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# The Impact of a Yearlong Diabetes Prevention Program-Based Lifestyle Intervention on Cardiovascular Health Metrics

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**Abstract**

**Introduction:** The American Heart Association created "Life's Simple Seven" metrics to estimate progress toward improving US cardiovascular health in a standardized manner. Given the widespread use of federally funded Diabetes Prevention Program (DPP)-based lifestyle interventions such as the Group Lifestyle Balance (DPP-GLB), evaluation of change in health metrics within such a program is of national interest. This study examined change in cardiovascular health metric scores during the course of a yearlong DPP-GLB intervention. **Methods:** Data were combined from 2 similar randomized trials offering a community based DPP-GLB lifestyle intervention to overweight/obese individuals with prediabetes and/or metabolic syndrome. Pre/post lifestyle intervention participation changes in 5 of the 7 cardiovascular health metrics were examined at 6 and 12 months (BMI, blood pressure, total cholesterol, fasting plasma glucose, physical activity). Smoking was rare and diet was not measured. **Results:** Among 305 participants with complete data (81.8% of 373 eligible adults), significant improvements were demonstrated in all 5 risk factors measured continuously at 6 and 12 months. There were significant positive shifts in the "ideal" and "total" metric scores at both time points. Also noted were beneficial shifts in the proportion of participants across categories for BMI, activity, and blood pressure. **Conclusion:** AHA-metrics could have clinical utility in estimating an individual's cardiovascular health status and in capturing improvement in cardiometabolic/behavioral risk factors resulting from participation in a community-based translation of the DPP lifestyle intervention.

**Keywords**

health promotion, lifestyle change, obesity, physical activity, community health, prevention

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## Introduction

The American Heart Association (AHA) set a goal of improving the cardiovascular health of all Americans by 20% by the year 2020 in an effort to reduce the burden of cardiovascular disease (CVD).[1] In order to measure progress toward this goal, the AHA created Life's Simple Seven (LS7) metrics to estimate cardiovascular health status. These 7 metrics include BMI, physical activity, diet, smoking, blood pressure, total cholesterol, and fasting plasma glucose.[1] The AHA established criteria classifying each metric as "ideal," "intermediate," or "poor" based on evidence in line with clinical practice and public health guidelines for promoting CVD free survival.[1] By including both behavioral and cardiometabolic factors, the LS7 concept captures a comprehensive picture of modifiable CVD risk while providing straightforward standardized definitions of optimal status. The LS7 could be a useful approach to identifying individuals who may be

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appropriate candidates for intervention programs promoting cardiovascular health, and monitoring progress resulting from program participation.

A growing body of evidence indicates that more favorable LS7 metric profiles are associated with decreased CVD,[2,3] mortality,[4–6] and other non-CVD outcomes, including type 2 diabetes.[7–9] Studies to date have demonstrated that lifestyle intervention programs specifically designed to improve cardiovascular health metrics by the AHA definition are feasible,[10,11] and show potential for improvement in individual metrics.[12,13] Unfortunately, these studies are limited by small sample size or interventions designed for use in specific settings.

Currently, there are a multitude of lifestyle intervention efforts underway that are based on the US Diabetes Prevention Program (DPP) lifestyle intervention.[14] The landmark DPP study demonstrated that those who participated in the lifestyle intervention had a 58% reduction in diabetes risk.[15] DPP lifestyle intervention participants were also less likely to develop metabolic syndrome, more likely to see metabolic syndrome resolve,[16] and were less likely to develop hypertension and dyslipidemia.[17] Building on the findings of the DPP, the lifestyle intervention program was translated to be more widely available in the public health arena.[14,18] The success of this program has led to the US Centers for Disease Control and Prevention (CDC) overseeing wide-scale delivery of the DPP-based intervention, with CDC approved DPP-based lifestyle intervention now reimbursable through the Centers for Medicare & Medicaid Services (CMS).[19] CDC recognition and CMS reimbursement have had significant implications for increasing access to DPP-based interventions, with over 324 000 individuals having participated in DPP-based programs to date.[14]

The Group Lifestyle Balance (DPP-GLB) is an intervention program translated from the DPP lifestyle intervention that is CDC-recognized and has been shown to be effective in improving CVD and diabetes risk factors in rigorous clinical trials offered across a variety of diverse community settings.[20–24] With modifications including moving from an individual to a group-based format, the DPP-GLB has been shown to be effective as described in detail elsewhere.[25] Given the increasing reach of DPP-based programs and the proven success of the DPP-GLB lifestyle intervention in improving behavioral and cardiometabolic risk factors, the DPP-GLB provided a unique opportunity to evaluate, for the first time in a DPP translation effort, the AHA-defined health metrics based on LS7 and their ability to measure improvements in risk factors in a population at high cardiometabolic risk. If effective, this approach would complement existing ways to measure cardiovascular risk by providing a standardized and simple way to report change in CVD risk factors in widely utilized DPP-based lifestyle intervention programs.

Using data from 2 large scale community-based DPP-GLB translation efforts completed over the past 10 years, this project aimed to assess changes in cardiovascular health metrics based on AHA criteria resulting from participation in this yearlong CDC-recognized intervention program. It was hypothesized that participants of the DPP-GLB would demonstrate an improvement in cardiovascular health metrics after 6 months and improvement would be maintained after 12 months of intervention.

## Methods

This project is a secondary data analysis of 2 NIH funded intervention trials evaluating the DPP-GLB in the community setting with almost identical eligibility criteria and study design. The Healthy Lifestyle Project (GLB-Healthy) was conducted from March 2010 through February 2014.[22] The Physical Activity and Sedentary Behavior Change study (GLB-Moves) was conducted from September 2014 through July 2019. Both studies received Institutional Review Board approval and all subjects provided written informed consent.

### *Sample*

Eligibility criteria for these studies included age ≥18 years of age (GLB-Healthy) or ≥40 years of age (GLB-Moves), BMI >24 kg/m$^2$ (>22 kg/m$^2$ for Asian persons, consistent with the DPP BMI eligibility criteria[15]), evidence of prediabetes defined as fasting glucose ≥100 to <126 and/or hemoglobin A1c 5.7% to 6.4%, and/or metabolic syndrome defined by National Cholesterol Education Program Adult Treatment Panel III criteria or hyperlipidemia and 1 component of metabolic syndrome.[26] Participants were ineligible if they had ever had diagnosed diabetes, planned to move away in the 18 months following screening, were taking metformin, had an initiation or change in blood pressure or lipid medication within the past 3 months, or were pregnant or breastfeeding. Recruitment and screening efforts were conducted for GLB-Healthy from September 2010 to November 2011, and for GLB-Moves from October 2014 through March 2017.

In both study efforts, investigators partnered with community organizations in Allegheny County, Pennsylvania (ie, the greater Pittsburgh area) to recruit in the geographic area around community centers. In GLB-Healthy, investigators also partnered with a worksite in the Pittsburgh metropolitan area, to recruit employees.[21,22] The lifestyle intervention and clinic assessment visits were conducted at the community centers and worksite.

### *Design*

Both studies had a randomized controlled design with participants assigned to begin the intervention program immediately or after a 6-month delay with randomization stratified by site location. Participants who were randomized to the delayed intervention arm received an identical yearlong intervention program but started 6 months later (Supplemental Figure 1). Baseline was considered to be the clinic visit immediately preceding the start of the lifestyle program sessions (ie, month 6 for delayed participants).

The focus of this analysis is change during the course of a yearlong DPP-GLB intervention that is currently widely used in community settings. For this reason, pre/post intervention assessments were examined to capture the time period of interest for these national programs. Randomized controlled trial results for DPP-GLB have been published previously.[21,22]

One of the intervention arms in the GLB-Moves study involved an alternative intervention with a focus on reducing time spent sitting. Participants from that study arm were excluded from this analysis due to the experimental nature of that intervention, and because it is a significant departure from the current CDC-recognized GLB curriculum. Although participants and lifestyle coaches could not be blinded to randomization assignment due to the nature of the intervention, lifestyle coaches were not involved in any outcome assessments.

## Intervention

The DPP-GLB lifestyle intervention used in both studies was adapted from the lifestyle intervention of the DPP to be a 22 session, year-long, group-based program, developed by individuals who helped direct both the DPP lifestyle intervention and the resulting translation efforts.[27] The first 12 sessions occurred weekly, followed by 4 biweekly sessions and 6 monthly maintenance sessions. All lifestyle coaches received standard training in the DPP-GLB curriculum.

The primary goals of the DPP-GLB lifestyle intervention were to achieve and maintain a 7% weight loss and to safely progress to 150 minutes per week of moderate physical activity, with an intensity similar to a brisk walk. The program curriculum consisted of group discussion and education surrounding topics encouraging activity, balanced diet and caloric restriction to promote weight loss, and behavioral strategies to support program goals. Delayed participants received the same program starting 6 months after randomization. During the delay, those participants randomized to this arm received occasional health-related handouts to promote retention. Attendance included both in-person small group sessions and make-up sessions, which were completed as needed.

## Measures

Five of the 7 AHA cardiovascular health metrics were analyzed in this study. Direct measures of diet were not collected in these 2 studies, and smoking prevalence was rare (4.9%) at baseline and therefore not collected beyond that point. All metric calculations are based on measures taken at clinic assessment visits that took place at intervention baseline, and after 6 months, and 12 months of intervention. The protocols for outcome measures were the same in both study cohorts.

Body mass index (BMI) was determined by measured height and weight. A BMI below 25 was considered ideal, 25 to <30 intermediate and ≥30 poor, in accordance with AHA criteria.[1] Asian participants with a BMI <23 were classified as ideal, 23 to 27.5 intermediate, and ≥27.5 poor, per the greater risk associated with lower BMI cut points in this demographic.[28,29]

Leisure physical activity was assessed using a past month version of the Modifiable Activity Questionnaire, which has been shown to be reliable and valid in adults,[30,31] and quantified as Metabolic Equivalent of Task (MET) hours per week. Activity of ≥7.5 MET hours/week was considered ideal, >0 to <7.5 MET hours/week intermediate, and no reported activity poor. The ideal cut point of 7.5 MET hours/week is roughly equivalent to the AHA criteria promoting 150 minutes or more of moderate intensity or 75 minutes or more of vigorous intensity activity each week,[1] as has been shown in previous literature,[32] and is consistent with commonly accepted physical activity guidelines.

Blood pressure was measured using the average of 2 readings taken after a 5-minute rest with an automatic digital sphygmomanometer. If measures differed by greater than 5 mmHg, a third measure was taken. Ideal blood pressure was defined as <120/80 mmHg without treatment, intermediate as 120 to 139 systolic or 80 to 89 mmHg diastolic or treated to ideal range, and poor as ≥140 systolic or ≥90 mmHg diastolic, as outlined by AHA criteria.[1]

Total cholesterol and fasting plasma glucose were determined using a fasting blood draw. Ideal total cholesterol was defined as <200 mg/dL, intermediate as 200 to 239 mg/dL or treated to ideal range, and poor as ≥240 mg/dL. Fasting plasma glucose was considered ideal with a level of <100 mg/dL, intermediate with 100 to 125 mg/dL or treated to ideal range, and poor was ≥126 mg/dL. Blood value cut points were consistent with AHA criteria.[1] Treatment for blood pressure, total cholesterol, and fasting plasma glucose was ascertained using a medication questionnaire.

## Analysis

Differences in demographic characteristics between those who were included in the analysis and those who were excluded were tested using chi-square, Fisher's exact, and *t*-tests.

Significant continuous change in each metric at 6 and 12 months was tested using Wilcoxon signed-rank tests due to the non-normal distribution of change variables. Since study participants had individual variability in their cardiometabolic risk profiles at baseline, for any 1 health metric, some participants were in need of improvement while others may have already met the ideal criteria for that metric per the definitions previously described. For that reason, additional separate analyses were done for continuous change for each metric, limited to only those participants at "high risk" for that metric (defined as having baseline values falling within the intermediate or poor range).

Differences in the proportion of metrics within each category (ideal, intermediate, and poor) were determined using a marginal homogeneity test of symmetry to assess whether there was a significant shift in off-diagonal terms from baseline to 6 months and from baseline to 12 months. A "total metric score" was calculated as the sum of the categories of each metric (poor = 0, intermediate = 1, ideal = 2; possible "total metric score" range 0-10). "Ideal metric score" was calculated as a count of metrics falling within the ideal range (possible "ideal metric score" range 0-5). Within group change for all participants from baseline to 6 months and baseline to 12 months was determined using the Wilcoxon signed-rank test, again due to the non-normal distribution of pairwise differences between timepoints. StatXact version 11.1 (Cytel Inc.) was used for the marginal homogeneity test. All other analyses were conducted in SAS version 9.4 (SAS Institute, Inc.).

Two sensitivity analyses were conducted to examine outcomes for stratified groups (1) study cohort: GLB-Healthy and GLB-Moves and (2) delivery site type: community center and worksite. Additionally, we assessed the impact of restricting our analyses to those with complete data by repeating our analyses using last observation carried forward (LOCF), an imputation method that can be used when repeated measures have been taken per subject by time point in which the last observed nonmissing value is used to fill in missing values.

## Results

Of the 373 participants eligible for this analysis in the combined cohorts, 305 participants (81.8%) had data available for 6- and 12-month pre/post intervention comparison (182 of 223 in GLB-Healthy, 123 of 150 in GLB-Moves). Screening and enrollment in both studies is shown in Supplemental Figure 1 but was described previously for the GLB-Healthy study only.[21,22] Median participant attendance was 21 out of 22 sessions.

Demographic characteristics for the combined cohorts used in pre/post analysis are shown in Table 1. The majority of participants were female (74.3%), and the mean age was 60.4 years. Nearly half of the participants indicated they were working full time (48.9%) and more than half had completed at least some college education. Participants identifying as Black were slightly more likely to have incomplete data than individuals self-identifying as White, Asian, or another race. When comparing the study cohorts (data not shown), the GLB-Moves study had significantly more females (82.1% vs 60.1%), was more diverse (87.0% White vs 92.9% White), had a higher percentage with some college education and a lower percentage with graduate degrees, and had more retired participants compared to GLB-Healthy.

### *Confirmation of Lifestyle Intervention Success*

When measured continuously, all of the outcome variables that form the basis of the cardiovascular health metrics for this study (Table 2) demonstrated significant improvement at 6 and maintenance at 12 months ($P < .01$), with the exception of total cholesterol at 12 months. In the additional "high risk" analysis (as defined in the methods), which examined continuous change in each metric, total cholesterol demonstrated a significant improvement ($P < .01$) at both 6 and 12 months (n = 127, median [IQR]: −11.5 mg/dL [−28.5, 5.5] and −4.0 [−24.0, 10.0], respectively). All other metrics also demonstrated a greater magnitude of improvement when measured continuously for those at "high risk" (data not shown). Participants with medication changes related to a metric over the course of the intervention study were excluded from the continuous change analysis of that metric, although all significant changes remained consistent when these participants were included.

### *Examining the Impact of the Intervention on the AHA Cardiovascular Health Metrics*

The percentages of participants within each metric category (poor, intermediate, ideal) showed improvement over the course of the intervention, as shown in Figure 1. Shifts in the ordered proportion of participants across categories for BMI, physical activity, and blood pressure were statistically significant from baseline to 6 months and from baseline to 12 months ($P < .05$), with a higher percentage of participants moving into the ideal range and a lower percentage of participants in the poor range after receiving the intervention. A favorable, but not statistically significant, shift was seen with the fasting plasma glucose metric. The proportion of participants within each category of total cholesterol did not change significantly.

Total" and "ideal" metric scores at each time point, and changes in metric scores are shown in Table 3. There was a significant positive shift in the distribution of the "total metric score" at both 6 ($P < .01$) and 12 months ($P < .01$) compared to baseline. There was also a significant positive shift in the distribution of "ideal metric score" at both 6 ($P < .01$) and 12 months ($P < .01$).

**Table 1.** Demographic Characteristics of Combined GLB Cohort Pre/Post Analysis Sample n (%) or mean (SD), Samples with Complete Metric Data Versus Missing Metric Data.

| | Complete data (n = 305) | Missing metric data (n = 68) | Between group *P*-value |
|---|---|---|---|
| Female | 165 (74.3) | 49 (72.1) | .68 |
| Age | 60.4 (10.3) | 57.9 (11.4) | .08 |
| Race/ethnicity | | | |
| White | 276 (90.5) | 57 (83.8) | .04 |
| Black | 17 (5.6) | 10 (14.7) | |
| Asian | 7 (2.3) | 0 (0) | |
| Other | 5 (1.6) | 1 (1.5) | |
| Spanish/Hispanic/Latino | 5 (1.6) | 1 (1) | .99 |
| Smoking status | | | |
| Current | 15 (4.9) | 2 (2.9) | .78 |
| Former | 101 (33.1) | 23 (33.8) | |
| Never | 189 (62.0) | 43 (63.2) | |
| Employment | | | |
| Working full-time | 149 (48.9) | 44 (64.7) | .19 |
| Working part-time | 33 (10.8) | 5 (7.4) | |
| Unemployed | 6 (2.0) | 0 (0) | |
| Homemaker | 8 (2.6) | 2 (2.9) | |
| Retired | 102 (33.4) | 14 (20.6) | |
| Disabled/unable to work | 7 (2.3) | 3 (4.4) | |
| Education | | | |
| 8th Grade or less | 1 (0.3) | 0 (0) | .06 |
| Some high school | 1 (0.3) | 1 (1.5) | |
| High school graduate | 29 (9.5) | 7 (10.3) | |
| Some college | 92 (30.2) | 28 (41.2) | |
| College graduate | 98 (32.1) | 11 (16.2) | |
| Graduate degree | 84 (27.5) | 21 (30.9) | |

Allegheny County, PA, USA. Study date: 2010 to 2019. Eligible population: overweight with prediabetes and/or metabolic syndrome.

These findings were largely consistent when looking at the 2 study cohorts separately, and when examining all community sites and the worksite setting separately (not shown). While results were generally similar to those observed overall, the smaller sample sizes in the subgroup analysis led to reduced power, thus continuous change in fasting plasma glucose did not reach statistical significance in the worksite only sample. Also, the shift in the percentage of participants within each blood pressure category did not reach statistical significance at either time point at the worksite and community sites when analyzed separately. All findings for LOCF analysis were consistent with the complete case analysis.

## Discussion

American Heart Association defined health metrics captured improvement in behavioral and cardiometabolic risk factors that occurred as the result of the effective DPP-GLB behavioral lifestyle intervention. This improvement was of substantial public health significance as it indicated that several metrics reached clinically meaningful cut points associated with lower CVD risk. In addition, it demonstrated the potential utility of the AHA-defined approach for monitoring progress during and after lifestyle intervention participation.

In this effort, continuous measures of the CVD risk factors of interest improved significantly at both 6 and 12 months, although total cholesterol change was only significant for initially "high risk" participants at the 12 month assessment. Continuous change in CVD risk factors was mirrored by beneficial shifts toward ideal metric status for BMI, blood pressure and physical activity and significant improvement in "total" and "ideal" composite scores.

Positive changes in BMI, physical activity, and blood pressure appeared to contribute most to the shifts toward more favorable "total" and "ideal" composite scores of cardiovascular health metrics. Although the metrics of total cholesterol and glucose levels appeared to be less influenced by the intervention in this cohort, it should be noted that the lack of a visible significant change in the total cholesterol metric may be due to the high percentage (44%) of participants reporting use of medication for lipid management, which could mask the effects of the program on lipid

**Table 2.** Continuous Change in CVH Metrics of Combined GLB Cohort Pre/Post Analysis Sample as Median (25th, 75th Percentile), n = 305.

| Metric | Baseline | 6 months | 12 months | 6-month change | 12-month change |
|---|---|---|---|---|---|
| BMI (kg/m$^2$) | 33.4 (29.9, 37.9) | 31.4 (27.6, 35.9) | 31.6 (27.9, 35.9) | −1.8 (−2.6, −0.8)[a] | −1.4 (−3.1, −0.3)[a] |
| Physical activity (leisure MET-h/wk) | 10.4 (3.0, 20.8) | 19.7 (9.1, 33.2) | 14.6 (7.2, 26.8) | 6.9 (−2.1, 19.5)[a] | 2.2 (−2.8, 10.8)[a] |
| Blood pressure | | | | | |
| SBP (mmHg) | 120.0 (112.0, 129.0) | 116.0 (107.0, 124.0) | 116.6 (107.0, 126.5) | −4.0 (−12.0, 3.0)[a] | −3.0 (−12.0, 5.0)[a] |
| DBP (mmHg) | 75.5 (69.0, 81.0) | 73.0 (66.0, 79.0) | 72.5 (66.3, 80.0) | −3.2 (−7.5, 2.0)[a] | −2.7 (−8.3, 4.0)[a] |
| Total cholesterol (mg/dL) | 193.0 (169.0, 217.0) | 188.0 (164.0, 213.0) | 195.0 (172.0, 219.0) | −4.5 (−21.0, 9.0)[a] | 1.0 (−11.0, 15.0) |
| Fasting plasma glucose (mg/dL) | 92.0 (86.0, 98.0) | 90.0 (86.0, 96.0) | 90.0 (85.0, 98.0) | −1.5 (−6.0, 3.0)[a] | −1.0 (−7.0, 3.0)[a] |

BMI 12-month n = 304; SBP/DBP 6-month n = 285, 12-month n = 272; total cholesterol 6-month n = 278, 12-month n = 262; glucose 6-month n = 304, 12-month n = 303.
[a]*P*-value for change <.05 using signed rank test. Participants with medication changes related to the variable examined were excluded from analysis.

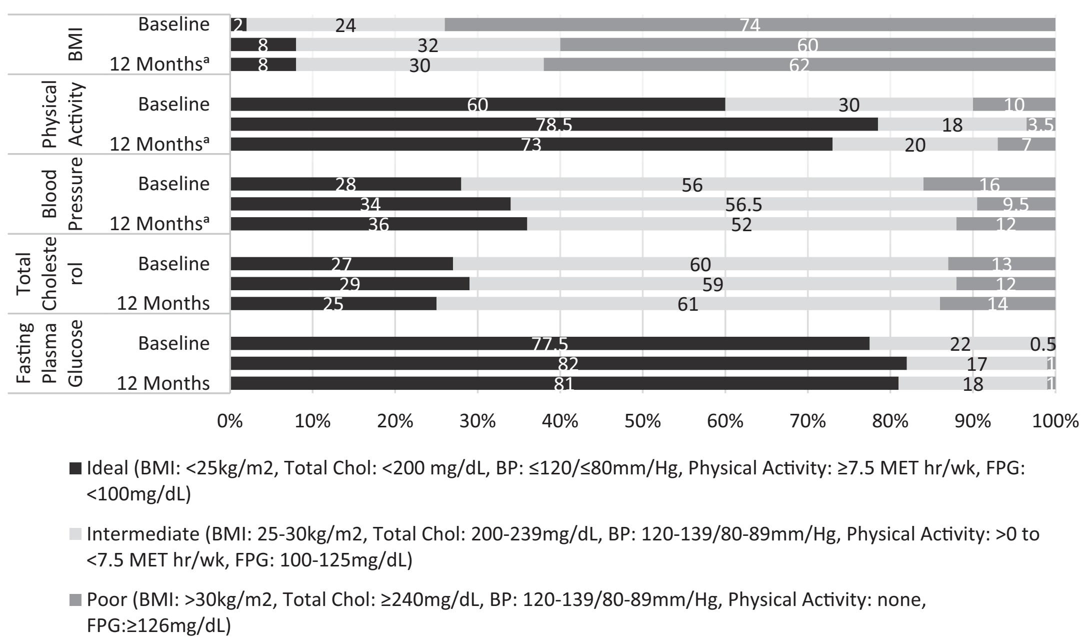


**Figure 1.** Individual metric category percentages at baseline, 6 and 12 months in combined GLB cohort pre/post analysis sample, n = 305: (a) *P*-value <.05 using marginal homogeneity test for shift in ordered proportion of participants within metric category compared to baseline.

levels. Additionally, we had a low prevalence of individuals with poor and intermediate glucose status which may account for the relatively lower impact of the intervention on changes in glucose as measured by the metric scores. However, in general, the beneficial impact of this DPP-based lifestyle intervention on cardiovascular risk factors in need of change specific to this cohort of individuals with prediabetes and/or metabolic syndrome as quantified by the AHA cardiovascular health metrics is encouraging.

Assessment and promotion of health behaviors and approaches to identifying appropriate lifestyle intervention candidates remain limited in clinical care,[33–36] making screening tools desirable. The AHA metrics provides both a standard assessment tool and goal-based guidance in addressing health behaviors and associated cardiometabolic risk, serving as a natural complement to a lifestyle intervention program. In addition, prevalence estimates of cardiovascular health metrics in the general population show room for improvement,[37,38] with projections suggesting a relative increase in cardiovascular health metric scores of about 6% in 2020, far lower than the 20% goal.[37] Given the improvement in AHA metrics demonstrated in the current analysis, referral to and coverage for DPP-GLB programs

**Table 3.** Total Metric and Ideal Metric Scores and Changes at 6 and 12 Months in Combined GLB Cohort Pre/Post Analysis Sample, n = 305.

| Composite metric score | Baseline: mean (SD), median (IQR) | 6 months: mean (SD), median (IQR) | 12 months: mean (SD), median (IQR) | 6 month change: mean (SD), median (IQR) | 12 month change: mean (SD), median (IQR) |
|---|---|---|---|---|---|
| Total metric score | 5.80 (1.41), 6.0 (5.0, 7.0) | 6.43 (1.42), 6.0 (5.0, 7.0) | 6.28 (1.43), 6.0 (5.0, 7.0) | 0.59 (1.11), +1.0 (0.0, +1.0)[a] | 0.48 (1.22), 0.0 (0.0, +1.0)[a] |
| Ideal metric score | 1.94 (0.94), 2.0 (1.0, 3.0) | 2.30 (1.01), 2.0 (2.0, 3.0) | 2.23 (1.01), 2.0 (2.0, 3.0) | 0.36 (0.95), 0.0 (0.0, +1.0)[a] | 0.29 (0.93), 0.0 (0.0, +1.0)[a] |

Abbreviations: IQR, interquartile range.
[a]*P*-value $<.01$ using signed-rank test to assess change.

based on initial cardiovascular health metric score status could meaningfully improve risk profiles in those in need of change.

Among the limitations of this effort, the lack of direct diet measures and low prevalence of smokers limited the ability to capture change in the entire AHA cardiovascular health metrics framework which includes 7 components. Changes in diet quality were not primary behavioral goals of these DPP-GLB study efforts, which focused primarily on weight loss and physical activity. In general, diet quality is not typically measured in these community-based programs. However, balanced heart healthy eating was discussed and encouraged during the course of the intervention. In a post-intervention survey conducted in the GLB-Moves study, 94% of participants said they made healthier food choices as a result of the program. Also, although diet quality is not routinely assessed as part of these intervention efforts, the AHA LS7 framework could potentially serve as a screening tool to assess and monitor diet quality in future intervention efforts.

While significant effort was made to sample communities to maximize diversity in these study cohorts, participation by non-white individuals was constrained by the fact that the greater Pittsburgh area has limited racial/ethnic diversity.[39] Although previous research has suggested that the DPP-GLB program is effective among older adults of varying socioeconomic status,[22] future studies should focus on other geographic regions with much more diverse populations.

A notable strength of this study is the consistent findings across 2 different study cohorts, spanning a period of 8 years, and across worksite and community settings. The consistency of the results across studies and sites justified the combination of these cohorts, in turn providing a more robust sample to examine effectiveness of the DPP-GLB program in improving cardiovascular health factors. In addition, the DPP-GLB programs demonstrated excellent adherence, with median attendance of 21 out of 22 sessions. Finally, post-intervention surveys reflected positive perceptions of the program among participants, with 95% of community participants and 99% of worksite participants surveyed in GLB-Healthy reporting they would recommend the DPP-GLB program to others.[21,22] Similarly, 94% of GLB-Moves participants surveyed reported that the program helped them achieve a healthier lifestyle.

## Conclusions

Participation in the highly successful, CDC-recognized and CMS funded, DPP-GLB resulted in improvement in several of the AHA cardiovascular health metrics, a composite of behavioral and cardiometabolic CVD risk factors. Each of the included AHA metrics improved significantly when measured continuously, confirming previous findings regarding participation in the DPP-GLB, and benefits to the cardiovascular risk profile. Improvement in “ideal” and “total” composite metric scores, as well as shifts toward more favorable individual cardiovascular health metric categories, mirrored this continuous change, signifying risk factor progression toward clinically desirable values. Given these metric improvements, the AHA metrics approach could have great utility in streamlining referral to and monitoring of success in behavioral lifestyle interventions, all of which would have important implications for CVD prevention.

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### Declaration of Conflicting Interests

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## Ethical Approval and Approval Number

Both clinical trials included in this current effort were conducted in accordance with the 1964 Declaration of Helsinki and received ethical approval from the University of Pittsburgh Institutional Review Board. All subjects provided written informed consent.

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## Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Supplemental Material

Supplemental material for this article is available online.

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