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12-Month Reach and Effectiveness of a University-Based Diabetes Prevention Initiative

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Abstract

Introduction: The University of California (UC) implemented the Diabetes Prevention Program (DPP) to address diabetes and obesity risk. This project examined the reach and effectiveness of this university-based DPP delivery approach.

Methods: This project compared 12-month weight change among three groups of UC beneficiaries with overweight/obesity: 1) those who received invitation letters and enrolled in UC DPP, 2) those mailed invitation letters but did not enroll, and 3) those who were not mailed letters and did not enroll (controls). Using 2012–2022 EHR, administrative and DPP cohort data, an interrupted time series was conducted in 2022–2023 to compare group differences in rate of weight change.

Results: Among 6,231 beneficiaries (132 UC DPP aware enrollees, 1,750 DPP aware non-enrollees, 4,349 controls), UC DPP enrollees were older (mean age 49), mostly women (76%), and more diverse (33% Asian, 8% Black, 20% Hispanic, 4% Multi/Other). Over 12-months of

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follow-up, UC DPP enrollee post-enrollment rate of weight loss was −0.68 lbs./month. UC DPP enrollees had significantly greater weight change from pre- to post-enrollment than DPP aware non-enrollees (adjusted Δ−1.02 vs. Δ−0.07 lbs./month, difference=−0.95, p <.001). Weight change among all participants who received letters with/without DPP enrollment was similar to controls.

Conclusions: UC DPP reached a diverse group and was effective for weight loss at 12-month follow-up. However, UC DPP invitation letters to raise prediabetes and DPP awareness were not associated with significant weight change in the absence of DPP enrollment. University-based approaches to DPP delivery are effective and may enhance reach of DPP among at-risk adults.

Introduction

Type 2 diabetes is a progressive disease which can lead to devastating complications and longterm disability.[1] According to the Centers for Disease Control and Prevention (CDC), 37.3 million individuals or 11.3% of the US population has been diagnosed with diabetes and 96 million (38%) adults have prediabetes.[1] In 2017, the estimated economic cost attributed to diabetes was $327 billion, a substantial increase from $245 billion in 2012.[2,3] Rising prevalence and cost estimates highlight the substantial societal burdens that prediabetes and diabetes impose.

Chronic conditions, such as diabetes, can significantly impact employee health and productivity and increases employer health care costs.[4] The estimated $327 billion spent on diabetes in 2017 included $237 billion in direct medical costs and $90 billion in reduced productivity.[4] Employers often promote workplace health promotion programs shown to improve absenteeism, productivity, retention of employees, and reduce health care costs for employers.[1] The benefits of worksite health promotion interventions may be further enhanced when interventions are targeted toward those at highest risk.[5] The Diabetes Prevention Program (DPP), which has reduced incident type 2 diabetes risk by as much as 58% in randomized trials[6], has long been considered the gold standard lifestyle intervention for type 2 diabetes prevention. Over the last decade, DPP coverage has been increasingly incorporated into health insurance benefits and offered to more employees at risk of developing type 2 diabetes.[7]

Employer-based DPP offerings can enhance reach among large proportions of the adult population who spend most of their waking hours at their worksite. Worksite health programs may help address some of the barriers to engaging in health promotion programs, including lack of time, transportation, or socioeconomic resources, that may prevent some adults from engaging in DPP outside of work.[8,9] Pre-existing employer organizational communication channels also provide opportunities to increase awareness of prediabetes and actions employees can take to reduce their diabetes risk (i.e., engage in DPP).

The University of California (UC) System is a large public university system and the third largest employer in the state of California that provides many health and wellness offerings to affiliates.[10] In 2016, the University of California at Los Angeles (UCLA) first piloted the DPP to address diabetes risk among its local affiliates (i.e., faculty, staff). The UCLA DPP team subsequently collaborated with the UC Office of the President (UCOP) to launch a system-wide UC DPP Initiative. By 2018, the UC DPP Initiative provided every UC campus with funding to implement DPP delivery and established a UC DPP Coordinating Center to conduct member outreach and support cross-campus efforts.[11] This project examined the reach and effectiveness of the UC DPP Initiative since little is known about university or campus-based diabetes prevention programming.

Methods

This was a retrospective analysis of 2012–2022 data from the UC system, including electronic health records (EHRs), administrative claims, and UC DPP cohort data. Details of the study design were previously published.[11]

Study Sample

The analytic cohort was derived from a sample of over 36,000 UC beneficiaries and 1203 UC affiliates (e.g., faculty, staff and patients) who participated in UC DPP as of August 2021. Adults with overweight/obesity (age≥18; BMI≥25 kg/m^2 or ≥23 kg/m^2 for Asians) with UC medical and administrative data during the study window were included. Adults who did not have at least one follow-up appointment during the study window, 2 or more weight assessments, and those with a prior history of diabetes (i.e., any prior ICD 9/10, A1c ≥ 6.5%, fasting glucose ≥126 mg/dL, and/or use of glycemic medication other than metformin) were excluded. UC DPP enrollees had to meet standardized DPP eligibility criteria defined by the CDC, including BMI of ≥25 kg/m^2 (or ≥23 if Asian) and have either prediabetes, history of gestational diabetes mellitus (GDM) or elevated diabetes risk score on a CDC questionnaire.[12]

Measures

The study outcomes were defined using the well-established reach, effectiveness, adoption, implementation, and maintenance (RE-AIM) evaluation framework,[10–12] and this report focuses on the reach and effectiveness of the UC DPP Initiative. To evaluate reach, the characteristics of eligible participants who enrolled in UC DPP were compared to those who did not (i.e., representativeness of UC DPP participants). To examine effectiveness, the mean rate of weight change from enrollment to 12-months follow-up was compared to the mean rate of weight change in a 24-month pre-enrollment period. The primary outcome was based on between group differences for the change in the rate of weight change before vs. after enrollment. Three groups were included in the analysis.

The first group included UC beneficiaries with overweight/obesity who reported receiving prediabetes and DPP awareness letters and enrolled in UC DPP (i.e., DPP aware enrollees who received “full treatment”, Group A). The second group included overweight/obese UC beneficiaries with history of prediabetes who were mailed UC DPP Initiative prediabetes and DPP awareness letters but never enrolled in UC DPP (i.e., DPP aware non-enrollees who received only “partial treatment”, Group B). The third group (Group C) included overweight/obese UC beneficiaries without documented prediabetes who were not mailed UC DPP Initiative letters and did not enroll in DPP. Group C served as a control group to account for secular trends and/or concurrent programs that may affect weight change outcomes among UC beneficiaries (such as weight management or health programs delivered as part of routine care or campus efforts).

Prediabetes and UC DPP awareness letters were mailed to beneficiaries who met DPP eligibility criteria. Letters were addressed to individual recipients and mentioned that they may be eligible to participate in a free type 2 diabetes prevention program, known as UC DPP. Letters described UC DPP as a “campus-based, small-group program that uses a scientifically based approach” to help participates “make important lifestyle changes.” All UC DPP sites adhered to CDC DPRP guidelines.[12] This included closed cohorts led by trained UC lifestyle coaches that met in-person until March 2020 pandemic-related campus closures prompted a transitioned to a synchronous online platform (i.e., UC Zoom).

All weight data was derived from UC DPP cohort records and/or the EHR. Weight change among UC DPP aware enrollees and non-enrollees (i.e., Groups A vs. B) was compared to estimate the effectiveness of UC DPP enrollment and impact of invitation letters on weight change with and without DPP enrollment. Weight change among all participants who received UC DPP invitation letters (Groups A + B) was compared to controls (Group A+B vs. Group C) to estimate the impact of UC DPP invitation letters as compared to usual care/programming.

Statistical Analyses

To assess reach of the UC DPP, demographics were compared between the three groups described above (A=DPP letter + enrolled, B=DPP letter only/non-enrollee, C=controls). The pre- and post-enrollment to DPP data availability was assessed by group. Group differences in the rate of weight change 24 months pre- vs. 12-months post-enrollment was compared to examine UC DPP effectiveness. Enrollment dates were defined using the actual UC DPP enrollment date for Group A members who enrolled (i.e., date of DPP session 1); two months after diabetes awareness letters were mailed for Group B members (to provide time to enroll in DPP after receipt of letter); and proxy enrollment dates were assigned to Group C members.

For those that did not enroll in DPP nor receive invitations (Group C, controls), we applied a proxy date[13] for DPP enrollment. This proxy date was based on matching the distribution of date (quarter & year) when first appearing in the claims dataset to those who enrolled or were invited to enroll in the DPP program (i.e., Groups A & B). Within these matched subsets, we randomly applied a proxy enrollment date that had the same distribution of the DPP enrollees/invitees. In this manner, we ensured that the length of time in the dataset and distribution of enrollment/invitation dates (or proxy) were exactly the same in the exposed (Groups A&B) and unexposed (Group C) groups. See Appendix for more details on this procedure.

The statistical analyses included fixed effects linear regression modeling and mixed effects linear regression modeling of within-person mean-centered weight. Random effects specified using unstructured covariance structure, and difference-in-difference were also conducted. The estimated difference-in-difference p value was based on a group–by–time from enrollment–by time period (pre- vs post- enrollment) interaction term. The mixed effects model included the following covariates: age at enrollment, sex, race, ethnicity, month and year of enrollment, and pre-enrollment history of coronary artery disease (CAD), hypertension (HTN), hyperlipidemia, and prediabetes. To compare weight change among all participants with invitation letters vs. controls (Group A+B vs. C), the mixed effects modeling strategy described above and inverse propensity weighting (IPW) with regression adjustment were used.

In addition to matching the follow-up time distribution between groups, we developed a propensity score weight based on a logistic regression model that incorporated non-linear terms for age at enrollment (modeled as cubic), baseline mean level and rate of change in weight (modeled as cubic), as well as main effect and interaction terms between race and sex with history of hypertension, hyperlipidemia, and prediabetes diagnosis from the pre-enrollment. Month and year of enrollment/awareness (or proxy) were also used as predictors in this model. This propensity score was converted to an inverse probability weight (IPW), and used in all subsequent analyses.

There were also two sensitivity analyses conducted. The first examined models that controlled for social vulnerability index (SVI)[14] as a proxy for socioeconomic status. Social determinants of Health (SDOH) are important drivers of health, and SVI was developed by the CDC to provide census tract level information on important factors such as "poverty, lack of access to transportation and crowded housing," with higher values indicate greater social vulnerability.[14] The second sensitivity analysis compared weight change between Group B vs. C to examine the effectiveness of letters in the absence of UC DPP enrollment. All analyses were conducted in Stata version 17.1 Stata Corp, LLC (College Station, Texas) in 2022–2023. This study was approved by the UCLA IRB.

Results

This analysis included 6,231 UC beneficiaries; N=132 participants reported receiving DPP invitation letters and enrolled in the UC DPP (Group A); N=1750 participants were mailed UC DPP letters but did not enroll in UC DPP (Group B); and N=4,349 participants who were not mailed letters and did not enroll in UC DPP (Group C). Overall participant mean age was 42 (SD 13), 48% were female, 25% Asian, 5% Black, 16% Hispanic, 6% Multiracial/Other, 1% Native American, 35% White, and 12% Unknown. Compared with non-enrollees, participants who enrolled in UC DPP were more likely to be women, more racially and ethnically diverse, and more likely to have had a risk test rather than a lab diagnosis of prediabetes. Tables 1 and 2 show participant baseline characteristics and Appendix Table 1 compares the availability of data across groups.

Participants who reported receiving DPP awareness letters and enrolled in UC DPP (Group A) had the greatest rate of weight change, (difference in rate of change per month from pre- to post-enrollment within Group A $\Delta -1.00$ lbs., 95% CI −1.15, −0.85, $p<.001$). Participants who reported receiving DPP letters and enrolled in UC DPP (Group A) also had a significantly greater rate of weight change pre- and post-enrollment as compared to those who were mailed invitation letters but did not enroll in DPP (Group B). The adjusted difference in rate of change per month from pre- to post-enrollment for Group A was

Δ−1.02 (−1.15, −0.89) vs. B Δ−0.07 (−0.14, 0.00), p<.001. The rate of weight change pre- and post-enrollment was similar among all participants who received letters irrespective of DPP enrollment (combined Group A + B) as compared to matched controls (Group C who were not mailed letters and did not enroll in DPP; Group A+B Δ−0.40 (−0.62, −0.18) vs. C Δ−0.31 (−0.98, 0.35), p=0.807). Table 3 includes group differences in rate of weight change pre- vs post-enrollment. Results were similar after additionally adjusting for social vulnerability index in a sensitivity analyses[14], with a significant difference in rate of change pre- and post-enrollment in Group A (Δ−0.87, 95% CI −1.03, −0.70, p<.001). There was no significant difference when comparing weight change between Group B vs. C (Δ−0.23(−0.46, −0.01) vs. C Δ−0.35(−0.87, 0.17), p=0.696). Appendix Table 2 includes group differences in weight change pre- vs post-enrollment after controlling for SVI and Appendix Table 3 includes differences between Group B vs. C.

Discussion

This study found that the UC DPP reached a diverse group of at-risk adults and led to significant percent weight change over 12-months follow-up (Group A). We also found that UC DPP invitation letters (Group B), aimed at increasing prediabetes and DPP awareness, were not associated with significant weight change in the absence of DPP enrollment (Group C).

It is notable that those who enrolled in UC DPP and reported receiving invitation letters (Group A) were more diverse than non-enrollees and the UC population overall (Group B+C). Although some National DPP evaluations have included limited racial and ethnic categories (i.e., Hispanic, Non-Hispanic White, Non-Hispanic Black, and Other),[15,16] one prior report provided expanded racial and ethnic categories allowing for more detailed comparison.[17] Among 455,954 adults who participated in the National DPP between 2012–2019, almost two-thirds were Non-Hispanic White (65%).[17] In contrast, only 36% of UC DPP participants were Non-Hispanic White.[17] The majority of UC DPP enrollees were from racial and ethnic backgrounds burdened with higher rates of type 2 diabetes, although no racial and ethnic groups were specifically recruited or encouraged to enroll in UC DPP. While the number of UC DPP enrollees who reported receiving a letter is relatively small (Group A), it is possible that university-based DPP delivery may decrease some of the known barriers to DPP enrollment among diverse participants. Future studies can examine whether university-based programming helps address factors such as competing demands and distance to DPP site (e.g., when DPP sessions take place onsite at lunch), to help enhance reach among higher risk adults from more diverse backgrounds.

While diabetes prevention is a recognized national goal and one that health systems, employers, and insurers have increasingly embraced, many challenges with participant- and system-level engagement remain. Approaches to DPP implementation and outcomes in real-world settings have varied. Known barriers to implementing DPP in the workplace include lack of infrastructure and resources to conduct the program, including the lack of available health promotion–trained staff, adequate facilities, and consistent management support to conduct the programs.[18] To overcome these challenges, interventions designed for worksite settings must be relatively easy to implement and not disruptive of normal site operations.

This work suggests that university-based approaches may help address some of the considerable DPP implementation challenges previously reported by other types of worksites.[18] Most universities routinely employ trained personnel who lead an array of health and wellness initiatives for faculty, staff and/or students. Thus, existing university-based resources and infrastructure can be leveraged to support DPP implementation. For example, UC DPP was delivered by trained coaches already employed across UC campuses. Numerous studies have shown that program intensity plays a major role in weight loss outcomes[19,20] and UC DPP included 22 or more sessions that UC DPP coaches integrated into normal university workflows. All 10 UC DPP sites are also recognized by the CDC Diabetes Prevention Recognition Program (DPRP), which sets national standards for DPP delivery including number of required sessions, as well as participation and weight loss outcomes.[12]

To augment national diabetes prevention efforts, we also need effective outreach strategies to raise prediabetes and DPP awareness.[21,22] Opportunities to conduct tailored outreach and long-term follow-up may be greater through worksites than through community-based programs.[23] University worksites also provide established processes to conduct outreach among faculty, staff and affiliates. The UC DPP Initiative mailed invitation letters aimed at increasing prediabetes and DPP awareness among at-risk beneficiaries, but very few participants who enrolled in UC DPP reported receiving a letter (7.5%). This study also showed that UC DPP initiation letters did not lead to changes in weight in the absence of DPP enrollment. Thus, invitation letters appear to be a low yield strategy and future studies should examine alternative ways in which DPP outreach should be conducted.

This study adds to the growing body of literature on DPP worksite translations and is unique in its focus on a university-based setting. Findings from the six prior evaluations of university based DPP were relatively positive, but these six prior studies included small sample sizes (mean 61;range 22–165) and shorter-term follow-up (fours studies with ≤4 months follow-up; one study with 2 years follow-up but only reported within-group change for 22 participants).[11,23–28] Unique attributes of the UC DPP Initiative that warrant further comparative studies also include integration and delivery of the program by UC staff, as opposed to outsourcing of DPP delivery to external vendors.[29,30] Overall, additional studies of university-based DPP delivery and other alternative DPP models with the potential to address some of the known participant- and system-level barriers are needed.

Limitations

These findings should be interpreted with several limitations. First, this was a retrospective analysis where data misclassification (EHR) can occur. However, there was no evidence that data misclassification would be likely to substantively affect results. Second, there was no adjustment for clustering at the household, and it is possible that a few individuals from the same household could have participated in UC DPP. Third, this study was based in the state of California and may not generalize to all locations. However, a large university system with 10 campuses of varying sizes and geographic locations was included to enhance generalizability to other university or college settings.

Conclusions

UC DPP reached a diverse group of at-risk adults, and this university-based DPP delivery approach was effective for weight loss among enrollees at 12-months follow-up. Invitation letters aimed at raising prediabetes and DPP awareness were not associated with weight change in the absence of DPP enrollment. University based approaches to DPP delivery may help address some of the known participant- and system-level barriers to DPP participation and warrant further study.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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All authors made substantial contributions to conception and design or analysis, interpretation of data, and drafting of the article or critical revision for important intellectual content. TM designed the study and obtained funding. SS, KS, TL, KR, MG, URC, NJJ and TM collected data. NJJ and URC conducted the statistical analyses. MG, NJJ and TM wrote the first draft of the manuscript. All authors reviewed and edited the manuscript. TM is the guarantor of this article.

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Table 1:

Characteristics of UC DPP Enrollees and Non-Enrollees who Received DPP Awareness Letters

Characteristics	**Group A** ***DPP Enrolled + Letter*** **N=132**	**Group B>** ***DPP Letter Only (Non-enrollee)*** **N=1,750**	**P**
Age at Enrollment[a], *Mean (SD)*	49.1 (11.5)	51.4 (12.9)	0.069
Sex, *%*			**<.001**
Female	76%	47%	
Male	24%	53%	
Race/Ethnicity, %			**<.001**
Asian	33%	32%	
Black	8%	6%	
Hispanic	20%	11%	
Native American		2%	
Multiracial/Other	4%	6%	
Unknown		10%	
White	36%	34%	
Weight (lbs.) at Enrollment[a], *Mean (SD)*	191 (50)	181 (47)	0.036
Social Vulnerability Index[b], *Median [IQR]*[c]	0.341 [0.137, 0.514]	0.261 [0.132, 0.425]	0.065
Comorbidities[d], *%*			
Coronary Artery Disease (CAD)	0%	1%	0.228
Hypertension (HTN)	1%	3%	0.094
Gestational Diabetes Mellitus (GDM)	0%	0%	-
Hyperlipidemia	0%	3%	0.033
Prediabetes[e]	23%	50%	**<.001**

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

[a] Enrollment defined as DPP enrollment date for Group A; two months after diabetes awareness letter date for Group B; proxy enrollment date for Group C

[b] Social Vulnerability Index has limited N: Group A (N=90); Group B (N=1,600)

[c] IQR = Interquartile range [25th percentile, 75th percentile]

[d] Indicates presence of comorbidity in the pre-enrollment period

[e] Prediabetes defined based on A1c from 5.7% – 6.4% or Fasting Plasma Glucose from 100 – 125 mg/dL or Hyperglycemia ICD code.

Table 2:

Comparison of Propensity Weighted Characteristics Among DPP Aware Groups with Letters vs. Controls

Characteristics	**Group A + B** ***DPP Aware +/− DPP Enrollment*** **N=1,749 [96 (A) + 1,653 (B)]**	**Group C** ***[f] Controls*** **N=4,349**	**P**
Age at Enrollment[a], *Mean (SD)*	43.0 (10.6)	43.1 (16.1)	0.916
Sex, *%*			0.623
Female	47%	46%	
Male	53%	54%	
Race/Ethnicity, %			0.952
Asian	25%	24%	
Black	5%	6%	
Hispanic	16%	15%	
Native American	1%	1%	
Multiracial/Other	7%	6%	
Unknown	12%	12%	
White	34%	36%	
Weight (lbs) at Enrollment[a], *Mean (SD)*	187 (36)	185 (53)	0.346
Social Vulnerability Index[b], *Median [IQR]*[c]	0.334 ± 0.180	0.263 ± 6.038	0.377
Comorbidity History[d], *%*			
Coronary Artery Disease	0%	2%	0.017
Hypertension	2%	3%	0.287
Gestational Diabetes	0%	0%	-
Hyperlipidemia	2%	2%	0.392
Prediabetes[e]	23%	25%	0.428

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

[a]Enrollment defined as DPP enrollment date for Group A; two months after diabetes awareness letter date for Group B; proxy enrollment date for Group C

[b]Social Vulnerability Index has limited N: Group A (N=90); Group B (N=1,511); Group C (N=3,877)

[c]IQR = Interquartile range [25th percentile, 75th percentile]

[d]Indicates presence of comorbidity in the pre-enrollment period

[e]Prediabetes defined based on A1c from 5.7% – 6.4% or Fasting Plasma Glucose from 100 – 125 mg/dL or Hyperglycemia ICD code.

[f]Group C randomly selected from a larger subset based on matching the distribution of the first available data, determined by quarter and year, from Groups A & B

Table 3:

Group Differences in Weight Change Pre- vs Post-enrollment

Analysis/Group	**Pre-Enrollment** ***Rate of Weight Change per month***[f] **b (95% CI)**	**Post-Enrollment** ***Rate of Weight Change per month***[f] **b (95% CI)**	**Δ(Post-Pre)** ***Difference in Rate of Change*** **b (95% CI)**	[g]**P** ***Difference in Rate of Change***
[a]Analysis 1 - Within Group A				
Group A (N=132) DPP Enrolled+Letter	0.32 (0.23, 0.40)	−0.68 (−0.81, −0.56)	−1.00 (−1.15, −0.85)	**<.001**
[b]Analysis 2 - Group A vs. B				
Group A (N=132) DPP Enrolled+Letter	0.44 (0.36, 0.53)	−0.58 (−0.70, −0.46)	−1.02 (−1.15, −0.89)	**<.001**
Group B (N=1750) DPP Letter Only	0.04 (0.02, 0.07)	−0.03 (−0.09, 0.04)	−0.07 (−0.14, 0.00)	0.052
Difference-in-Difference P				**<.001**
[c]Analysis 3 - Group A+B vs. C				
Group A+B (N=1749 [96+1653]) All Letters	0.10 (0.05, 0.15)	−0.30 (−0.50, −0.10)	−0.40 (−0.62, −0.18)	**<.001**
Group C (N=4349) Controls - No Letters	0.10 (0.04, 0.16)	−0.21 (−0.84, 0.41)	−0.31 (−0.98, 0.35)	0.353
Difference-in-Difference P				0.807

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

[a]Fixed effects linear regression model

[b]Mixed effects linear regression modeling of within-person mean-centered weight using person random intercept and nested random slope for time from enrollment. Random effects specified using unstructured covariance structure. Difference-in-Difference p value based on a group–by–time from enrollment–by time period (pre- vs post- enrollment) interaction term. Model adjusts for age at enrollment, sex, race/ethnicity, month and year of enrollment, and pre-enrollment history of CAD, HTN, hyperlipidemia, and prediabetes.

[c]Mixed effects linear regression modeling of within-person mean-centered weight using person random intercept and nested random slope for time from enrollment. Random effects specified using unstructured covariance structure. Difference-in-Difference p value based on a group–by–time from enrollment–by time period (pre- vs post- enrollment) interaction term. Model estimated using inverse propensity weighting (IPW) with regression adjustment. IPW was based on age at enrollment, rate of weight change in the pre-enrollment period, estimated weight at enrollment, sex, race/ethnicity, month and year of enrollment, and pre-enrollment history of CAD, HTN, hyperlipidemia, and prediabetes. Covariates in the model were the same as in Analysis 2

[f]Rate of weight change in pounds per month. 95% Confidence Intervals that exclude 0 indicate statistical significant ($p < 0.05$) rates of change within time period

[g]P value for within-group difference based on time from enrollment – by – time period (pre- vs post- enrollment) interaction term