HHS Public Access

Author manuscript

Contemp Clin Trials. Author manuscript; available in PMC 2020 August 01.

Published in final edited form as:

Contemp Clin Trials. 2019 August ; 83: 1–9. doi:10.1016/j.cct.2019.06.006.

Health coaching to encourage obese adults to enroll in commercially-available weight management programs: The path to health study

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Abstract

Physicians are recommended to screen and refer obese patients to weight management programs (WMPs). There are often limited referral options for physicians, though commercially-available WMPs could be a potential solution. The purpose of this study (Path to Health) was to evaluate the efficacy of health coaching to promote enrollment in commercially-available WMPs through a two-arm, RCT with obese patients (n = 168) randomly assigned to intervention (n = 84) or control groups (n = 84). Intervention participants received phone health coaching to help them select and enroll in WMPs. We collected data on program enrollment, weight, self-reported physical activity (PA), and fruit and vegetable (FV) intake at baseline, 3- and 6-months. We used logistic regression to assess the intervention effect on enrollment in WMPs and longitudinal regression models to evaluate the effect on weight change, PA and FV intake. The average age was 54.7 years, 59% were female and 43% were Black and 49% were White. At 6 months, 39% of the intervention group (vs. 29% of control) had enrolled in WMPs. We found no longitudinal intervention effect on weight, PA and FV intake. We found that there was more weight loss for those who completed ≥ 4 calls as compared to those who completed < 4 calls. We also found significant dose response relationships for PA and FV intake at 3 months. In this study, we found that phone health coaching was successful in increasing obese adults' enrollment in commercially-available WMPs and that there was a dose response relationship for weight and behavioral outcomes.

Keywords

Obesity; Weight management programs; Behavior change

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1. Introduction

Obesity rates in the US are high and continue to increase [1,2], doubling over the past three decades [3]. Obesity is linked to increased risk of heart disease, type 2 diabetes (high blood sugar), high blood pressure, certain cancers, and other chronic conditions. Obesity results partially from an elevated dietary intake and insufficient physical activity. Americans have increased their average total daily energy intake by 571 kcal per day since 1977 [4]. Meanwhile, the percentage of individuals reporting no leisure-time physical activity has increased for adult women (from 19% to 52%) and men (11% to 44%) [5]. The increase in obesity prevalence indicates a need for concerted efforts to facilitate weight management strategies for the prevention of disease and disability.

The US Preventive Service Task Force (USPSTF) has recommended screening all adults for obesity and referring patients with a body mass index (BMI) of 30kg/m^2 or higher to intensive multimodality interventions [6]. Primary care provides an optimal setting in which to identify people who need weight management support, and research has shown that physicians' recommendations for obese patients to lose weight is associated with weight loss [7–10]. Obesity treatment is often an intensive process requiring individualized attention and multi-component behavioral interventions. Many insurance plans do not cover treatment [11,12], and although the Centers for Medicare & Medicaid Services reimburse primary care physicians for intensive behavioral therapy to treat obese patients, this reimbursement is only for Medicaid beneficiaries [13]. This leaves physicians with limited resources for providing behavioral weight management programs for many of their patients.

Existing commercially-available weight management programs are one potential avenue for physicians to meet the USPSTF recommendations and connect obese adults to evidence-based weight management programs. Commercially-available weight management programs, which generally address both diet and physical activity behaviors, are widely-available and could be used by the general population for weight treatment. Although there is a need for additional evidence on the efficacy of some of the programs currently available [14], several of the more well-known programs (e.g., Weight Watchers®) have been evaluated and shown to be effective for short-term (i.e., less than one year after program initiation) weight loss; whether weight loss is maintained after 12 months has not yet been established [15,16]. Unfortunately, there also are many weight management options available in the marketplace which are not efficacious or healthy [17]. The plethora of weight management programs and various claims of effectiveness may present confusion for some individuals who are interested in finding one. These individuals may benefit from assistance in identifying an evidence-based program that fits their specific needs.

The purpose of this study was to evaluate the efficacy of health coaching to promote patient enrollment in commercially-available, evidence-based weight management programs by providing support to adopt a program that best fit the participants' values and preferences. We hypothesized that health coaching would increase the selection of and enrollment in weight management programs among obese patients. As a secondary aim, we also evaluated

the effectiveness of the health coaching support in increasing physical activity, improving diet and facilitating weight loss.

2. Methods

2.1. Study design

This study, called *Path to Health,* was a two-arm, randomized controlled trial. A total of 168 patients were randomly assigned to the intervention (n = 84) or control group (n = 84) using minimization randomization based on age group, sex, and race/ethnicity [18]. Data were collected at baseline and at 3- and 6-month follow-ups. This study was reviewed and approved by the Institutional Review Boards at the University of Texas MD Anderson Cancer Center and UTHealth.

3. Study participants

We partnered with the clinical practice associated with an academic health care system in Houston, TX, UT Physicians. We recruited 11 physicians from 2 separate clinics in 2015–2016, representing both General and Family Medicine. We identified eligible patients, associated with participating physicians, through electronic medical records. After generating a list of eligible patients, physicians reviewed the list to remove any individuals they believed should not be referred to the study due to comorbidities or other reasons. After receiving an approved list of potentially eligible patients (n = 1554), study staff mailed these patients letters signed by their physician inviting them to participate in the study. Letters were followed by subsequent automated phone call messages (see Fig. 1 for additional details).

Inclusion criteria for this study included: a body mass index (BMI) ≥ 30 and ≤ 45 kg/m^2, age 18 or older, ability to read and speak English, having a working telephone number and address where materials could be mailed, ability to engage in moderate-intensity physical activity as determined by the Physical Activity Readiness Questionnaire (PAR-Q) [19,20], and having Internet access at home or some other location. Participants were excluded if they were currently enrolled or had participated in a weight loss, exercise, or dietary modification program within the previous 6 months, if they had involuntary or voluntary weight loss of > 5% of their body weight in the previous 6 months, if another person in the same household had already enrolled, if they were pregnant or thinking about becoming pregnant, or if they were currently using weight loss medications.

Following an automated call or letter, patients who were interested in hearing more, called the study number and spoke with a staff member. After additional study information was provided, 339 individuals were interested in participating in the study and consented to be further screened, of which 245 were initially deemed eligible. Several individuals were found to be ineligible for the following reasons: BMI at the baseline visit, never scheduled their baseline appointment, canceled or did not show for their appointment, decided not to enroll upon arrival at the appointment, or withdrew shortly after consenting to be part of the study (additional details are presented in Fig. 1).

4. Intervention

We selected commercially-available weight management programs for inclusion in the study based on evidence-based criteria. First, we identified criteria for management of obesity in adults from meta-analyses and systematic reviews, and scored existing programs based on whether or not they satisfied these criteria [6,21]. Effective behavioral interventions typically included behavioral change and management activities such as goal-setting, improving diet or nutrition and increasing physical activity, addressing barriers to change, self-monitoring, and planning how to maintain lifestyle change [6], reducing caloric intake, contact with a dietician, and use of techniques that compare the participant's behavior with other's behavior [21]. From our initial pool of commercially-available weight management programs, which included online/mobile, face-to-face/in-person, medically supervised, and food-delivery programs (n = 22), we narrowed the list to 5 programs: Nutrisystem (online program with food delivery), SparkPeople (online program), Weight Watchers Online Plus (online program), Weight Watchers meetings (face-to-face program), and a medically supervised weight management program at UT Physicians (medically supervised program) (see Fig. 2). These programs included the highest number of evidence-based strategies, and Nutrisystem and Weight Watchers as entire programs had evidence of helping adults lose weight [15]. These programs ranged from being free (Sparkpeople.com) to modest monthly charges (Weight Watchers meetings: $45/month; Weight Watchers Online Plus: $19.95/month) or being relatively expensive but more comprehensive such as including packaged meals or meal replacements (Nutrisystem basic package: $375/month; medically supervised program at UT Physicians: $445 for first two visits, $65/visit thereafter, and $50–70/week for meal supplements). Participants were not provided financial assistance for the weight management programs.

4.1. Health coaching group

To help patients select and adopt a weight management program, intervention group patients received support from a health coach. The coaches were trained to help patients understand the commercially-available weight management programs recommended by the study, and then help them choose the program that was most appropriate based on cost, structure of the program, available features and other considerations important to the individual participant. In addition to program selection, health coaches also helped to motivate patients to utilize the program and reduce barriers to program use. The coaching component was based on core tenets of motivational interviewing (MI) [22]. MI is a client-centered non-confrontational therapeutic approach, focused on achieving goals set by the client while enhancing the client's motivation for change. For individuals who selected a program, patients worked with the health coach to resolve ambivalence, explore their attitudes and values with respect to healthy lifestyles, reduce barriers, and set goals/develop action plans [23]. The interaction with the health coach was via telephone. Calls typically lasted between 20 and 30 min and patients could receive up to 6 calls from the coaches over the 6 month period. Coaches were master's level trained with at least 2 years of clinical experience. Coaches received 20 h of training on motivational interviewing and additional cognitive behavioral approaches, accompanied by additional booster trainings. The coaches were also trained on cultural competency and cultural factors related to obesity, diet and physical activity.

4.2. Control group

Control group participants received printed material on the various weight management programs recommended. They were provided this printed material upon study enrollment, which encouraged them to review and adopt one of the recommended weight management programs.

5. Data collection

Staff collected data in person at MD Anderson Cancer Center at baseline, 3 and 6 months. Each visit lasted about 1–2 h and participants were compensated with $40 gift cards at each visit. Participant anthropometric measurements were collected, followed by computer-based (REDCap) self-administered questionnaires [24].

5.1. Measures

Anthropometric data. Study staff collected anthropometric measures at the start of the visit. Height, weight, blood pressure, and body fat percentage were all collected twice and then the two measurements were averaged. Weight and percentage body fat were assessed using the Tanita integrated bioelectrical impedance body fat monitor scale (Tanita Body Fat Analyzer TBF 350, Tanita Corporation of America, Inc., Arlington Heights, IL). Participants removed shoes and heavy outer clothing prior to measurements. Percent weight change between two visits (3 months duration) was determined as ([weight at current visit] − [weight at previous visit])/[weight at current visit] × 100. Hip and waist circumference were measured using a measuring tape and established protocols [25].

Behavioral variables. Our primary outcome was enrollment in a commercially-available weight management program. This outcome was self-reported by participants at each data collection time point. Participants were asked if they had enrolled in a weight management program since the previous visit, and if so, which program they had selected. Individuals could indicate that they had enrolled in multiple programs or in programs that were not included in the referral. We used a binary outcome variable, overall enrollment status, to define whether the participant indicated at either of their follow-up visits that they had enrolled in a program (= 1) or not (= 0).

Self-reported physical activity was collected using a modified version of the Godin-Shepherd Leisure-Time physical activity questionnaire [26,27]. Weekly frequency of moderate or vigorous activity was multiplied by the minutes of activity to calculate total minutes of moderate-to-vigorous intensity physical activity. This was then converted to MET/mins per week using established procedures [26].

Total fruit and vegetable intake was assessed with the NIH/NCI all-day fruit and vegetable screener [28]. The all-day Screener had evidence of adequate validity ($r = 0.68$ in men, 0.49 in women) in Non-Hispanic white adults [29]. Individuals responded with how often over the last day, week or month they consumed several items, including 100% juice, fruit, lettuce salad, potatoes, cooked dried beans, tomato sauce, vegetable soup, and any other vegetables or mixtures that included vegetables. Participants also indicated what quantity they consumed each time. Using established scoring procedures [28], we calculated average daily

fruit and vegetable intake. We excluded outliers, which included participants who reported > 14 servings of fruits and vegetables per day.

5.2. Covariates

We also collected self-reported demographic and general health variables, including race/ethnicity, age, sex, self-rated health, annual household income, current health conditions and involvement in a previous weight management program.

5.3. Statistical analyses

We first carried out univariable comparisons of demographic information and clinical characteristics for patients between the two study arms using Chi-squared-tests for categorical data, Student's *t*-test for continuous data. Logistic regression analyses were conducted to assess the intervention effect on the enrollment in weight management programs, while controlling for potential confounders which were evaluated and determined based on univariable regression analyses.

To evaluate the longitudinal intervention effect, we conducted comparisons between the intervention and control groups for each outcome (weight change, physical activity and fruit and vegetable in-take) using longitudinal regression models with generalized estimating equation (GEE) method to account for correlations of repeated measures over time. We performed a Poisson regression or negative binomial model for the non-negative count (or rate) data such as self-reported moderate-to-vigorous intensity physical activity in minutes and total fruit and vegetable consumption per week, and a linear regression model for percent weight change data, which are normally distributed. Over dispersion and zero-inflation in the Poisson model were examined to determine whether a negative binomial or zero-inflated model was needed to supersede the Poisson model. Specifically, we assessed over-dispersion using a dispersion parameter from negative binomial regressions, and evaluated whether there are any factors that indicate excess zeros through zero-inflated regressions in order to choose the best model [30].

To assess whether the intervention effect on each outcome changed over time, we conducted interactive models by including the interaction term of study group (intervention and control) and time variable (baseline, month 6 and month 12), which enabled us to estimate the intervention effect at each time point. Potential confounders including demographic variables such as age, race, sex, and baseline BMI were assessed using univariable analyses and adjusted in the multivariable models if they were not in the causal pathway between the study group and each outcome, and were theoretically relevant and significantly contributed to the model (e.g. if they were associated with both outcome and study group with the arbitrary p-value cut-off of < 0.20, as suggested by several epidemiological studies and text books [31]).

We also conducted dose response analyses using data from participants in the intervention group, to evaluate how dosage of the intervention (i.e., number of counseling calls that participants completed) affected weight, physical activity and fruit and vegetable intake. We compared each outcome between those who completed 4 or more calls vs < 4 calls.

We explored drop-outs and missing data, which are common problems with longitudinal data. We used multiple imputation using the Markov chain Monte Carlo (MCMC) method [32] to impute the missing values and conducted both intent-to-treat analyses and analyses using imputed data. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC) at a significance level of 0.05.

6. Results

Fig. 1 illustrates the stages of data collection and intervention. The total sample was 168, with 84 individuals randomized to each group. At 3 months, 53 intervention participants (63%) and 67 control participants (80%) completed the assessment. At 6 months, 58 intervention participants (69%) and 69 control participants (82%) completed the assessment.

Table 1 shows the demographic characteristics of the whole sample (n = 168), as well as by each group. There were no statistically significant differences between the intervention and control group at baseline on demographic characteristics and other important covariates. The average age of the sample was 54.7 years. The sample was 41% male and 59% female and racially/ethnically diverse: 43% were Black/African American, 49% were White, 12% were Hispanic, and 8% self-identified as Other. More than half of the sample were college graduates (55%), were employed for wages (64%) and had an income of $55,000 or more (67%). About half of the participants were married or living with a partner (51%), 21% were divorced or separated, 22% were never married, and 4% were widowed. Most of the sample self-reported a “good” general health status (57%), with 15% and 6% reporting “very good” or “excellent” general health, respectively. About 77% reported at least one comorbidity. The most frequently reported comorbidities included hypertension (58%), high cholesterol (33%), thyroid problems (17%) and diabetes (14%) (data not shown).

7. Enrollment in a weight management program

At 6 months, 39% (33/84) of the intervention and 29% (24/84) of the control group had enrolled in at least one program (individuals could enroll in more than one program if they chose). SparkPeople® was the program most often selected in either group (n = 19 in the intervention and n = 16 in the control). In the intervention group, 2 individuals enrolled in Weight Watchers® in-person meetings and 2 enrolled in Weight Watchers OnlinePlus®, while in the control group the number were 3 and 2, respectively. In the intervention group, 3 individuals enrolled in the UT Physicians medically-supervised program and 2 individuals enrolled in Nutrisystem®, while no one in the control group enrolled in either of these programs. There were also 4 individuals in the intervention and 3 in the control group who enrolled in programs outside of the recommended programs, including a membership at the YMCA®, Quick Weight Loss, LLC, Myfitnesspal©, Atkins™, and Naturally Slim.

Our primary aim was to determine whether providing health coaching support would help to increase patient enrollment in commercially-available, evidence-based weight management programs. Table 2 shows the intervention effect on enrollment in a weight management program based on a multivariable logistic regression analysis. We included 137 participants who completed either the 3- or 6-month assessment or both in the model. The odds of

enrollment in a weight management program was higher in the intervention group patients as compared to control group patients (adjusted odds ratio (OR) = 4.75; 95% CI = [1.9, 11.83]; p = 0.0008). We also found that individuals who were previously involved in a weight management program, female, and non-Hispanic white were more likely to enroll in a weight management program during the study period.

8. Weight change, physical activity, and diet

Table 3 shows the intervention effects on behavioral changes, our secondary aim based on multivariable longitudinal interactive regression model that accounts for the potential interaction effect between intervention group and time in relation to percent weight change, physical activity and fruit and vegetable intake, after adjusting for potential confounders (race/ethnicity, age, sex, self-rated health, annual household income, current health conditions, baseline BMI and involvement in a previous weight management program). In these multivariable interactive models, which enabled us to assess the intervention effects at each time point, we found no statistically significant differences in percent weight change, physical activity and fruit and vegetable intake between the intervention and control groups at any time point (model 1). This observation remained even after imputation (model 2). Though marginally significant, we found that the intervention group had more weight loss than control group at 6 month (in model 1: mean difference of % change from month 3 to 6 = −1.02%; p = 0.0544).

9. Dose response analyses

We also examined the effect of the intervention on outcomes by exploring dose-response effects, based on the number of calls participants in the intervention group were able to complete. A total of 64.3% of participants completed 4 or more counseling calls (out of 6), with 52.4% completing all 6 calls (data not shown). Table 4 shows the results based on multivariable interactive regression models, which enabled us to assess the dose-response effects at each time point, among the intervention group, comparing individuals who completed 4 or more counseling calls to those who completed < 4 calls. After controlling for potential confounders including race/ethnicity, age, sex, self-rated health, annual household income, current health conditions, baseline BMI and involvement in a previous weight management program, we found based on multivariable longitudinal linear regression, that there was more weight loss at 3 months for those who completed 4 or more calls as compared to those who completed < 4 calls (mean difference of percent change from baseline to 3 months = −3.1%; p =0.01). At 6 months this difference was attenuated (mean difference of % change from 3 to 6 months = −0.76%; p = 0.54). After imputation, we found that the mean percent weight change at 3 months for those who completed 4 or more calls was significantly lower (more weight loss) compared to those who completed < 4 calls (mean difference of % change from baseline to 3 months = − 2.67%; p = 0.0007), and this significant difference was maintained at 6 months (mean difference of percent change 3 to 6 months = − 1.43%; p = 0.03).

Based on multivariable longitudinal Poisson analyses, we found that individuals who completed 4 or more calls reported significantly higher levels of physical activity at 3

months compared to individuals who completed < 4 calls, but these findings were not statistically significant (model 1). However, after imputation (model 2), we found significantly higher levels of physical activity at 3 months for individuals who completed 4 or more calls compared to individuals who completed < 4 calls (adjusted rate ratio (RR) = 2.18; p = 0.04).

A significant dose-response effects on fruit and vegetable intake was identified at 3 months after controlling for potential confounders. Based on multivariable longitudinal negative binomial regression analyses, those who completed 4 or more calls had significantly higher fruit and vegetable intake at 3 months as compared to those who completed < 4 calls (adjusted RR = 1.98; p = 0.005, model 1). We found the same significant association at 3 months after imputation (adjusted RR = 2.26, p = 0.006, model 2). However, this dose-response effects at 3 months were attenuated at 6 months in both model 1 (adjusted RR = 1.32, p = 0.33) and model 2 (adjusted RR = 1.88, p = 0.05).

10. Discussion

In this paper, we evaluated the *Path to Health* study, a randomized controlled trial to test whether health coaching would be effective in increasing enrollment in commercially-available weight management programs in primary care patients compared to provision of written material on weight management programs only. Among those who completed either the 3- or 6-month assessment, or both, we found that, as compared to the control group, the intervention group had almost 5 times the odds of enrollment in a commercially-available weight management program. A handful of other trials have attempted this approach of referring obese patients to commercially-available weight management programs and have also demonstrated successful patient enrollment or participation as well as weight change [33–38]. Studies that have specifically tested the approach of adding brief telephone coaching or other personalized support, often based on motivational interviewing, to an existing weight management program have shown improvements in engagement with the weight management program as well as improved weight outcomes when compared to individuals who received only the program [39–42]. Thus, our study complements the existing literature indicating that referral to online or other commercial weight-management programs, supported by brief or limited telephone coaching, may be effective in helping individuals enroll in a program and begin losing weight.

Our secondary aim examined differences in behavioral outcomes between groups. Although there was no overall difference between the intervention and control groups in weight from baseline to 6 months, we found a marginally significant decrease in weight in the intervention group compared to the control group from 3 to 6 months in complete case analyses. Significant differences between the intervention and control groups for other behavioral outcomes, including physical activity and fruit and vegetable intake, were not identified. In this study, we were unable to gather data on engagement with the weight management programs. Therefore, although intervention group participants enrolled in weight management programs at higher levels than the control group participants did, intervention group participants may not have engaged enough with the weight management programs to elicit significant changes in these behaviors as compared to the control group.

We also assessed how dosage of the intervention affected weight, physical activity and fruit and vegetable intake. We found that in the intervention group, those who completed 4 or more of the health coaching calls had significantly more weight loss, a higher rate of fruit and vegetable intake, and more physical activity as compared to those who completed < 4 calls. This finding is in line with other studies indicating that individuals who receive more doses of health coaching have better intervention-related outcomes, including higher enrollment in additional chronic disease prevention programs [43], greater weight reduction [44], improved diet [45,46], more physical activity [47], and other health outcomes [48]. However, it is also possible that the group of individuals who completed 4 or more calls was inherently more motivated to lose weight than those who completed < 4 of the calls, a motivation which may have both encouraged them to complete the calls and also lose weight. In fact, motivation has been demonstrated to be protective of attrition [49], to be predictive of adherence to protocol [50,51], and to produce better results from weight-related studies [52–54]. It is currently unclear whether participants' baseline motivation influenced the results of our study.

In this study, participants were allowed to select the commercially-available weight management program of choice, including programs not listed in our study that they perceived as fitting their needs. Given cost concerns, most participants enrolled in the only free program recommended: SparkPeople. Interestingly, a study that tested the effects of randomly allocating participants to 1 of 6 commercially-available programs vs. allowing individuals to choose one of the 6 programs themselves found that those who chose their program did not fare better than those who were randomly assigned [36]. Other studies have shown that participant choice of treatment does not enhance weight outcomes [55,56]. Future iterations of this referral model can further test choosing vs. random allocation to a program and outcomes, although it appears that adherence to any evidence-based program can produce successful weight loss.

Our study has several limitations. First, we relied on self-report for enrollment in weight management programs. Although reporting on enrollment is likely to be very accurate, we are uncertain to what extent individuals actually engaged with the programs and all of their various features. Future research should aim to assess engagement metrics to allow for in-depth understanding of observed outcomes. We also relied on self-report for physical activity and dietary behaviors, which could introduce bias [57,58]. As our sample was referred from a clinic system, almost all individuals had some form of private or government health insurance; the sample was also well-educated. Both of these factors may limit the generalizability of the findings. Lastly, we are unable to evaluate the effectiveness of the commercially-available weight management programs themselves, as that was not the purpose of this study.

11. Conclusions

Given the startling increase in obesity in US adults [1–3] and USPSTF recommendations for physicians to screen for BMI/obesity and provide or refer individuals to behavioral interventions [6], there is an urgent need to meet the increasing demand for weight management. Commercially-available programs, which have shown success at weight

management and loss [15,16,36] and have resources that most physicians do not have at their disposal [59], may be an ideal referral source. In this study, we found that brief health coaching conducted over the phone was successful in increasing enrollment in commercially-available weight management programs among a racially-diverse group of obese adults. However, it is clear that more intensive interventions are likely needed to assist obese individuals with weight loss and maintenance.

Funding

This research was funded by the National Center for Advancing Translational Sciences (NCATS), Centers for Translational Science Award (UL1 TR000371), the National Cancer Institute at the National Institutes of Health through The University of Texas MD Anderson''s Cancer Center Support Grant (CA016672), the Cancer Prevention and Research Institute of Texas (RP170259) and by the Duncan Family Institute through the Center for Community-Engaged Translational Research.

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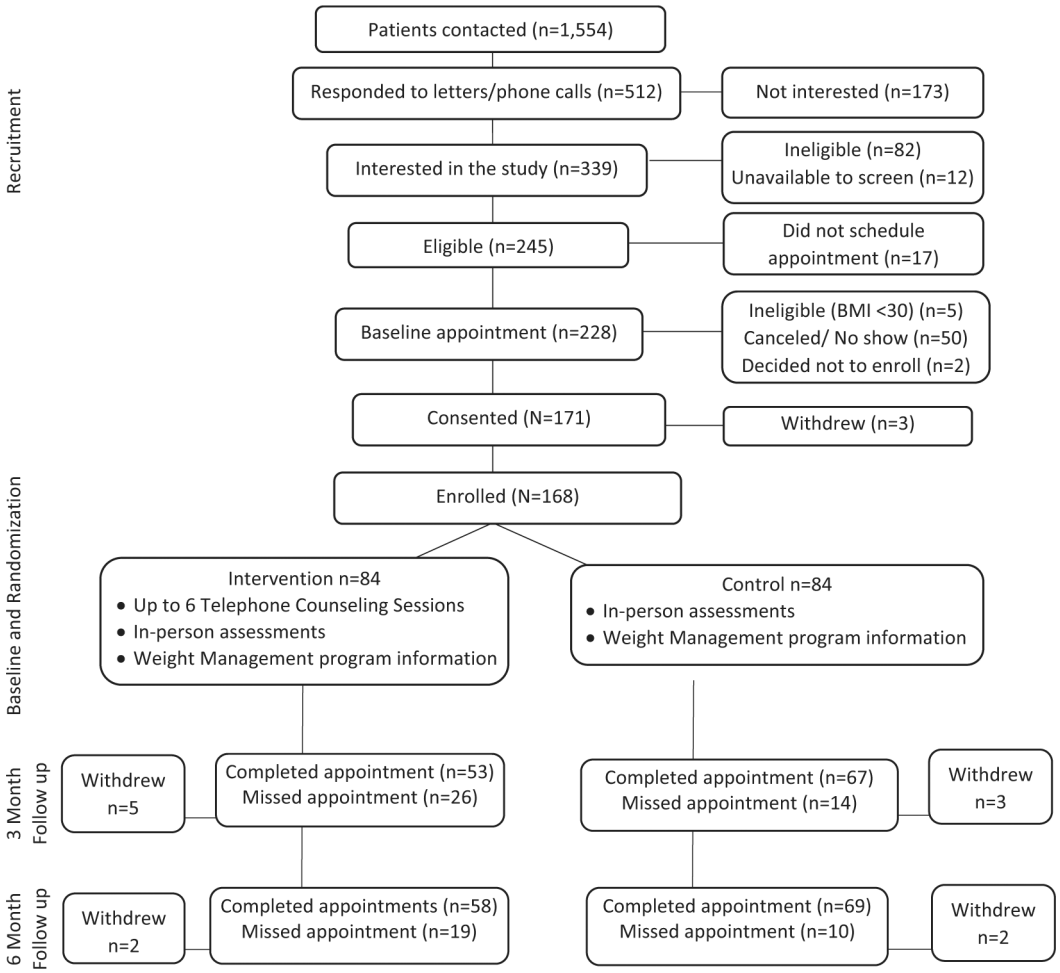

Fig. 1.
CONSORT diagram.

	Nutrisystem	SparkPeople	Weight Watchers online Plus	Weight Watchers meetings	UT Physicians
Behavioral management activities, such as setting weight-loss goals	X	X	X	X	X
Improving diet or nutrition and increasing physical activity	X	X	X	X	X
Addressing barriers to change	X	X	X	X	X
Self-monitoring	X	X	X	X	X
Strategizing how to maintain lifestyle change	X	X	X	X	X
Calorie counting		X	X	X	X
Contact with a dietician		X			X
Use of techniques that compare participant's behavior with others	X	X	X	X	X

Fig. 2.
Weight Management Programs with most evidence-based strategies.

Table 1

Demographic characteristics of participants in Path to Health study (n = 168).

Variables, n (%)	ALL (n = 168)	Control (n = 84)	Intervention (n = 84)	p value*
Age (years), mean (SD)	54.73 (12.84)	55.68 (12.21)	53.79 (13.45)	0.42
Sex, male	69 (41.07)	35 (41.67)	34 (40.48)	0.88
Race [a]				0.88
White	81 (48.80)	41 (49.40)	40 (48.19)	
Black or African American	71 (42.77)	36 (43.37)	35 (42.17)	
Other	14 (8.43)	6 (7.22)	8 (9.64)	
Ethnicity, Hispanic	20 (11.90)	10 (11.90)	10(11.90)	0.99
College 4 years or more (College graduate)	92 (54.76)	49 (58.33)	43 (51.19)	0.35
Married or living with a partner [b]	85 (50.90)	45 (54.22)	40 (47.62)	0.39
Annual household income ≥$55,000 [c]	102 (67.11)	58 (71.60)	44 (61.97)	0.21
Employed for wages	108 (64.29)	53 (63.10)	55 (65.48)	0.75
General Health status (Excellent, Very Good, or Good)	131 (77.98)	67 (79.76)	64 (76.19)	0.75
Involvement in previous weight management program	33 (19.64)	21 (25.00)	12 (14.29)	0.08
Reported at least one comorbidity [b]	129 (77.25)	65 (78.31)	64 (76.19)	0.74

[a] data missing n = 2

[b] data missing n = 1

[c] data missing n = 16

Table 2

Intervention effect on enrollment in weight management program based on a multivariable logistic regression model (n = 137*).

Variables	Adjusted odds ratio (95% CI)	p value
Intervention effect (intervention vs Control)	**4.75(1.9,11.83)**	**< 0.001**
Previous involvement in a weight management program vs other	3.17(1.09,9.2)	**0.03**
Income > $55,000 vs ≤ $55,000	0.97(0.37,2.59)	0.96
At least one comorbidity vs other	1.37(0.5,3.78)	0.54
BMI at baseline	0.93(0.83,1.05)	0.24
High self-rated health vs other	2.02(0.64,6.39)	0.23
Male vs Female	0.36(0.13,0.99)	**0.04**
Race/Ethnicity		
Non-Hispanic-White vs Non-Hispanic-Black	5.42(1.71,17.13)	**<0.01**
Non-Hispanic-White vs other	5.58(1.4,22.27)	**0.02**
Non-Hispanic-Black vs other	1.03(0.28,3.85)	0.97
Age at baseline	0.97(0.93,1.01)	**0.11**

bold indicates significance at $p < 0.05$

95% CI: 95% confidence interval

*137 participants who completed either the 3- or 6-month assessment or both.

Table 3

Intervention effects on percent weight change, physical activity and fruit/vegetable intake at each time point based on multivariable longitudinal interactive regression models. (n = 168).

Variables		Model 1 Adjusted mean difference (95% CI)	Model 2 Adjusted mean difference (95% CI)
Percent weight change [a]	Intervention effect (Intervention vs. Control)		
	at 3 month[d]	−0.53 (−2.03, 0.97)	0.20 (−1.04, 1.44)
	at 6 month[e]	−1.02 (−2.05, 0.019)	−0.73 (−1.61, 0.16)
		Adjusted Rate Ratio (95% CI)	**Adjusted Rate Ratio (95% CI)**
Self-reported moderate-to-vigorous intensity physical activity [b]	Intervention effect (Intervention vs. Control)		
	at baseline	0.87 (0.55, 1.37)	1.01 (0.68, 1.51)
	at 3 month	0.83 (0.51, 1.33)	0.92 (0.62, 1.36)
	at 6 month	0.79 (0.52, 1.19)	0.93 (0.62, 1.39)
Total fruit and vegetable intake (NCI/NIH FV Screener)[c]	Intervention effect (Intervention vs. Control)		
	at baseline	1.07 (0.83, 1.37)	1.07 (0.84, 1.38)
	at 3 month	1.01 (0.76, 1.35)	0.90 (0.66, 1.22)
	at 6 month	1.03 (0.79, 1.35)	0.99 (0.74, 1.33)

Note: model 1: before imputing missing values; model 2: after imputing missing values, which included n=75 for percent weight change, n=59 for self-reported moderate-to-vigorous intensity physical activity, and n=56 for total fruit and vegetable intake; we adjusted for race/ethnicity, age, sex, self-rated health, annual household income, current health conditions, baseline BMI and involvement in a previous weight management program were adjusted in multivariable models.

[a] linear regression, interaction effect between intervention and time in relation to percent weight change were 0.58 (model 1) and 0.20 (model 2).

[b] Poisson regression, interaction effect between intervention and time in relation to physical activity were 0.92 (model 1) and 0.90 (model 2)

[c] Poisson regression, interaction effect between intervention and time in relation to physical activity were 0.92 (model 1) and 0.45 (model 2) 95% CI: 95% confidence interval.

[d] Percent weight change was calculated at 3 month based on the difference in weights from baseline to month 3.

[e] Percent weight change was calculated at 6 month based on the difference in weights from month 3 to month 6.

Table 4

Dose-response effects on percent weight change, physical activity and fruit/vegetable intake at each time point based on multivariable interactive regression models for intervention group participants (n = 84).

Variables		Model 1 Adjusted mean difference (95% CI)	Model 2 Adjusted mean difference (95% CI)
Percent Weight change[a]	Dose-response effect (#calls ≥ 4 vs. #calls < 4)		
	at 3 month [d]	**−3.09 (−5.47, −0.)** *	**−2.67 (−4.21, −1.12)** ***
	at 6 month [e]	−0.76 (−3.20, 1.67)	**−1.43 (−2.77, −0.09)** *
		Adjusted rate ratio (95% CI)	Adjusted rate ratio (95% CI)
Self-reported moderate-to-vigorous intensity physical activity[b]	Dose-response effect (#calls ≥ 4 vs. #calls < 4)		
	at baseline	1.35 (0.75, 2.42)	1.02 (0.56, 1.88)
	at 3 month	1.57 (0.73, 3.39)	**2.18 (1.04, 4.57)** *
	at 6 month	2.11 (0.76, 5.88)	1.97 (0.61, 6.32)
Total fruit and vegetable intake (NC1/NIH FV Screener)[c]	Dose-response effect (#calls ≥ 4 vs. #calls < 4)		
	at baseline	1.20 (0.82, 1.75)	1.18 (0.81, 1.72)
	at 3 month	**1.98 (1.23, 3.21)** **	**2.26 (1.27, 4.01)** **
	at 6 month	1.32 (0.76, 2.30)	1.88 (1.00, 3.54)

Note: model 1: before imputing missing values; model 2: after imputing missing values; we adjusted for race/ethnicity, age, sex, self-rated health, annual income, current health conditions, baseline BMI and involvement in a previous weight management program were adjusted in multivariable models. 95% CI: confidence interval.

* p < 0.05

** p< 0.01

*** p < 0.001

[a] Linear regression, dose-response group between group and time in relation to percent weight change were 0.19 (model 1) and 0.22 (model 2).

[b] Poisson regression, interaction effect between dose-response group and time in relation to percent weight change were 0.46 (model 1) and 0.99 (model 2).

[c] Negative binomial regression, interaction effect between dose-response group and time in relation to percent weight change were 0.25 (model 1) and 0.08 (model 2).

[d] Percent weight change was calculated at 3 month based on the difference in weights from baseline to month 3.

[e] Percent weight change was calculated at 6 month based on the difference in weights from month 3 to month 6.