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Predictors of sustained reduction in energy and fat intake in the Diabetes Prevention Program Outcomes Study (DPPOS) Intensive Lifestyle Intervention

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Abstract

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Background—Few lifestyle intervention studies examine long-term sustainability of dietary changes.

Objective—To describe sustainability of dietary changes over 9 years in the Diabetes Prevention Program (DPP) and its Outcomes Study (DPPOS) among participants receiving the intensive lifestyle (ILS) intervention.

Design—1079 participants were enrolled in the ILS arm of DPP; 910 continued participation in DPPOS. Fat and caloric intake derived from food frequency questionnaires (FFQ) at baseline and post-randomization years 1 and 9 were examined. Parsimonious models determined if baseline characteristics and ILS session participation predicted sustainability.

Results—Self-reported caloric intake was reduced from a median of 1876 kcal/d [inter-quartile range (IQR) 1452-2549] at baseline to 1520 kcal/d (IQR 1192 -1986) at year 1, and 1560 kcal/d (IQR 1223 -2026) at year 9. Dietary fat was reduced from a median of 70.4 grams (IQR 49.3-102.5) to 45 grams (IQR 32.2-63.8) at year 1 and increased to 61.0 grams (IQR 44.6-82.7) at year 9. Percent calories from fat was reduced from a median of 34.4% (IQR 29.6-38.5) to 27.1% (IQR 23.1-31.5) at year 1 but increased to 35.3% (IQR 29.7-40.2) at year 9. Lower baseline energy intake and year 1 dietary reduction predicted lower caloric and fat gram intake at year 9. Higher leisure physical activity predicted lower fat gram intake but not caloric intake.

Conclusions—Intensive lifestyle intervention can result in reductions in total energy intake for up to 9 years. Initial success in achieving reductions in fat and caloric intake and success in attaining activity goals appear to predict long-term success at maintaining changes.

Keywords

diet; lifestyle intervention; diabetes prevention; dietary intake; dietary change

Background

Lifestyle interventions successfully reduce diabetes incidence. [1-4] Achieving and sustaining dietary change, however, is difficult. Few large-scale intervention studies have examined the sustainability of dietary change beyond one year of a lifestyle intervention. [1,5,6] The Diabetes Prevention Program (DPP) investigated the effects of an intensive lifestyle intervention (ILS) for the prevention of diabetes. The DPP was designed to decrease body weight through reductions in fat and energy intake and increasing physical activity levels. The weight loss goal in the DPP was to lose 7% of initial body weight. The physical activity goal was to achieve at least 150 minutes of moderately intense physical activity per week.[7] Participants assigned to the ILS achieved a mean post-randomization weight loss of 7 kg at one year, 4 kg at 2.8 years, and 2 kg at 10 years, resulting in a 58% reduced risk of diabetes over a 2.8 year period [2] and a 34% reduction of risk over 10 years [8] compared with persons randomized to the placebo control intervention. During the first year of the DPP trial, ILS participants achieved a median reduction in energy of 452 kcals/d and a median reduction in dietary fat of 6.6%, and for the metformin and placebo groups, the respective changes in median total energy were (-294 kcal/d and -250 kcal/d) with 0.8% fat reduction for both groups. [11]

In the ILS group, reduction in fat intake was associated with lower diabetes incidence. [9,10] For every 5% reduction in dietary fat intake, incident diabetes was reduced by 25%.[9] Among ILS participants, reduction in fat and energy intake was similar for men and women. Hispanic participants achieved the greatest reduction in dietary fat (while Asian American/ Pacific Islander participants, who at baseline reported the lowest total energy intake and percent energy from fat, had the least change.[11]

Little is known, however, about the longer-term sustainability of these dietary changes and whether any baseline characteristics can predict who will successfully achieve and maintain dietary changes. As efforts are made to translate the findings of the DPP to clinical and community settings it is important to understand factors that may be related to sustaining dietary changes. The objective of this analysis was to determine whether the dietary changes achieved between baseline and 1-year post randomization were sustainable for up to 9-years post-randomization, and to identify factors that determine the sustainability of specific dietary changes in the DPP and DPPOS.

Subjects and Methods

The design and methods of the DPP and the DPPOS have been published.[8,12] Briefly, eligibility requirements for DPP participants were age ≥25 years, body mass index (BMI) ≥24 kg/m2 (≥22 for Asian Americans) a plasma glucose concentration of 5.3 to 6.9 mmol/liter (95 to 125 mg/deciliter) in the fasting state (≤125 mg per deciliter in American Indian clinical centers) and 7.8 to 11.0 mmol/liter (140 to 199 mg/deciliter) two hours after a 75-g oral glucose load. Participants were recruited from 27 clinical centers throughout the U.S. between 1996 and 1999 and 3234 participants were enrolled (68% women, 45% from ethnic and racial minority groups). This paper describes the long-term dietary changes in the ILS arm of 1079 subjects. The local institutional review boards of the participating study centers approved the protocol and written informed consent was obtained from participants.

Intervention

Participants in the ILS arm were assigned a daily dietary fat gram goal that approximated 25% of energy needs based on their baseline weight. Daily fat gram goals were 33, 42, 50 and 55 grams for the weight groups <175, 175-220, 220-250, and >250 lbs., accordingly. If a participant was not on track to achieve a 7% weight loss by the seventh week of the intervention, a calorie goal was added to the fat gram goal. Participants were encouraged to increase their physical activity levels to achieve and maintain at least 150 minutes each week of moderately intense activity similar to a brisk walk.[7] The DPP had very high retention rates with only 2.5% attrition secondary to death or withdrawal.[8] The ongoing DPPOS began in September 2002 and DPP participants who were alive and did not withdraw consent before September 2002 were eligible for enrollment. Of 1,046 eligible ILS participants, 910 enrolled in DPPOS.

The thirteen-month time period between the end of DPP and the beginning of DPPOS was referred to as the Bridge. During the Bridge, participants in all three arms were offered a group-administered version of the 16-session lifestyle curriculum used in DPP. Details of the Bridge period have been described.[8,13] During DPPOS, all participants were offered a lifestyle session (HELP) once every 3 months. These sessions provided educational materials that reinforced the 7% weight loss and 150 min/week physical activity goals. In addition, the original ILS participants were offered refresher programs (BOOST) lasting 4 – 6 weeks twice per year. These motivational campaigns were designed to reinforce behavioral self-management skills.[8] Details of the HELP and BOOST curriculum have been reported.[8]

Dietary intake was assessed by in-person interview with a semi-quantitative Food Frequency Questionnaire (FFQ).[11] In the DPP, the FFQ was administered at baseline, one year later and at the fifth annual visit during DPPOS, which corresponds to an average of nine years of follow-up post DPP randomization.

The FFQ was comprised of 117 items that included ethnic and regional foods that represented the ethnic diversity of DPP participants.[11] Nine response categories indicating the frequency of food consumption were available for each question and ranged from “never or less than once per month” to “2 or more times per day”. For beverages, responses range from “never or less than once per month”, to “6 or more times per day”. Participants were asked to report their perception of portion sizes as small, medium, or large compared to those consumed by others of the same gender and age.

Self-reported leisure physical activity was assessed annually during DPPOS with the Modifiable Activities Questionnaire (MAQ).[14] Only physical activities that demand energy expenditure greater than that required by activities of daily living (e.g., bathing, grooming, and feeding) were assessed. Individuals were presented with a comprehensive list of activities developed for the entire DPP cohort and were asked to report the activities that they participated in during the past 12 months and to estimate the frequency and duration for each activity identified. Estimates of leisure activity were calculated as hours per week ($h \cdot wk^{-1}$) averaged over the past year. Each activity was also weighted by its relative intensity, referred to as a MET, thereby deriving MET-hours per week ($MET \cdot h \cdot wk^{-1}$) as the final unit of expression. One MET represents the energy expenditure for an individual at rest (1 MET = 3.5 $mL \cdot kg^{-1} \cdot min^{-1}$ of oxygen consumption), whereas a 10-MET activity requires 10 times the resting energy expenditure.[14]

Statistical Analysis

Our analysis of nutrient intake focused on total kilocalories, fat grams, and percent of energy from fat as the nutrition variables of interest in the DPP intervention to reduce energy intake and achieve the weight loss goal. Due to non-normal data distributions, the descriptive measures of the dietary intake variables are reported as median values with 25^{th} and 75^{th} percentiles.

Based on predictors of dietary change identified in prior studies, [5] we used the Wilcoxon's rank sum tests (or Kruskal-Wallis if more than two categories) to compare dietary outcomes at year 9 by participant baseline characteristics, participation at the ILS training sessions during the DPP, the Bridge period and the DPPOS, and average physical activity during the follow-up period. The baseline characteristics included demographics (age, sex, race/ ethnicity, marital status, education and income), medical history (diagnosis of hypertension, hyperlipidemia and heart attack), family medical history (mother having diabetes, heart attack; father having diabetes, heart attack), psychosocial status (Beck Depression and Anxiety Inventory Scores,[15,16] health-related quality of life (Physical Component Summary Score (PCS) and Mental Component Summary Score (MCS) from the SF-36 Health Survey),[17] leisure physical activity (MAQ) [18], and body weight. Having a diagnosis of diabetes, and time since diabetes diagnosis were also considered. We used multivariate linear regression with stepwise model selection [19] to build a parsimonious model for each dietary outcome at year 9. To avoid over-fitting, Schwarz Bayesian Information Criterion [20] was used as the selection criteria instead of the traditional F statistic. In addition to the above characteristics, we also controlled for the same dietary measure at baseline, and change from baseline to year 1 (calculated as year 1 minus baseline value). Age, sex, race/ethnicity, diabetes duration (0 entered for participants without diabetes) were forced to stay in the model.

Results

At DPP entry, 1054 of the original 1079 participants in the ILS cohort had nutrition data. Participants had a median age of 50.0 (Inter quartile range 42-59) years; 68.1% were women; and their self-identified race/ethnicity were 54.6% White, 18.7% African American, 16.3% Hispanic, 5.1% American Indian, and 5.2% Asian American or Pacific Islander. [21] After an average of nine years of follow-up, nutritional data were available for 790 participants, about 73% of the original 1079 participants enrolled in the intensive lifestyle arm. The 790 participants were fairly comparable at DPP baseline to those who had no dietary data, except that they were slightly older [median age and IQR 50.8(43.6- 59.3)], more likely to be White (55%), more educated (76% with at least some college education), and leaner [(median weight and IQR 90.5 (78.5-103.6) kg), median BMI and IQR 31.5 (27.9-36.5)]. Nutritional data at baseline, year 1 and year 9 are summarized in Table 1. The median self-reported caloric intake at baseline was 1876 kcal/d, compared to 1520 kcal/d at year 1, a 19% reduction from baseline. A median intake of 1560 kcal/d was reported at year 9, suggesting sustained reduction in caloric intake. At baseline, median fat grams were 70.4 grams, which was reduced to 45.2 grams after year 1, but then increased to 61.0 grams by year 9. Percent energy from fat initially decreased from a baseline value of 34.4% to 27.1% at year 1, but increased to 35.3% at year 9. The differences in energy intake, fat grams and percent energy from fat at baseline and 9 years post-randomization was significant (p<0.0001).

We compared intake of total energy, fat grams and percent energy from fat at year 9 by baseline demographic, medical and psychosocial variables, physical activity during follow-up, and study session participation characteristics. Those showing statistically significant differences (p<0.05) are presented in Table 1. All three nutrient outcomes were inversely related with age categories. Men consumed more energy and fat grams compared to women, but consumed less percent energy from fat. Among the five race/ethnic groups, American Indians consumed the highest intake of energy, fat grams, and percent of energy from fat while Asian Americans/Pacific Islanders had the lowest total energy and fat gram intake. Participants with higher levels of physical activity and participants with higher income (> $50,000) tended to consume lower percent of total energy from fat.

Univariate analyses of baseline medical and psychosocial scales demonstrated that participants with history of hypertension at baseline had lower intake of energy and fat grams at year 9. Higher Beck anxiety score indicating greater severity of anxiety was associated with both higher total calorie and fat gram intake but not percent energy from fat, whereas depression scores were not related to dietary intake. Higher baseline weight was associated with higher intake of kilocalories, grams of fat and higher percent of energy from fat at year 9. (See Table 1). Baseline leisure physical activity levels were not associated with total caloric or fat gram intake, but they were inversely associated with percent energy from fat. Leisure activity during the follow-up period was inversely associated with fat grams and percent energy from fat. The number of Bridge and the number of HELP/BOOST sessions that participants attended were each inversely associated with fat grams and percent of energy from fat.

After stepwise model selection, we obtained a final model for each of the three outcomes. The final regression models, which are summarized in Tables 2-4, accounted for 40% of the variance for total energy intake, 35% for fat gram intake, and 23% of the energy intake from fat at year 9. For total energy intake, only the baseline and change from baseline to year 1 remained statistically significant in the final model. Participants with lower baseline total calories and participants with greater reduction in caloric intake at year 1 had lower intake at year 9. In the model for total fat gram intake at year 9, significant predictors were baseline fat gram intake, change in fat gram intake from baseline to 1 year, and leisure physical activity during follow-up. Participants with lower baseline intake of fat grams, and greater fat gram reduction at year 1, had lower fat grams at year 9. Higher levels of physical activity during follow-up period predicted lower intake of fat grams at year 9. For the model predicting percent of energy from fat, being male, and participating in more HELP/BOOST sessions predicted a lower percent of energy from fat, while higher levels of physical activity during follow-up predicted lower percent of energy from fat. The 10-year diabetes incidence rate, which has published elsewhere, [8] for the ILS arm was reduced by 34% (95% CI 24–42) compared with placebo. Neither diabetes incidence nor diabetes duration predicted the year 9 dietary outcomes.

Discussion

Our findings demonstrate that participants assigned to the ILS arm of the DPP maintained lower self-reported intake of total energy for up to 9 years post-randomization, a primary goal of the dietary intervention. The initial reduction in percent energy from fat observed in year 1 was not maintained at year 9. Our final regression models were better predictors of total energy and fat gram intake, accounting for 40% and 35% of their respective variance, than the model for percent energy from fat, which accounted for only 23% of the variance.

We considered several factors that might have predicted sustainability of dietary changes, and found that baseline intake was a significant predictor of year 9 dietary intake; such that lower caloric and dietary fat intake at baseline predicted lower caloric and dietary fat intake at year 9. This finding supports the long-term findings from the Women's Health Initiative (WHI) dietary modification trial, in which baseline dietary intake was a significant predictor of maintenance of dietary fat gram goal at 3 years.[5] In the WHI, women who were closer to dietary goals at baseline remained closer to dietary goals at 3 years. In contrast to the findings of the WHI, however, demographic characteristics and psychosocial factors in the DPP did not predict sustainability of dietary changes. This difference in findings may be due to the fact that all participants in DPP had prediabetes, which may have minimized the impact of psychosocial and ethnic differences. Also the smaller sample size in DPP had less power to demonstrate potential associations between demographics and psychosocial factors with maintenance of dietary changes.

For each outcome, initial change in year one predicted year 9 intake, such that participants who made the greatest reduction had lower intake of that variable at year 9. Recidivism is very common in weight control programs and long-term sustainability of weight loss or dietary changes is a challenge. Although participants increased their energy and fat gram intake between year 1 of DPP and year 9 post-randomization follow-up; neither caloric nor fat intake returned to baseline levels. A similar pattern was previously reported for the sustainability of weight loss in the DPP and DPPOS and although participants in the lifestyle arm regained weight they did not return to baseline weight when evaluated at 10 years post-randomization [8]. Because the initial one-year change predicts long-term sustainability, our dietary results may have implications for translation. In efforts to translate the DPP ILS intervention in community settings it is critical to understand the importance of delivering an intense intervention early in the process to increase the likelihood of long-term success.

Although we observed a sustained reduction in energy intake, the median fat intake increased by ~ 15 grams from the year 1 to the year 9 FFQ assessment even though the median fat intake was ~ 10 gram below the baseline level. However, the proportion of energy intake from fat at year 9 was slightly higher than at baseline because the total caloric intake was ~ 300 kcal below the baseline level. Weight regain from year 1 to year 10 post-randomization, which was previously reported,[8] may be related to increased energy intake and/or decreased energy expenditure over that time period. Self-reported changes in caloric intake and energy expenditure did not fully account for the weight regain observed.

Reported levels of physical activity during the follow-up were significantly associated with the sustainability of changes in fat grams and percentage of energy from fat. This is consistent with other evidence showing that the maintenance of physical activity plays a critical role in weight loss maintenance.[22,23] We had previously shown that success at achieving the physical activity goal within the first 6 months of the DPP was strongly related to success at meeting both the activity goal and the weight loss goal at the final intervention visit (mean= 3.2 years).[24] This current report identifies another benefit of an active lifestyle, as participants who continued to engage in physical activity appeared to be better able to maintain their dietary goals over time.

During the DPPOS, intervention intensity was greatly reduced, however the ILS participants continued to have study visits. These visits addressed maintaining changes in food intake exercise, and strategies for achieving and maintaining weight loss. The number of HELP/BOOST sessions attended was a significant predictor of percent energy from fat; those who attended more sessions were more likely to sustain lower fat dietary changes. Attendance at intervention visits is a well-documented predictor of outcomes in lifestyle interventions.[5,25] HELP/BOOST session attendance variables were associated with lower caloric and fat gram intake at year 9; however they were not independent predictors of these outcomes in the multivariate model. This may highlight the complexity of factors related to session attendance. Knowler et al. found that in the DPP, session attendance was associated with older age, which may have contributed to long-term weight loss success.[8]

The Asian Americans had lower total caloric and fat gram intake at year 9. This group consists of 27% Asian Indians, 20% Chinese, 15% Hawaiian, 13% Japanese, 13% Filipino and 10% others. Although Asian Americans had lower BMI at study entry, their lower calorie and fat gram intake were not due to their baseline lower body weight.

The data reported here are unique, but not without limitations. The primary limitation is the use of self-reported dietary data that is subject to the biases of social desirability of responses and underestimation of caloric intake. Compared to other methods of dietary assessment, FFQs tend to underestimate energy intake,[26,27] particularly among individuals who are overweight.[28] Our measures of physical activity were also self-reported and may be more prone to bias and errors than objective measures that were unavailable in the DPP. As seen in Table 1, our sample size of completed questionnaires was smaller at year 9 than at baseline and year 1, which may have limited the power to detect additional predictors of dietary intake at year 9. Further, the self-selection of those who continued in DPPOS (88% of the DPP cohort) may reflect the well-recognized tendency for healthier people to join and continue in clinical trials and to complete questionnaire. We recognize that such secondary questions are hypothesis generating rather than hypothesis testing; further study will be needed to confirm these results.

In summary, our study demonstrates that people assigned to the DPP intensive lifestyle intervention can achieve and sustain dietary change over a decade of follow-up, and that dietary changes made during the higher intensity initial phases of the intervention contribute to greater long-term sustainability. Achieving initial success in reducing fat and kcals to achieve weight loss and long-term success in maintaining physical activity goals appears to predict long-term dietary success. Further research to understand potential benefits of the combination of diet and physical activity as mutually reinforcing health behaviors is needed.

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Table 1

Energy and fat intake of Intervention participants by baseline characteristics and intervention participation[1] at baseline, and years 1 and 9 post-randomization

	DPP Baseline				Post Randomization Year 1				Post Randomization Year 9			
Characteristics	**N**	**Total Calories**	**Fat Grams**	**% energy from Fat**	**N**	**Total Calories**	**Fat Grams**	**% energy from Fat**	**N**	**Total Calories**	**Fat Grams**	**%energy from Fat**
Total	1054	1876 (1452-2549)	70.4 (49.3-102.5)	34.4 (29.6-38.5)	987	1520 (1192-1986)	45.2 (32.3-63.8)	27.1 (23.1-31.5)	790	1560 (1223-2026)	61.0 (44.6-82.7)	35.3 (29.7-40.2)
Age										0.0275	<0.0001	<0.0001
25-<45 years	350	2059 (1533- 2859)	80.4 (56.7-119.1)	35.6 (31.3- 39.8)	321	1581 (1248- 2090)	51.5 (37.9- 69.7)	28.5 (24.4- 33.0)	230	1638 (1271- 2190)	69.0 (46.9- 94.4)	37.5 (32.1- 41.6)
45-<60	475	1881 (1442- 2511)	70.5 (47.6-100.1)	34.4 (29.7- 38.5)	453	1508 (1192- 1969)	43.7 (31.0- 63.6)	26.8 (22.8- 31.0)	376	1578 (1238- 2007)	61.3 (44.8- 79.0)	35.1 (29.8- 40.5)
60+	229	1758 (1340- 2195)	57.1 (43.4- 80.9)	32.6 (26.9- 36.6)	213	1468 (1101- 1870)	41.3 (29.3- 54.5)	25.7 (21.7- 29.6)	184	1496 (1164- 1918)	52.7 (40.5- 67.3)	33.0 (27.5- 38.0)
Sex										<0.0001	0.0621	<0.0001
Female	718	1789 (1373- 2415)	67.5 (47.4- 95.6)	34.6 (30.0- 38.8)	671	1438 (1108- 1853)	43.7 (30.4- 60.9)	27.5 (23.4- 31.8)	532	1510 (1157- 1960)	59.0 (44.4- 82.4)	35.9 (30.5- 40.9)
Male	336	2064 (1678- 2827)	78.3 (54.6-113.3)	33.9 (29.3- 38.0)	316	1785 (1337- 2294)	49.9 (36.6- 69.7)	26.7 (22.1- 30.5)	258	1694 (1375- 2205)	64.7 (46.9- 83.3)	33.1 (28.4- 39.2)
Race/Ethnicity										0.0027	0.0012	0.7016
White	576	1880 (1466- 2511)	70.4 (49.2- 95.5)	34.1 (29.4- 37.9)	537	1531 (1216- 1959)	45.0 (32.8- 61.6)	26.7 (22.8- 30.2)	432	1601 (1289- 2046)	62.9 (48.6- 83.4)	35.3 (29.9- 40.2)
African American	197	1782 (1385- 2415)	66.1 (46.6- 95.8)	34.1 (29.8- 38.1)	178	1472 (1076- 1838)	43.4 (30.7- 59.1)	27.4 (23.4- 31.4)	151	1442 (1088- 2059)	57.8 (42.9- 78.9)	35.5 (30.0- 40.9)
Hispanic	172	2019 (1545- 2797)	77.5 (56.6-116.2)	35.8 (30.9- 40.0)	164	1655 (1182- 2067)	48.4 (34.0- 66.1)	27.1 (23.0- 31.9)	114	1564 (1304- 1891)	59.5 (45.0- 76.5)	34.7 (28.2- 39.9)
American Indian	55	2289 (1357- 3242)	91.6 (51.5-148.6)	37.8 (31.4- 42.7)	56	1582 (1200- 2302)	61.4 (35.0- 85.5)	33.8 (26.6- 38.4)	45	1855 (1220- 2330)	74.2 (46.3- 98.0)	37.4 (31.3- 39.9)
Asian American or Pacific Islander	54	1834 (1360- 2300)	60.7 (42.3- 91.9)	31.7 (27.1- 35.6)	52	1477 (1059- 1991)	43.2 (30.5- 59.2)	26.1 (22.6- 32.4)	48	1411 (966.6- 1642)	47.6 (36.6- 71.2)	35.7 (25.7- 40.7)
Income										0.1869	0.0578	0.0429
$50,000+/year	430	1893 (1499- 2573)	70.7 (47.4-100.8)	33.8 (29.4- 37.8)	403	1539 (1215- 1976)	44.6 (33.8- 63.3)	27.2 (23.4- 30.8)	331	1591 (1292- 2068)	64.4 (47.6- 84.9)	36.0 (30.5- 40.9)
<50,000	542	1881 (1442- 2565)	70.7 (50.1-107.4)	34.9 (30.1- 39.1)	507	1495 (1169- 2005)	45.6 (30.8- 65.2)	27.1 (22.9- 32.0)	397	1547 (1210- 2001)	59.6 (44.4- 80.2)	34.8 (29.5- 39.9)
Hypertension history										0.0418	0.0665	0.9327
No	760	1893 (1477- 2572)	72.7 (50.9-103.8)	34.5 (30.0- 38.7)	718	1537 (1201- 2003)	47.0 (33.6- 65.2)	27.2 (23.4- 31.4)	565	1598 (1257- 2054)	63.0 (44.8- 83.5)	35.4 (30.0- 40.2)
Yes	294	1821 (1370- 2431)	66.4 (45.7- 95.8)	33.8 (28.6- 38.1)	269	1476 (1132- 1929)	42.2 (29.6- 59.1)	26.9 (22.2- 31.5)	225	1502 (1150- 1932)	56.8 (43.5- 79.7)	35.2 (29.6- 40.3)
Quartile of Anxiety Score[2]										0.0172	0.0310	0.7728

	DPP Baseline				Post Randomization Year 1				Post Randomization Year 9			
Characteristics	**N**	**Total Calories**	**Fat Grams**	**% energy from Fat**	**N**	**Total Calories**	**Fat Grams**	**% energy from Fat**	**N**	**Total Calories**	**Fat Grams**	**%energy from Fat**
1st Quartile 0(0-0)	239	1810 (1419- 2556)	65.7 (46.9- 94.6)	33.8 (28.7- 37.4)	223	1513 (1201- 1932)	44.1 (32.2- 56.4)	27.1 (22.9- 30.1)	182	1450 (1147- 1880)	56.7 (41.9- 74.6)	34.9 (28.9- 40.3)
2nd Quartile 2(1-2)	280	1831 (1418- 2509)	69.6 (47.7-103.5)	34.4 (29.7- 38.4)	265	1562 (1213- 1987)	45.0 (32.6- 64.3)	26.8 (23.1- 31.2)	209	1556 (1310- 2005)	62.8 (46.6- 83.9)	35.4 (30.8- 40.2)
3rd Quartile 4(3-5)	267	1900 (1498- 2547)	70.2 (49.3-101.5)	35.0 (29.5- 38.9)	251	1473 (1140- 2023)	44.6 (31.3- 65.4)	27.1 (23.2- 31.5)	207	1576 (1221- 2004)	60.6 (44.3- 83.5)	35.3 (29.3- 40.8)
4th Quartile 9(6-44)	254	2043 (1509- 2603)	77.3 (54.4-108.2)	35.3 (30.4- 39.6)	239	1531 (1203- 2041)	49.3 (33.4- 65.7)	28.0 (23.3- 33.0)	181	1703 (1224- 2148)	63.5 (47.9- 86.1)	35.5 (29.7- 39.9)
Quartile of MCS[3]										0.0838	0.0062	0.0532
1st Quartile 45.7(14.5-50.7)	262	2085 (1450- 2719)	77.5 (52.4-114.7)	35.3 (30.7- 39.1)	249	1561 (1248- 2069)	50.1 (34.7- 69.3)	28.2 (24.2- 32.6)	192	1611 (1269- 2135)	65.6 (45.8- 94.0)	35.6 (30.5- 41.0)
2nd Quartile 53.7(50.7-55.7)	259	1827 (1466- 2431)	67.6 (49.4- 94.2)	33.7 (29.6- 37.9)	242	1480 (1169- 1921)	44.3 (31.3- 61.6)	27.0 (22.8- 30.7)	193	1618 (1260- 2031)	65.3 (48.4- 85.0)	35.8 (30.2- 40.4)
3rd Quartile 57.3(55.7-58.6)	264	1916 (1454- 2559)	72.9 (47.8-104.1)	34.6 (30.3- 39.0)	244	1537 (1195- 1992)	45.0 (33.1- 62.3)	27.0 (23.4- 31.2)	208	1524 (1223- 1932)	60.0 (44.2- 77.3)	35.7 (30.6- 39.6)
4th Quartile 60.5(58.8-68.2)	262	1821 (1426- 2508)	66.0 (48.4- 94.2)	34.0 (27.9- 37.9)	248	1508 (1141- 1949)	43.2 (30.7- 58.7)	26.2 (22.1- 30.6)	191	1541 (1165- 1959)	57.2 (41.1- 72.8)	33.4 (28.2- 40.2)
Quartile of Baseline Weight* (kg)										<0.0001	<0.0001	0.0021
1st Quartile 72.4(48.6-79.1) kg	262	1684 (1289- 2191)	59.3 (42.7- 87.6)	32.9 (27.4- 37.8)	250	1372 (1073- 1759)	41.1 (28.6- 52.9)	25.9 (22.3- 30.2)	204	1440 (1135- 1758)	54.1 (39.7- 69.5)	34.3 (28.8- 39.7)
2nd Quartile 84.9(79.2-91.0)	263	1792 (1377- 2357)	64.2 (46.9- 92.9)	34.0 (29.2- 37.6)	245	1522 (1148- 1916)	43.6 (31.7- 65.2)	27.3 (22.5- 31.2)	204	1538 (1229- 1948)	59.9 (43.4- 77.4)	34.8 (29.5- 39.6)
3rd Quartile 97.7(91.1-105.1)	267	1993 (1580- 2635)	75.0 (53.2-105.6)	34.3 (29.3- 38.1)	252	1636 (1256- 2118)	49.1 (34.1- 63.7)	26.8 (23.0- 31.6)	202	1629 (1329- 2072)	63.8 (49.0- 83.4)	35.1 (30.0- 40.5)
4th Quartile 117.1(105.1-192.2)	262	2209 (1561- 2954)	86.1 (60.8-123.2)	36.0 (32.2- 39.9)	240	1603 (1285- 2130)	51.5 (36.8- 70.0)	28.2 (24.2- 32.7)	180	1728 (1289- 2212)	70.0 (52.1- 96.2)	37.3 (32.1- 41.9)
Quartile of leisure activity*[4] (Met hours /wk at baseline										0.4867	0.8520	0.0034
1st Quartile 1.5(0-3.8)	255	1921 (1499- 2670)	78.8 (55.8-115.1)	36.2 (32.1- 40.7)	241	1480 (1102- 1908)	48.1 (31.6- 65.4)	27.4 (24.5- 32.6)	189	1554 (1221- 2038)	60.5 (45.0- 88.9)	35.7 (29.5- 40.9)
2nd Quartile 6.3(3.8-9.5)	263	1792 (1367- 2483)	67.9 (49.2- 97.7)	34.6 (30.0- 39.1)	255	1495 (1137- 1963)	43.8 (30.7- 59.9)	27.3 (22.9- 31.2)	209	1520 (1208- 2005)	63.3 (43.9- 83.3)	36.1 (30.6- 41.3)
3rd Quartile 13.7(9.5-19.3)	268	1835 (1443- 2503)	69.0 (45.6- 98.9)	33.5 (28.8- 37.4)	245	1572 (1216- 1925)	46.5 (33.5- 63.6)	26.8 (22.9- 31.2)	191	1559 (1233- 1974)	60.3 (46.5- 79.7)	35.7 (30.3- 39.9)
4th Quartile 30.8(19.4-252.8)	266	1917 (1480- 2595)	67.2 (47.8- 99.5)	32.6 (27.1- 37.5)	244	1534 (1271- 2122)	45.1 (33.6- 65.5)	26.3 (21.8- 31.1)	199	1588 (1261- 2099)	60.0 (42.5- 78.3)	33.1 (28.8- 39.1)
Quartile of average leisure activity[4] (Met hours / wk during follow-up										0.2045	0.0395	<0.0001
1st Quartile 6.0(0.1-9.0)	248	1838 (1430- 2516)	75.8 (50.5-106.3)	35.2 (31.1- 39.7)	239	1479 (1086- 1945)	47.8 (34.3- 65.6)	28.9 (24.6- 34.3)	199	1555 (1183- 2075)	65.5 (49.8- 89.9)	37.6 (32.6- 43.4)
2nd Quartile 11.9(9.0-15.0)	254	1821 (1402- 2453)	70.6 (48.0-100.8)	35.5 (31.2- 39.2)	254	1465 (1134- 1908)	43.3 (30.6- 61.6)	26.7 (22.6- 31.5)	200	1511 (1205- 1955)	57.3 (43.7- 83.4)	35.6 (30.1- 40.2)
3rd Quartile 18.7(15.0-24.0)	259	1915 (1436- 2549)	68.8 (46.6-103.6)	34.2 (29.0- 37.9)	247	1537 (1213- 1991)	46.3 (32.3- 63.2)	27.5 (23.1- 30.8)	193	1578 (1220- 1987)	58.8 (44.3- 78.9)	34.0 (29.6- 39.4)
4th Quartile 34.3(24.1-134.4)	258	1966 (1515- 2605)	69.6 (50.1- 98.3)	32.5 (27.1- 37.5)	246	1661 (1293- 2146)	45.2 (34.3- 65.5)	25.7 (21.5- 29.4)	198	1601 (1307- 2117)	60.8 (43.2- 76.2)	33.1 (28.3- 37.9)

	DPP Baseline				Post Randomization Year 1				Post Randomization Year 9			
Characteristics	**N**	**Total Calories**	**Fat Grams**	**% energy from Fat**	**N**	**Total Calories**	**Fat Grams**	**% energy from Fat**	**N**	**Total Calories**	**Fat Grams**	**%energy from Fat**
Quartile of HELP/BOOST sessions attended in DPPOS										0.5940	0.0238	0.0010
1st Quartile 2(1-3)	169	1895 (1544- 2532)	72.9 (53.5-104.3)	35.1 (30.3- 38.5)	160	1591 (1193- 2105)	50.4 (35.9- 66.9)	28.5 (24.3- 32.9)	170	1602 (1271- 2129)	63.3 (49.1- 91.4)	36.3 (30.9- 41.5)
2nd Quartile 6(4-8)	226	1935 (1473- 2511)	71.0 (49.8-102.7)	34.6 (29.7- 38.6)	217	1531 (1217- 1945)	45.1 (32.0- 60.8)	26.6 (23.2- 30.5)	228	1562 (1222- 1999)	64.9 (44.9- 80.8)	36.5 (30.2- 41.1)
3rd Quartile 14(9-21)	187	1798 (1369- 2472)	67.4 (46.6-100.5)	34.1 (30.0- 38.2)	185	1489 (1173- 1916)	42.6 (32.9- 60.9)	26.6 (22.3- 31.0)	192	1562 (1276- 1950)	59.4 (44.4- 82.7)	34.4 (29.3- 39.9)
4th Quartile 31(22-59)	193	1879 (1449- 2549)	70.4 (47.5-100.1)	34.0 (28.6- 38.6)	194	1477 (1179- 1999)	43.7 (30.3- 58.5)	26.4 (22.3- 29.9)	200	1513 (1193- 2062)	56.8 (42.8- 75.7)	33.6 (28.8- 37.9)

[1] Values reported are medians with inter-quartile range, numbers under each quartile are median (minimum-maximum).

[2] Higher quartiles represent greater severity of anxiety on the Beck Anxiety Inventory.

[3] Higher scores represent better psychological health on the Mental Component Scale

[4] Higher scores represent higher leisure energy expenditure on the Modifiable Activity Questionnaire

Table 2

Final regression model of predictors of total daily energy intake (kcal/day) at year 9 post-randomization

	Estimate	Standard Error	t-value	Pr> |t|
Intercept	630.5	156.2	4.04	<0.0001
Age at Randomization (years)	1.2	2.2	0.56	0.58
Female	-83.6	48.5	-1.72	0.086
African American	-38.6	57.1	-0.68	0.50
Hispanic	-57.4	63.2	-0.91	0.36
American Indian	21.6	96.7	0.22	0.82
Asian American or Pacific Islander	-206.8	92.6	-2.23	0.026
Diabetes duration (years)	0.54	6.90	0.08	0.94
Baseline total energy intake (kcal/day)	0.59	0.032	18.6	<0.0001
Caloric change from baseline to DPP year 1 (kcal/day)	0.31	0.037	8.4	<0.0001

Age, sex, race/ethnicity and diabetes duration (0 for non-diabetic) are forced to stay in the model, regardless of significance. White is the reference group for race/ethnicity. Model R^2 is 0.40.

Table 3

Final regression model for daily fat gram intake at year 9 post-randomization

	Estimate	Standard Error	t-value	Pr> |t|
Intercept	41.5	7.5	5.5	<.0001
Age at Randomization	-0.081	0.11	-0.76	0.45
Female	-3.02	2.49	-1.22	0.22
African American	-1.57	2.76	-0.57	0.57
Hispanic	-4.87	3.06	-1.59	0.11
American Indian	-3.36	4.73	-0.71	0.48
Asian American or Pacific Islander	-10.8	4.47	-2.42	0.016
Diabetes duration (years)	0.042	0.33	0.13	0.90
Baseline fat grams	0.61	0.038	16.2	<.0001
Fat grams change from baseline to DPP year 1	0.39	0.043	9.01	<.0001
Average leisure activity during follow-up (Met-hours)	-0.21	0.083	-2.54	0.01

Age, sex, race/ethnicity and diabetes duration (0 for non-diabetic) are forced to stay in the model, regardless of significance. White is the reference group for race/ethnicity.

Model R^2 is 0.35.

Table 4

Final regression model for daily percent energy from fat intake at year 9 post-randomization

	Estimate	Standard Error	t-value	Pr> |t|
Intercept	22.3	2.42	9.21	<0.0001
Age at Randomization	-0.023	0.027	-0.84	0.40
Female	1.75	0.62	2.80	0.005
African American	0.46	0.69	0.66	0.51
Hispanic	-0.98	0.77	-1.27	0.20
American Indian	-1.09	1.23	-0.89	0.37
Asian American or Pacific Islander	-0.55	1.13	-0.49	0.63
Diabetes Duration (years)	0.076	0.084	0.90	0.37
Baseline percent energy from fat	0.49	0.049	10.2	<0.0001
Change from baseline to DPP year 1	0.26	0.045	5.92	<0.0001
Number of HELP/BOOST participation	-0.063	0.021	-2.8	0.003
Average leisure activity during follow-up (Met-hours)	-0.060	0.021	-2.87	0.006

Age, sex, race/ethnicity and diabetes duration (0 for non-diabetic) are forced to stay in the model, regardless of significance. White is the reference group for race/ethnicity.

Model R^2 is 0.23.