Time-specific diff. I-C		−0.24 (0.386)		−0.12 (0.388)		−0.21 (0.390)		−0.15 (0.394)	
Weight (Kg)									
Intervention (I)	224	71.5 (0.835)	205	72.3 (0.834)	197	72.4 (0.839)	187	73.8 (0.857)	0.253
Control (C)	217	72.4 (0.842)	201	72.7 (0.840)	190	73.1 (0.844)	179	74.4 (0.863)	*p*=0.707
Time-specific diff. I-C		−0.83 (1.181)		−0.46 (1.186)		−0.73 (1.193)		−0.58 (1.203)	
Waist (cm)[c]									
Intervention (I)	223	88.5 (0.714)					180	89.1 (0.750)	0.146
Control (C)	215	88.5 (0.721)					169	88.9 (0.762)	*p*=0.848
Time-specific diff. I-C		0.02 (1.107)						0.17 (1.058)	
% Body fat									
Intervention (I)	224	26.8 (0.483)	204	27.3 (0.484)	193	27.5 (0.488)	179	28.2 (0.501)	0.422
Control (C)	217	27.2 (0.487)	200	27.4 (0.487)	186	27.5 (0.491)	167	28.1 0.506)	*p*=0.352
Time-specific diff. I-C		−0.32 (0.683)		−0.10 (0.688)		−0.07 (0.694)		0.10 (0.704)	
Prevalence BMI≥25 Kg/m^2									
Intervention (I)	224	44.0 (3.56)	205	45.0 (3.59)	197	46.5 (3.64)	187	46.5 (3.74)	−8.3%
Control (C)	217	46.8 (3.61)	201	51.0 (3.63)	190	54.3 (3.66)	179	57.6 (3.73)	**p=0.049**
Time-specific diff. I-C		−2.84 (5.07)		−5.99 (5.11)		−7.81 (5.16)		−11.17 (5.28)	

Note: Boldface indicates statistical significance ($p<0.05$).

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[a] Adjusted for baseline age, sex, race, and household education. College and cohort entered as fixed effect.

[b] 'Net Diff' is defined as $I_{24\ mos}$-$C_{24\ mos}$)-($I_{baseline}$-$C_{baseline}$) and accounts for differences in outcomes and covariates between conditions at baseline

[c] Waist circumference assessed at Baseline and 24 months only.