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Patient-Reported Outcomes in the Practice-based Opportunities for Weight Reduction (POWER) Trial

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Abstract

Purpose—To evaluate effects of two behavioral weight loss interventions (in-person, remote) on health-related quality of life (HRQOL) compared to a control intervention.

Methods—415 obese US adults with at least one cardiovascular risk factor completed five measures of HRQOL and depression: MOS SF-12 physical component summary [PCS] and mental component summary [MCS]; EuroQoL 5-Dimensions [EQ-5D] single index and visual analog scale; PHQ-8 depression symptoms, and PSQI sleep quality scores at baseline and 6 and 24 months after randomization. Change in each outcome was analyzed using outcome-specific mixed effects models controlling for participant demographic characteristics.

Results—PCS-12 scores over 24 months improved more among participants in the in-person active intervention arm than among control arm participants ($P<0.05$, ES = 0.21); there were no other statistically significant treatment arm differences in HRQOL change. Greater weight loss was associated with improvements in most outcomes ($P<0.05$ to <0.0001).

Conclusions—Participants in the in-person active intervention improved more in physical function HRQOL than participants in the control arm did. Greater weight loss during the study was associated with greater improvement in all PRO except for sleep quality, suggesting that weight loss is a key factor in improving HRQOL.

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Conflict of Interest

Dr. Louis reports receiving consulting fees from Bristol-Meyers Squibb and Merck and royalties from Taylor and Francis Publishing. Johns Hopkins University has an institutional consulting agreement with Healthways. No other potential conflict of interest relevant to this article was reported.

Keywords

weight reduction trial; comparative effectiveness trial; patient-reported outcomes; quality of life; depression

INTRODUCTION

Obesity is a serious and highly prevalent public health problem. In the United States, more than 30% of adults are obese [1]. Obesity increases the risk for type 2 diabetes, cardiovascular disease, osteoarthritis, certain cancers [2,3], and overall mortality [4]. In 2008, obesity was associated with annual direct and indirect costs of almost $150 billion dollars in the United States [5]. Obesity is also associated with poorer health-related quality of life (HRQOL) and higher levels of depression [6–14].

Recently, studies have begun to assess the effects of weight management interventions on patient-reported outcomes (PRO), including HRQOL, depression, and sleep quality. PRO assess perceptions of current health functioning in physical, social, and psychological domains. In cohort longitudinal studies, PRO have been shown to predict morbidity and mortality [15,16]. Changes in PRO may also cast light on the likelihood that patients will adopt and maintain treatments [17].

Until recently, most studies of weight loss interventions, including studies of behavioral weight loss interventions, showed no consistent improvement in HRQOL or depression symptoms [18]. In more recent behavioral weight loss trials (the Diabetes Prevention Program [DPP] [19], Look AHEAD [20], and PREMIER [21]), physical HRQOL improved more in the active intervention arms than in the control arms, with no significant between-arm differences in mental HRQOL change, and a small advantage for the active intervention arm in improved depression symptoms.

Despite the growing literature examining PRO in weight loss trials, the effects of these interventions on HRQOL and depression symptoms remains unclear, and these effects have not been assessed outside of the context of efficacy trials. The association of weight loss and changes in PRO is an area that also requires further evaluation. The current analyses evaluate these effects and associations on a broad range of PRO, including quality of life, depression, and sleep quality, in a large, racially diverse population of obese medical outpatients enrolled in a 2-year randomized comparative effectiveness trial with a control arm and two behavioral weight loss interventions. The current analyses allow PRO assessment in “everyday” patients who are part of primary care practices.

Our research has two objectives: 1) to describe the associations of the interventions with PRO change over 24 months, and to test for differences between the intervention arms, and 2) to assess the associations of baseline BMI and weight change over 24 months with PRO change over 24 months, independent of treatment arm. We hypothesized that PRO would improve in the two active intervention arms compared to the control arm. We also hypothesized that either lower baseline BMI or greater weight reduction during the study would be associated with improved PRO independent of treatment arm.

METHODS AND PROCEDURES

Participants and design

Detailed descriptions of trial methods and main results have been published [22]. The study population consisted of obese adults, with body mass index (BMI) ≥ 30 kg/m^2, at least 22 years of age, with one or more cardiovascular risk factors (hypertension, hypercholesterolemia, or diabetes). All participants were patients of one of the participating primary care clinics, and all had regular access to a computer and were able to access Websites, enter data, and receive and send e-mail. Potential participants were excluded if they had recently lost ≥5% of their body weight or were taking medication that would likely cause weight gain or inhibit weight loss. In general, eligibility criteria were less stringent than those typically used in efficacy trials [23,24,21, 25]. Study participants were enrolled even when it was uncertain whether the person would adhere to the study protocol or complete follow-up visits. There was no run-in to exclude such participants.

Participants were recruited from six primary care practices in the Baltimore metropolitan area from February 2008 to February 2009 through physician referral, brochures, and targeted mailings. This trial was one of three independent trials in the Practice-based Opportunities for Weight Reduction (POWER) study, supported by the National Heart, Lung, and Blood Institute (NHLBI) [26]. No patient was enrolled in more than one study. An institutional review board approved the study, which was overseen by an independent data safety and monitoring board appointed by NHLBI. All participants provided written informed consent prior to randomization.

Participants were randomly assigned to one of three study arms, two of which involved an active behavioral weight loss intervention. Randomization assignments were stratified by gender and generated in block sizes of 3 and 6 by a web-based program. Assignment was carried out by unmasked staff who were not involved in follow-up data collection.

Control arm participants received a brochure that provided guidance on weight control and a list of recommended Web sites that promoted weight loss. Participants in both of the active intervention arms were encouraged to use a study-specific Web site that contained learning modules and tools for self-monitoring of weight, caloric intake, and exercise. Active intervention participants were encouraged to log on to the study Web site at least weekly, and they received a monthly e-mail summarizing weight-loss progress. Participants who had not logged on to the Web site in the previous week were sent automated re-engagement e-mail.

One active intervention arm (labeled “in-person”) received in-person and telephone coaching from health coaches employed by Johns Hopkins University. Participants in this arm could choose whether to meet with their coach in person or by phone. They were also encouraged to attend group weight loss meetings. The other active intervention arm (labeled “remote”) received telephone coaching only, from coaches employed by Healthways, a disease management company. Participants in the control arm met with a Hopkins weight-loss coach at randomization and were offered another meeting after final data collection, at 24 months.

Each of the in-person coaches had at least a Bachelor's degree. One was a registered dietitian, and two others had a Master's degree in Psychology or Public Health. The Healthways remote coaches had Master's degrees and were Certified Health Education Specialists. All coaches, whether Hopkins or Healthways staff members, received the same training before the study began and during the course of the trial.

Primary care providers (PCP) played a supportive role in the study, recruiting participants, reviewing weights, and encouraging full participation. Before each routine office visit, the PCP received a brief progress report that included a graph showing the participant's baseline, target, and self-reported weights. The PCP was advised to use this report as a tool to encourage continued participation in the study.

At the randomization visit and each follow-up visit, (6, 12, and 24 months after randomization) participants were weighed and PRO were assessed. Visits took place at the Johns Hopkins University ProHealth facility.

Primary outcome

The primary study outcome was change in weight from baseline to 24 months, based on the intent-to-treat principle. Primary outcome results have been reported [22]. In brief, mean change in weight from baseline to 24 months was −0.8 kg in the control arm, −4.6 kg in the remote arm ($P<0.001$ compared to control), and −5.1 kg in the in-person arm ($P<0.001$ compared to control). Change in weight from baseline did not differ significantly between the remote and in-person arms. Ninety-five per cent of enrolled participants were weighed at 24 months.

Patient-reported outcomes (PRO) measures

PRO were assessed with widely used, well-validated instruments. All measures were administered on the website; paper versions were available to participants upon request. These PRO included two HRQOL and health status instruments (the SF-12 Health Survey [SF-12] and the EuroQol-5 Dimensions [EQ-5D]), a measure of depression symptoms (the Patient Health Questionnaire-8 [PHQ-8]), and a measure of sleep quality (the Pittsburgh Sleep Quality Questionnaire [PSQI]). PHQ-8 assessments were performed at baseline, 6 month, 12 month and 24 month visits; other PRO were assessed at randomization, 6 month and 24 month visits, and all available data were included in the analyses.

The SF-12 [27] generates two composite scores, the Physical Component Summary (PCS-12) and the Mental Component Summary (MCS-12). These are norm-based with a mean of 50 and a standard deviation of 10 in the normative U.S. population. Scores on SF-12 measures range from 0 to 100, with higher scores indicating better quality of life. Average scores for the two SF-12 composite measures closely approximate those for the more widely validated SF-36 [26].

The EQ-5D [28], a generic measure of health status, provides a single index value that can be used in clinical and economic evaluation of health care. The EQ-5D describes health status according to five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression), and it is one of the few measures recommended for use in cost-

effectiveness analyses by the U.S. Public Health Service's Panel on Cost Effectiveness in Health and Medicine (possible range = 0–1, with higher scores indicating better health status) [29]. The EQ-5D also provides a one-item rating of overall health status using a Visual Analog Scale (VAS) with a possible range = 0–100.

The PHQ-8 [30] can be used either as a diagnostic algorithm to make probable diagnosis of major depressive disorder (MDD) or as a continuous measure, with scores ranging from 0 to 27 and cut points of 5, 10, 15, and 20 representing mild, moderate, moderately severe, and severe levels of depression symptoms, respectively. In the Hopkins POWER study we analyzed continuous PHQ-8 scores. Baseline Chronbach alpha for this study was 0.78.

The PSQI [31] is a 19-item scale, with items assessing subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Responses are scored from 0 to 3, with lower scores indicating more functional responses. The sum of these component scores yields a total score with a range of 0 to 21. A total PSQI score >5 is highly specific and sensitive in distinguishing poor from good sleepers [31], and has been validated in a number of populations [32]. In the current study we assessed PSQI total scores. Baseline Chronbach alpha for this study was 0.53.

Analysis

Our goals for the primary analyses were twofold – intention-to-treat analyses that compare the change in each PRO between randomized arms, and observational analyses that assess the relation between change in weight and change in PRO, independent of randomized arms. All outcome values obtained before a protocol-defined censoring event (i.e., pregnancy, bariatric surgery, or amputation) were included in the analyses. Results related to changes over 24 months in PRO are presented.

A repeated-measures, mixed-effects modeling approach was utilized for the main analyses, with missing data indicators to maintain the data structure. The mean model employed a cell means model for visit (baseline, 6, and 24 months for all PRO, except PHQ-8 which also included the 12-month visit) and randomized arms, and included adjustment for PCP clinic, age, gender, ethnicity, education, income, employment, smoking status, and body mass index (BMI), all collected at baseline before randomization. An unstructured covariance model was used to relate the repeated measures, and robust standard errors were computed. This approach produces valid estimates under the missing at random (MAR) mechanism where missing data depended only on the observed outcomes and/or the covariates included in the model [33, 34].

An additional model further included a measure of time-dependent weight change, which was used to explore the degree to which weight change mediated the effect of the intervention on PRO. The model without weight change controlled indicates the total effect of the treatment interventions and generates the main findings; the model with weight change controlled is an ancillary analysis that indicates the effect of treatment beyond that attributable to weight change per se.

Within-arm effect sizes (ES) were calculated as 24-month change in PRO for each intervention arm, derived from the model-based analyses, divided by the overall baseline standard deviation (SD) for the corresponding PRO. Treatment-arm ES were calculated as the difference between within arm ES. Analyses were conducted using the Statistical Analysis System (SAS) version 9.2 (SAS Institute, Carey, NC), or R 2.10.0, a software environment for statistical computing and graphics. A 2-sided p-value < 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

Baseline characteristics of the study population appear in Table 1. Mean age of study participants was 54.0 years, mean BMI was 36.6 kg/m^2, 63.6% were female, 56.1% were Caucasian and 41.0% were African-American, 89.4% had at least some college education, 76.3% had hypertension, 23.2% had diabetes, and 67.7% had hypercholesterolimea.

Table 1 also shows baseline PRO scores for the study population

Available PRO data

At 24 months, assessments were available for 303 (73.0%) of the participants for SF-12, 356 (85.8%) participants for PHQ-8, 311 (74.9%) participants for EQ-5D, and 291 (70.1%) participants for PSQI. PRO completion rates in this trial were lower than for the primary outcome of weight. Among the PRO the PHQ-8 had the highest priority because it was used for depression alert monitoring.

Several participant attributes were significantly associated with greater probability of missing PRO data at 24 months, including: younger age, non-white race, female gender, not having a college degree, being in the control arm, some clinical sites, higher baseline BMI, and less weight loss at 24 months. We included these predictors of missing PRO as covariates in the mixed-effects models anchored on MAR to improve ignorability of the missing data process in data analyses and ensure validity of statistical inferences.

Within-arm Changes in PRO at 24 Months

Table 2 displays within-arm changes in PRO over 24 months (first set of columns). Within-arm assessments show that PCS-12 scores improved in the in-person active intervention arm (ES = 0.30), and EQ-5D VAS health status scores improved in all arms (control ES = 0.24, remote ES = 0.23; in-person ES = 0.35). There were no other significant within-arm changes in any PRO.

Between-arm Differences in PRO Change at 24 Months

Table 2 also displays between-arm differences in the change in PRO scores from baseline to 24 months, without adjustment for weight change during the trial (second set of columns), and with adjustment for weight change (third set of columns). Between-arm assessments without adjustment for weight change show that mean PCS-12 scores over 24 months improved more among participants in the in-person active intervention arm than among

control arm participants (P<0.05, ES = 0.21); there were no other statistically significant differences among treatment arms. After adjustment for weight change, the difference in PCS-12 score change over 24 months between the in-person active intervention arm and the control arm was no longer statistically significant.

After adjustment for weight change PHQ-8 scores worsened in the in-person active intervention arm compared to the control arm (P<0.05; ES = 0.24).

Other than these two results, between-arm differences in PRO changes over 24 months were not statistically significant after adjustment for weight change during the trial.

Associations of Baseline Weight and Changes in Weight with Changes in PRO

The independent associations of baseline BMI and weight change, with change in PRO over 24 months appear in Table 3, adjusted for ethnicity, clinic, age, gender, education, income, employment, and smoking status. Higher baseline BMI was associated less improvement in all PRO except for MCS scores (P<0.05 to P<0.0001; PCS ES = 0.75, PHQ-8 ES = 0.28, EQ5D-VAS ES = 0.58, EQ5D Single Index ES = 0.51, PSQI ES = 0.34). Weight loss during the trial was associated with improvement in all PRO except sleep quality (P<0.05 to P<0.0001; PCS ES = 0.59, MCS ES = 0.20 PHQ-8 ES = 0.48, EQ5D-VAS ES = 0.72, EQ5D Single Index ES = 0.36).

DISCUSSION

In the Hopkins POWER trial comparing two behavioral weight loss interventions to a control intervention in a diverse population of obese adults with at least one cardiovascular risk factor, physical function HRQOL as assessed by the PCS-12 improved more at 24 months in the active treatment arms than in the control arm. Higher baseline BMI was associated with less improvement during the trial in a broad range of PRO, but it did not significantly interact with treatment effects on PRO. Greater weight loss during the study was associated with greater improvement in all PRO except for sleep quality. Intervention effects on PRO were partly dependent on weight loss.

Baseline SF-12 physical and mental HRQOL status scores in the current comparative effectiveness trial did not differ by a minimally important difference [35] from corresponding scores in the general population of obese adults in the U.S. [7], or from those in some large behavioral weight loss efficacy studies (DPP [19], Look AHEAD [20], and PREMIER [21]).

Between-arm Changes in PRO at 24 Months

Improvements in a measure of physical HRQOL (PCS-12 scores) were greater in the in-person active intervention arm than in the control arm, based on 24-month changes for each of the in-person intervention compared to control. This was the only between-arm difference in treatment effect on PRO change in the current study; there were no significant differences between the active treatment arms in change for any PRO measure, suggesting that the active interventions are equivalent in their effects on all measures of HRQOL and wellbeing included in this study.

Findings from Hopkins POWER are similar to those of earlier studies. In the DPP [19], Look AHEAD [20], and PREMIER [21] trials, HRQOL was assessed using the SF-36, the parent of the SF-12 used in POWER. In the United States, the SF-12 has been shown to reproduce the SF-36 PCS and MCS summary measures, with the same interpretations [27]. In these studies PCS scores improved in the active intervention arm more than in the control arm, with no between-arm differences in MCS score change.

Adjustment for weight change allows us to disentangle the effect of study participation from that of weight change. When adjusted for weight change during the trial, the PCS-12 difference in change between the in-person intervention arm and the control arm was no longer statistically significant, suggesting that the PCS-12 benefit of the intervention was partly due to weight loss. Also, after adjustment for weight change the change in PHQ-8 depression scores favored the control arm over the in-person intervention arm ($P<0.05$). The latter results may reflect some negative effects of participation in the in-person active intervention arm (e.g., treatment burden or disappointment among those who did not achieve the desired/anticipated weight-loss), although these effects were offset by the benefits of weight loss. We did not assess these possible negative effects of participation in this study. Controlling for weight change partitions the non-significant between-arm difference into the two offsetting components, each of which is significant in the opposite direction.

The total treatment effect for PHQ-8 scores was not significant. Depression symptoms in the DPP [19] and Look AHEAD [20], assessed using the Beck Depression Inventory (BDI), improved more in the lifestyle arm than in the control arm, but the differences were small, and sample sizes were very large, increasing the likelihood that small differences would be statistically significant. Also, antidepressant medication use increased while BDI scores declined, suggesting that reduced symptom scores could be attributable to effective antidepressant medication [36]. The similarity in findings across the Hopkins POWER intervention and other similar interventions in trials reflects the fact that behavioral weight loss interventions, as currently designed, do not affect mental wellbeing (i.e. MCS-12, MCS-36, or depression symptom scores).

It appears that in the Hopkins POWER study and others, the benefits of weight-loss interventions, and of weight loss independent of intervention, on HRQOL are largely experienced through improved physical function. We found no total treatment effects for measures of mental function (MCS-12 or PHQ-8). We also found no between treatment arm effects for the EQ-5D. The EQ-5D includes questions that assess anxiety/depression, as well as measures of physical function, which may be less sensitive to moderate weight loss than PCS-12 items, because the EQ-5D assesses less demanding activities. For example, the EQ-5D asks if the respondent has trouble walking about, or is able to wash and dress independently, while the PCS-12 asks about ability to climb several flights of stairs, or to move a table, push a vacuum cleaner, or play golf. Activities assessed in the PCS-12 are more similar to those addressed in the POWER intervention. This could explain the difference between treatment effects with the PCS-12 and the EQ-5D.

We also found no treatment effects related to sleep, assessed by the PSQI. The specificity of the focus on sleep quality for this measure could make it less sensitive to weight change than

the PCS-12. Moreover, sleep improvements in obese individuals were not specifically addressed in POWER and may need to be addressed with specific, specialized sleep interventions (e.g., cognitive-behavioral treatment for insomnia) rather than indirectly through weight loss.

Association of Baseline BMI and Change in PRO

In the Hopkins POWER study, participants with higher baseline BMI improved less than participants with lower BMI on all patient-reported outcomes except for SF-12 MCS scores, after accounting for the amounts of weight change. These associations with baseline BMI were all statistically significant ($P<0.05$ to $P<0.001$). Effect size for the association of baseline BMI and change in SF-12 PCS scores was in the moderate to large range; all other associations of baseline BMI and PRO score change were in the small to moderate range.

Association of Change in Weight and Change in PRO

In the Hopkins POWER study, greater weight loss during the 24-month trial was associated with greater improvement in all patient-reported outcomes except for sleep quality, with effect sizes in the small range for the MCS and EQ-5D Single Index, the moderate range for the PCS and PHQ-8, and the moderate to large range for the EQ-5D VAS. As in Look AHEAD (20) changes in bodyweight during POWER accounted for a portion of changes in PCS scores attributable to treatment arm, suggesting that other factors (e.g., counseling and group support, changes in social and or family environment, improved physical fitness) may be critical variables for improvements in HRQOL associated with successful lifestyle interventions related to weight management in obese adults. In PREMIER PCS scores improved in those who lost >4kg and declined slightly in those who lost less weight (effect size for difference = 0.38) [21]. In contrast to POWER, weight loss in DPP [19], Look AHEAD [20] and PREMIER [21] were not associated with change in MCS scores.

Study Strengths and Limitations

Study strengths included a relatively large racially and ethnically diverse population of obese individuals with cardiovascular comorbidities typical of an obese, adult U.S. population, drawn from primary care practices, and with baseline physical and mental HRQOL status similar to that in the general population of obese adults in the U.S. Another strength was the comparative effectiveness design with recruitment, retention, and two active behavioral weight loss interventions, all closer to potential real-world experience than earlier efficacy trials, and therefore more likely to be generally adopted. A third strength was the relatively long duration of intervention and follow up (24 months). A fourth strength was the broad range of well-validated measures of health-related quality of life, health status, depression, and sleep quality utilized in the trial, all of which have been shown to be associated with obesity. A fifth strength was the analysis that tested treatment effects adjusted for weight change, allowing us to disentangle the effect of study participation from that of weight change. This is the first study examining HRQOL in behavioral weight loss interventions we know of that combines all of these strengths.

This study also has some limitations, including loss to attrition by 24 months; however, the analysis used all available data in estimating various model parameters. Second, this study

included no weight-specific measure of health-related quality of life. One study [10] included such a measure, and reported that weight loss effect sizes for this measure were greater than those for generic measures of HRQOL. Third, though participants in the current study were selected using less stringent criteria than participants in earlier weight loss efficacy trials, participants might not be representative of the general population of obese adults with cardiovascular risk factors, particularly with regard to their relatively high educational level. Their decision to enter a weight loss trial could distinguish them from the general population.

Conclusion

Results of the Hopkins POWER study are generally consistent with those of earlier large efficacy trials of behavioral weight loss interventions (DPP, Look AHEAD, PREMIER). In all these studies the benefits of the active weight loss interventions, and of weight loss *per se*, were experienced largely through improved physical HRQOL.

Results of the POWER Hopkins study indicate that it is possible to deliver behavioral weight-loss interventions to patients of primary care physicians. In addition to successful weight loss, participants who lost weight experienced substantial benefits, with effect sizes ranging from small to large, in all PRO except for sleep quality.

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Table 1

Baseline Characteristics of Study Participants*

	Control	Remote Support Only	In-Person Support	All
Characteristic	**N=138**	**N=139**	**N=138**	**N=415**
Age-years	52.9 (10.1)	55.8 (9.7)	53.3 (10.5)	54.0 (10.2)
Weight-kg	104.4 (18.6)	102.1 (13.9)	105.0 (20.7)	103.8 (17.9)
Body Mass Index, kg/m^2	36.8 (5.1)	36.0 (4.7)	36.8 (5.2)	36.6 (5.0)
Female sex-%	63.8%	63.3%	63.8%	63.6%
Race/ethnicity %				
% Asian	1.4%	1.4%	0.0%	1.0%
% African-American	42.8%	37.4%	42.8%	41.0%
% Caucasian	52.2%	59.7%	56.5%	56.1%
% Other	3.6%	1.4%	0.7%	1.9%
Ethnicity-%				
% Hispanic	2.2%	2.2%	2.2%	2.2%
Education-%				
High School Graduate or less	13.0%	10.8%	8.0%	10.6%
Some college	32.6%	30.9%	26.8%	30.1%
College graduate	54.3%	58.3%	65.2%	59.3%
Medical Conditions-%				
Hypertension	77.4%	80.6%	71.0%	76.3%
Diabetes	23.2%	22.3%	23.9%	23.1%
Hypercholesterolemia	68.1%	71.2%	63.8%	67.7%
Patient-Reported Outcomes				
SF-12 PCS	46.83(7.95)	47.53 (8.42)	47.06 (8.92)	47.14 (8.42)
SF-12 MCS	51.06 (8.71)	52.53 (7.40)	52.16 (9.60)	51.92 (8.61)
PHQ-8	3.09 (3.20)	2.71 (3.10)	2.70 (2.90)	2.83 (3.06)
EQ-5D VAS	73.34 (17.63)	76.64 (15.72)	75.12 (18.95)	75.04
EQ-5D Single Index	0.87 (0.11)	0.88 (0.12)	0.88 (0.12)	0.88 (0.11)
PSQI#	7.53 (2.91)	7.24 (3.03)	7.21(2.89)	7.33 (2.94)

* Mean (Standard Deviation) or %

Race or ethnic group was self-reported and categories were mutually exclusive; total may not sum to 100% due to rounding.
SF-12 PCS: Medical Outcomes Study Short Form-12 Physical Component Summary
SF-12 MCS: Medical Outcomes Study Short Form-12 Mental Component Summary
PHQ-8: Patient Health Questionnaire-8 depression scale
EQ-5D VAS : EuroQol 5 Dimensions visual analog scale
EQ-5D Single Index : EuroQol 5 Dimensions single index value
PSQI: Pittsburgh Sleep Quality Index total score

[#]PSQI Total scores were available only in 135 participants in the control group, in 135 participants in in-person group, and in 137 participants in the remote group at baseline.

Table 2

PRO Within-Group Change, Total Between-Arm Treatment Effect, and Treatment Effect Net of Weight Change

	Within-Arm Changes† Mean±Standard Error [N at 24 months]			Between-Arm Differences†† Mean (95% Confidence Interval)			Between-Arm Differences, Adjusted for Weight Change††† Mean (95% Confidence Interval)		
Outcome	**Control [N=138]**	**Remote [N=139]**	**In-person [N=138]**	**Remote minus Control**	**In-person minus Control**	**In-person minus Remote**	**Remote minus Control**	**In-person minus Control**	**In-person minus Remote**
SF-12 PCS	−0.29±0.97 [88]	1.16±0.77 [115]	2.23*±0.75 [100]	1.45 (−0.99,3.90)	2.52* (0.11,4.93)	1.06 (−1.05,3.18)	0.45 (−1.95,2.85)	1.29 (−1.07,3.65)	0.84 (−1.21,2.89)
SF-12 MCS	0.62±0.95 [88]	−1.07±0.68 [115]	−0.50±0.76 [100]	−1.70 (−3.99,0.60)	−1.12 (−3.52,1.27)	0.58 (−1.43,2.58)	−2.10 (−4.45,0.26)	−1.52 (−3.97,0.93)	0.58 (−1.43,2.58)
PHQ-8	−0.47±0.32 [111]	−0.36±0.27 [120]	0.25±0.32 [125]	0.11 (−0.71,0.94)	0.73 (−0.16,1.62)	0.62 (−0.20,1.43)	0.55 (−0.30,1.40)	1.09* (0.19,1.99)	0.54 (−0.27,1.36)
EQ-5D VAS	4.31*±1.77 [89]	3.45*±1.53 [118]	6.14***±1.78 [104]	−0.86 (−5.47,3.75)	1.83 (−3.07,6.74)	2.69 (−1.93,7.32)	−3.01 (−7.59,1.57)	−0.65 (−5.28,3.98)	2.35 (−2.07,6.78)
EQ-5D Single Index	−0.01±0.01 [89]	−0.01±0.01 [118]	−0.01±0.01 [104]	−0.004 (−0.04,0.03)	−0.0003 (−0.04,0.03)	0.003 (−0.03,0.04)	−0.01 (−0.05,0.02)	−0.01 (−0.05,0.02)	0.0004 (−0.03,0.03)
PSQI#	−0.15±0.34 [86]	−0.23±0.23 [109]	−0.38±0.31 [96]	−0.08 (−0.89,0.73)	−0.23 (−1.13,0.67)	−0.15 (−0.91,0.61)	0.07 (−0.75,0.89)	−0.05 (−0.97, 0.87)	−0.12 (−0.88, 0.64)

† Estimated within-arm 24 month mean changes ±SE [N at 24 months] from outcome-specific mixed effects models using all available data (PHQ-8 data were from baseline, 6 month, 12 month and 24 month visits; data for other outcomes were from baseline, 6 month and 24 month visits), assuming missing at random and adjusting for ethnicity, clinic, age, gender, education, income, employment, smoking, and baseline BMI.

†† Estimated between-arm 24 month mean changes (95% CI) from outcome-specific mixed effects models used to obtain estimated within-arm 24 month mean changes.

††† Estimated between-arm 24 month mean changes (95% CI) from adding time-dependent weight change to outcome-specific mixed effects models used to obtain estimated within-arm 24 month mean changes.

* P-value<0.05;

** P-value<0.01;

*** P-value<0.001;

**** P-value < 0.0001

PSQI Total scores were available only in 135 participants in the control group, in 135 participants in in-person group, and in 137 participants in the remote group at baseline.

Higher scores for SF-12 and EQ-5D and lower scores for PHQ-8 and PSQI represent better scores.

Table 3

Association of Baseline BMI and Time-Dependent Weight Change with Change in Patient-Reported Outcomes

	Baseline BMI, per kg/m^2↑	**Weight Loss, per kg ↓**
Outcome	**Mean outcome Change (95% CI)**	**Mean Outcome Change (95% CI)**
SF-12 PCS	−0.49**** (−0.62, −0.36)	0.25**** (0.33,0.17)
SF-12 MCS	−0.15 (−0.24,0.05)	0.09* (−0.18,0.0008)
PHQ-8	0.08** (0.02,0.13)	−0.09**** (−0.12,−0.05)
EQ-5D VAS	−0.67**** (−0.91,−0.44)	0.54**** (0.39,0.68)
EQ-5D Single Index Value	−0.005**** (−0.006,−0.003)	0.002*** (0.001,0.004)
PSQI	0.08** (0.03,0.14)	−0.03 (−0.07,0.004)

Estimated mean change (and 95% CI) in PRO per kg/m^2 increase in baseline BMI or per kg decrease in weight from outcome-specific mixed effects models using all available data (PHQ-8 data were from baseline, 6 month, 12 month and 24 month visits; data for other outcomes were from baseline, 6 month and 24 month visits), assuming missing at random, adjusting for ethnicity, clinic, age, gender, education, income, employment, and smoking status, treatment assignment, baseline BMI and time dependent weight change.

* P-value < 0.05;

** P-value < 0.01;

*** P-value < 0.001;

**** P-value < 0.0001.

Higher scores for SF-12 and EQ-5D and lower scores for PHQ-8 and PSQI represent better scores.