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ABSTRACT Introduction: The Diabetes Prevention Program (DPP) demonstrated that lifestyle intervention programs were effective in preventing or delaying the onset of diabetes. The Group Lifestyle Balance (GLB) program translated the DPP curriculum into a 12-wk group intervention for those at risk for diabetes. This retrospective evaluation examined clinical outcomes for patients in the Diabetes Center of Excellence GLB program located at Wilford Hall Ambulatory Surgical Center from 2009 to 2013. Objectives included determining rates of retention, demographic characteristics of program completers, and changes in metabolic surrogates of disease prevalence. Study Design: Adults with prediabetes or metabolic syndrome (MetS) were referred to the GLB program. Updated participant metabolic data were collected at regular intervals during their participation. Results: During the 5-yr study, 704 patients attended the initial class. Overall, 52% of all participants completed the program with the greatest decline in participation occurring by the fourth week (30%). Baseline prevalence of conditions of interest for those who completed the program was prediabetes (93.2%), obesity (56.1%), and MetS (31.5%). GLB completers were older and retired ($p < 0.05$). A significant number of active duty military members (44.9%, $p < 0.01$, $n = 53$) dropped out of the program before the fourth week. Furthermore, those who completed the program saw a 2.0% reduction in prediabetes prevalence ($p < 0.001$), obesity decreased by 8.7% ($p < 0.001$), and MetS decreased by 6.8% ($p < 0.01$). Significant differences were found for central obesity, triglycerides, and fasting blood sugar ($p < 0.001$). Conclusions: The GLB program is a valuable DPP and was effective at improving clinical outcomes and reducing the incidence of prediabetes, obesity, and MetS for participants who completed the program. Every effort should be made to support and encourage GLB participants to complete the program.

According to the Centers for Disease Control and Prevention, 89 million Americans have prediabetes.[1] People with prediabetes are at increased risk for developing type 2 diabetes mellitus, but not all cases of prediabetes progress to diabetes. People with diabetes are twice as likely to have cardiovascular disease or stroke at an early age compared with patients without diabetes.[2] In addition, recent National Health and Nutrition Examination Survey data suggest that 33% of the U.S. population has metabolic syndrome (MetS), a conglomeration of cardiovascular disease risk factors, including abdominal obesity, hyperglycemia, dyslipidemia, and hypertension.[3] There is ample evidence in the medical literature suggesting that lifestyle change interventions focused on weight loss can prevent or delay the progression of these early conditions into more advanced disease states.

The landmark Diabetes Prevention Program (DPP) trial demonstrated that intensive diet and exercise lifestyle interventions, with a goal of 7% weight loss, reduced the progression of prediabetes to diabetes by 58% over 2.8 yr.[4] Evidence from other prediabetes lifestyle intervention studies demonstrated that self-directed and coach-led programs yield effective results in weight loss.[5,6] In a meta-analysis, effectiveness and retention results of 22 lifestyle intervention programs concentrated on dietary intervention, physical activity, or both. These programs examined outcomes including weight, body mass index (BMI), waist circumference, fasting blood sugar (FBS), glycated hemoglobin (HbA1C), lipids, and blood pressure. More intensive programs demonstrated greater weight loss compared with less intensive programs. Programs considered more intensive utilized coach-led and self-study features. In addition, more effective programs included the use of group interventions to minimize cost and used specific behavior change strategies that are associated with better outcomes.

The success of the DPP trial, which was a resource-intensive intervention with multiple individual appointments, led to modification of the program into a 12-wk group-based intervention called the Group Lifestyle Balance (GLB) program.[7] The GLB program participants received specific classroom-based training in lifestyle changes including a low-fat/low-calorie diet, exercising 150 min per week, and behavior modification. The goal was for participants to lose 7% of their body weight over the 12 wk of the program. Since its introduction, the GLB program has shown to be an effective model for decreasing diabetes and

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cardiovascular disease for those at high risk, to include those with MetS.[8] The translation of the DPP into successful GLB programs continues as it has been adapted for implementation in a variety of populations and settings including a poor urban community,[9] an underserved Latino population,[10] Native American youth,[11] YMCA sites,[12] and programs delivered by diabetes educators in urban, suburban, and rural outpatient hospitals.[13]

Wilford Hall Ambulatory Surgical Center (WHASC) is home to the U.S. Air Force's Diabetes Center of Excellence (DCOE), the largest diabetes clinic in the Military Health System (MHS). Although the DCOE patient population includes active duty (AD) service members and their families, the majority of patients with diabetes are retired service members and their spouses. Of particular note, after there is no longer a requirement to meet military fitness standards, newly retired members tend to gain weight and increase their risk for developing diabetes and MetS.[14] Thus, the MHS has a need to offer DPP to patients with prediabetes. In 2009, the DCOE launched the GLB program, and the purpose of this retrospective study is to analyze the anthropometric and clinical outcomes for patients completing the GLB program at the DCOE.

METHODS

The WHASC Institutional Review Board approved this interventional study, which retrospectively analyzed clinical data routinely collected for patients participating in the GLB program at WHASC DCOE from January 1, 2009 through December 31, 2013.

Participants

Patients at risk for diabetes were referred to the GLB program through their primary care physician or self-referral. Those deemed to be at risk for diabetes included individuals with either of the following: (1) prediabetes defined as fasting glucose ≥100 mg/dL and ≤125 mg/dL or HbA1c ≥5.7% and ≤6.4%; or (2) MetS. MetS was defined as three or more of the following: waist circumference ≥102 cm in males or ≥88 cm in females, triglyceride (TG) ≥150 mg/dL, high-density lipoprotein (HDL) <40 mg/dL in males or < 50 mg/dL in females, blood pressure ≥130/85 mm Hg, and FBS >100 mg/dL and <126 mg/dL. Approximately 90.6% of participants who enrolled in the GLB program met the definition of prediabetes and 33.2% of participants met the criteria for MetS; 31.1% met the definition for both prediabetes and MetS.

At the time of data collection, the GLB program consisted of four in-person monthly group sessions approximately 4 wk apart (concurrent with weeks 1, 5, 9, and 12), weekly self-study modules, and weekly interaction with the lifestyle coach via telephone or a secure messaging system. The lifestyle coach and program coordinator was an exercise physiologist who was assisted by a licensed vocational nurse. They both received training to deliver the GLB curriculum by the University of Pittsburgh program. At each group session, the self-study modules to be completed before the next group session were distributed. The self-study modules included a DVD/CD that provided video instruction for each week's topics, supplemental information, and printed course materials.

Goals for participants in the GLB program included intensive lifestyle modification resulting in weight loss of 7% by the 12th week, weekly moderate physical activity to reach 150 min/wk by the 12th week, completion of food and activity logs for 12 wk, weekly review of educational materials, and participation in group sessions held approximately every 4 wk.

Participants were expected to complete the self-study module each week before the scheduled phone call/message, so they could discuss any questions regarding the material and the status of their personal goals. Participants with a smartphone or computer were encouraged to track their activity and share the information electronically with the lifestyle coach to facilitate activity and food log reviews.

Group sessions were offered during weekdays at various times; however, no sessions were offered in the evening or on weekends.

Data Collection

Patients were monitored throughout the program. Baseline data were collected including standard demographic information (e.g., gender, race/ethnicity, employment status, military status, highest education level completed, and family history of diabetes). Participant weight, height, waist circumference, and blood pressure were collected at baseline and upon completion of the 12-wk GLB program. Furthermore, laboratory tests at baseline and completion of the GLB program included HbA1c, FBS, cholesterol (CHOL), TG, low-density lipoprotein, and HDL.

Data were analyzed using SPSS version 19. Data are presented using descriptive statistics and frequencies. Independent samples *t*-tests were conducted to analyze differences in baseline clinical measures between program completers and those who did not complete. Paired *t*-tests analyzed baseline to completion outcomes.

RESULTS

There were 704 baseline attendees (Table I). Baseline participants were primarily female (61%), mostly Caucasian (61%) and non-Hispanic (66%), and had a mean age of about 52 years old. Many baseline participants were college graduates (39%); half were employed full time and 22% were retired from the military and not employed. Approximately half of participants (52%) had a family history of diabetes.

Both men and women were retained at similar rates from baseline to completion. Those who were employed full time experienced higher dropout rates. In addition, those who were AD were less likely to complete the program than those who were retired military, especially for women, as 55 AD women began the GLB program and only 10 completed (18%).

The participants retained throughout the program were older with mean age of 55.51 years old for those who completed all

TABLE I. Demographics by Gender at Baseline ($N = 704$) and Completion at 12 wk ($N = 364$)

Variable *n* (%)	Overall		Female		Male	
	Baseline ($n = 704$)	Completion ($n = 364$)	Baseline ($n = 429$)	Completion ($n = 216$)	Baseline ($n = 275$)	Completion ($n = 148$)
Gender	—	—	429 (61%)	216 (59%)	275 (39%)	148 (41%)
Mean age	52.36	55.51	51.43	54.66	53.81	56.70
Race						
Caucasian	429 (61%)	221 (61%)	259 (60%)	133 (62%)	170 (63%)	88 (60%)
African-American	179 (25%)	93 (26%)	99 (23%)	48 (22%)	80 (30%)	45 (31%)
API	46 (7%)	23 (6%)	36 (8%)	17 (8%)	10 (4%)	6 (4%)
AIAN	8 (1%)	8 (2%)	4 (1%)	4 (2%)	4 (2%)	4 (3%)
Ethnicity						
Non-Hispanic	462 (66%)	240 (73%)	261 (67%)	135 (70%)	201 (78%)	105 (77%)
Hispanic	185 (26%)	90 (27%)	129 (33%)	58 (30%)	56 (22%)	32 (23%)
Employment						
Full time	353 (50%)	170 (49%)	179 (44%)	83 (40%)	174 (66%)	87 (61%)
Part time	46 (7%)	28 (8%)	37 (9%)	24 (12%)	9 (3%)	4 (3%)
Retired	156 (22%)	96 (28%)	86 (21%)	51 (25%)	70 (27%)	45 (32%)
Unemployed	98 (14%)	46 (13%)	92 (23%)	43 (21%)	6 (2%)	3 (1%)
Education level						
High school/GED	104 (15%)	56 (16%)	77 (19%)	40 (20%)	27 (10%)	16 (12%)
Some college	281 (40%)	128 (37%)	179 (45%)	77 (38%)	102 (39%)	51 (37%)
College graduate	165 (23%)	97 (28%)	94 (23%)	62 (30%)	71 (27%)	35 (25%)
Graduate degree	108 (15%)	61 (17%)	47 (12%)	24 (12%)	61 (23%)	37 (27%)
Military status						
Retired military	232 (33%)	136 (43%)	47 (12%)	29 (16%)	185 (73%)	107 (81%)
Dependent	282 (40%)	146 (46%)	276 (73%)	144 (79%)	6 (2%)	2 (2%)
AD	117 (17%)	33 (11%)	55 (15%)	10 (6%)	62 (25%)	23 (17%)
DM family history	368 (52%)	178 (52%)	235 (58%)	112 (55%)	132 (50%)	66 (47%)

AIAN = American Indian/Alaskan Native; API = Asian/Pacific Islander.
Note: Totals are not 100% due to rounding and missing data.

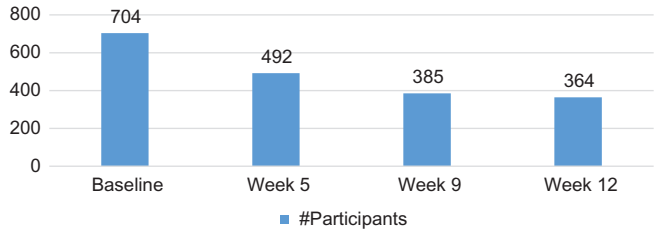

FIGURE 1. GLB retention from baseline through week 12.

12 wk compared with 52.36 at baseline. Consistent with older age, the percentage of retired military increased from baseline (33%) to completion (43%). Moreover, college graduates (23–28%) and those with graduate degrees (15–17%) were retained at higher rates from baseline to completion.

Figure 1 shows the number of participants in each of the four in-person sessions. The greatest decline in participation occurred from baseline to week 5 with a decrease of 212 participants (30%). From week 5 to week 9, an additional 107 participants (22%) were lost. Few participants were lost from week 9 to week 12 (5%). Thus, 51.7% completed the 12-wk program.

Independent samples *t*-tests were conducted between the two groups for baseline clinical measures between those who completed the program ($n = 364$) and those who did not complete ($n = 340$). No clinically significant differences were observed in weight, BMI, waist circumference, blood pressure, HbA1c, FBS, or lipids between the two groups. Therefore, attention was given to clinical outcomes for those who completed the GLB program.

Paired *t*-tests compared observed clinical measures at baseline to the same measures at completion of the program (Table II). Although only about a 4% weight loss was observed in participants who completed the 12-wk program, the difference was statistically significant ($p < 0.01$). Corresponding BMI significantly decreased from 31.53 kg/m^2 at baseline to 30.31 kg/m^2 at completion ($p < 0.01$). Additional benefits for those who completed were realized. Average weight loss was 3.43 kg and 37.9% achieved at least 5.0% reduction in weight; 19.4% achieved 7.0% or greater weight loss. The mean waist circumference significantly decreased ($p < 0.01$). However, no significant differences in blood pressure were observed. The mean FBS significantly improved ($p < 0.01$) and there was a significant improvement in HbA1c ($p < 0.01$). CHOL markers significantly improved for both men and women, with significant improvements in CHOL, TG, and low-density lipoprotein measures ($p < 0.01$) and negligible differences in HDL.

In addition, conditions of interest for the 364 completers were examined including prediabetes, obesity, and MetS (Table III). Prediabetes prevalence fell by 2.0% ($p < 0.001$). Obesity was reduced by 8.7% ($p < 0.001$) and MetS

TABLE II. Clinical Measure Means by Gender for Completers at Baseline and Completion at 12 wk

Measure	Overall (n = 364)			Female (n = 216)			Male (n = 148)		
	Baseline	Completion	p-value	Baseline	Completion	p-value	Baseline	Completion	p-value
Weight (kg)	87.98**	84.55**	<0.001	81.31**	78.47**	<0.001	97.94**	93.65**	<0.001
BMI (kg/m^2)	31.53**	30.31**	<0.001	31.36**	30.25**	<0.001	31.83**	30.46**	<0.001
Waist (cm)	102.95**	96.52**	<0.001	99.03**	90.37**	<0.001	108.61**	101.68**	<0.001
Blood pressure									
Systolic blood pressure (mm Hg)	122.06	123.21	0.08	121.06*	123.21*	0.01	123.48	123.25	0.83
Diastolic blood pressure (mm Hg)	75.51	75.40	0.76	74.84	75.44	0.19	76.56	75.36	0.06
Blood glucose									
HbA1c (%)	6.01**	5.83**	0.001	5.98**	5.78**	<0.001	6.04**	5.78**	<0.001
FBS (mg/dL)	100.73**	96.76**	<0.001	98.82**	98.73	<0.001	103.47	98.73	<0.001
Lipids									
CHOL (mg/dL)	185.04**	174.16**	<0.001	191.07**	181.39**	<0.001	176.26**	163.36**	<0.001
TG (mg/dL)	119.98**	104.96**	<0.001	115.66**	102.62**	0.001	129.73**	110.28**	0.001
Low-density lipoprotein (mg/dL)	106.05**	99.31**	<0.001	108.39**	102.63**	0.003	102.53**	94.30**	<0.001
HDL (mg/dL)	54.37	54.00	0.38	59.73*	58.55*	0.03	46.39	47.23	0.18

*$p < 0.05$; **$p < 0.01$.

TABLE III. Percent of Participants with Conditions of Interest and MetS Risk Factors from Baseline to Week 12

	Baseline	Week 12	p-Value
Condition			
Prediabetes**	93.2%	91.2%	<0.001
Obesity (BMI ≥30)**	56.1%	47.4%	<0.001
MetS*	31.5%	24.7%	<0.01
MetS risk factor			
Central obesity**	72.1%	54.2%	<0.001
High TG**	24.0%	14.4%	<0.001
Low HDL	29.2%	31.4%	0.109
High blood pressure	30.3%	33.0%	0.078
High FBS**	45.7%	34.9%	<0.001

*$p < 0.05$; **$p < 0.01$.

decreased by 6.8% overall ($p < 0.01$). Furthermore, Table III displays the change in MetS risk factors from baseline to completion. Significant differences were found for central obesity, TG, and FBS ($p < 0.001$).

Not all completers lost weight. In fact, 44 completers (12.1%) gained weight (range of 0.05–5.06 kg) with a mean weight gain of 1.46 kg. However, even those completers who did not lose weight had a significant reduction in HbA1c from baseline to completion (6.03–5.87; $p = 0.001$) and the mean waist circumference was significantly reduced from 102.36 cm to 100.03 cm ($p = 0.001$).

DISCUSSION

The primary purpose of this study is to determine the efficacy of the GLB program in our population. The GLB program was successful in reducing several measures of clinical interest for completers. Completers of the 12-wk program lost an average 4% of their baseline body weight (3.43 kg), with 37.9% of completers achieving a 5% or greater weight loss, and 19.4% exceeding 7% weight loss. Group markers of glucose and cholesterol metabolism improved for the group as a whole, as did the number of those classified as having prediabetes, obesity, and MetS. The DCOE results are similar to those reported in other lifestyle change programs published in the literature. A recent meta-analysis of 11 randomized controlled trials of intensive lifestyle change programs for prediabetes found a mean weight loss of 2.30 kg compared with the DCOE GLB program's 3.43 kg.[6] Even those who did not lose weight in the DCOE program realized clinical benefit in terms of HbA1c reduction and mean waist circumference reduction. Therefore, it was clear that there was overall clinical benefit for patients who completed the program. As such, it is worthwhile to consider investment in this type of program on a larger scale in the MHS.

Although weight changes were only reported through 12 wk, the weight loss observed in DCOE participants exceeded mean weight loss observed in other studies by over 1 kg. It is unclear whether DCOE participants maintained this degree of weight loss over a longer period of time. Even so, it should be noted that the DCOE GLB program was similarly structured to many of these programs, and it is reasonable to presume that long-term performance would likewise be similar. The meta-analysis also found that DPPs that adhered to specific principles tended to be more successful. These principles were obtained from the Development and Implementation of a European Guideline and Training Standards for Diabetes Prevention (IMAGE project)[15] and the United Kingdom's National Institute for Health and Clinical Excellence (NICE).[16] Currently, the DCOE GLB program utilizes about half of these strategies including promoting changes to both diet and physical activity, utilizing behavior change strategies, maximizing frequency of contact with participants given available resources, using self-regulatory techniques, and building self-efficacy through short-term achievable goals. Table IV provides a comprehensive list of potential strategies to

TABLE IV. Factors Associated with Successful Diabetes Prevention Interventions

1. Aim to promote changes in both diet and physical activity.
2. Use established, well-defined behavior change techniques (e.g., specific goal-setting, relapse prevention, self-monitoring, motivational interviewing, prompting self-talk, prompting practice, individual tailoring, and time management).
3. Work with participants to engage social support for the planned behavior change (i.e., engage important others such as family, friends, and colleagues).
4. Maximize the frequency or number of contacts with participants (within the resources available).
5. Use a coherent set of "self-regulatory" intervention techniques (specific goal-setting [ideally with coping planning aka "relapse prevention"], prompting self-monitoring, providing feedback on performance, problem-solving, review of behavioral goals).
6. Use a group size of 10–15.
7. Provide at least 16 h of contact time over the first 18 mo.
8. Ensure programs adopt a person-centered, empathy-building approach.
9. Allow time between sessions, spreading them over a period of 9–18 mo.
10. Information provision: to raise awareness of the benefits of and types of lifestyle changes needed.
11. Exploration and reinforcement of participants' reasons for wanting to change and their confidence about making changes.
12. Gradual building of confidence (self-efficacy) by starting with achievable and sustainable short-term goals and setting of graded tasks.
13. Use a logical sequence of intervention methods (e.g., motivation, action-planning, and maintenance).

Sources: IMAGE (Chatterton et al., 2012)[16]: Items 1–5.
NICE (Greaves et al., 2011)15: Items 1-13 (except item 4, which is replaced by item 7).

maximize efficacy and retention. There may be even greater success with program completers if more of these principles were incorporated. The DCOE is currently expanding the program to include additional core classes over 9 mo after program completion.

Although it is clear that completers receive significant clinical benefits, there was a high attrition rate. Nearly half (48.3%) of the patients who started our program dropped out before 12 wk, losing some of the potential benefit they may have otherwise achieved. Therefore, improving retention must be a focus of the GLB program moving forward. As about 30% of participants dropped out between in-person sessions held at week 1 and week 5, many enrollees may not be prepared for the rigorous nature of the GLB program. Thus, in April 2016, the DCOE GLB program started including an orientation before enrollment to assess readiness to change and to help participants make an informed choice about whether the GLB program would be right for them. Participants now learn about the history of the program, goals, and requirements; are shown a time line syllabus for each week of the program; and have an opportunity to review course materials. Participants are now encouraged to choose their start date and have a greater sense of benefits of the program. Those who are not ready to start are welcome to join the GLB program at any time in the future. In addition, alternative options are now provided to those who do not desire to enroll in the GLB program, which could include medication, dietary counseling, or another weight management program offered at WHASC.

As retired individuals were more likely to complete the GLB, holding in-person sessions when convenient for working individuals (e.g., evenings and weekends) may improve retention. AD participants were more likely to discontinue with nearly three-fourths not completing the program. Efforts are underway to gain support from supervisors for AD at risk for diabetes to attend the GLB program.

Limitations

It must be noted that there were two different program coordinators during the study. This may have an effect on retention and the fidelity of the program. There was no formal longitudinal follow-up with GLB program completers after the 12-wk program; therefore, results only reflect outcomes at the time of program completion.

Future Studies

Future studies should examine longer term benefits for completers who were able to achieve 5–7% weight loss. In addition, determining strategies utilized by GLB participants who were able to achieve significant weight loss may assist other participants achieve similar results. Moreover, a longitudinal study should be conducted to see how many completers were able to maintain lifestyle changes that resulted in significant clinical benefits. In addition, longitudinal studies could identify what percentage of GLB completers converted to diabetes within 5 yr versus those who were able to delay or prevent conversion to diabetes. Finally, continued investigation into motivational factors for patients to engage and complete the GLB would be helpful to realize the full efficacy of this type of program.

CONCLUSIONS

The GLB program is a valuable DPP and was effective at improving clinical outcomes and reducing the incidence of prediabetes, obesity, and MetS for many participants who completed the program. Therefore, the MHS should consider expanding this program to reach more patients at risk. Every effort should be made to support and encourage GLB participants to complete the program.

CONFLICT OF INTEREST STATEMENTS/ FINANCIAL DISCLOSURES

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