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Weight loss experiences of African-American, Hispanic and non-Hispanic White men and women with type 2 diabetes: The Look AHEAD Trial

Delia Smith West, PhD,
Department of Exercise Science, University of South Carolina, Columbia, South Carolina USA

Gareth Dutton, PhD,
Division of Preventive Medicine, Department of Medicine, University of Alabama at Birmingham, Birmingham, AL USA

Linda M. Delahanty, MS, RDN, LDN,
Diabetes Research Center, Massachusetts General Hospital, Department of Medicine, Harvard Medical School, Boston, MA USA

Helen P. Hazuda, PhD,
Division of Nephrology, Department of Medicine, University of Texas Health Science Center at San Antonio, San Antonio, TX USA

Amy D. Rickman, PhD, RD, LDN, FACSM,
Department of Exercise & Rehabilitative Sciences, Slippery Rock University, Slippery Rock, PA USA

William C. Knowler, MD, DrPH,
Diabetes Epidemiology and Clinical Research Section, NIDDK, Phoenix, AZ USA

Mara Z. Vitolins, DrPH, RDN, FAND,
Department of Epidemiology and Prevention, Wake Forest School of Medicine, Winston-Salem, NC USA

Rebecca H. Neiberg, MS,
Department of Biostatistics and Data Science, Wake Forest School of Medicine, Winston-Salem, NC USA

Anne Peters, MD,
Department of Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA USA

Corresponding author westds@mailbox.sc.edu.
Contact Information: Delia Smith West, PhD, Professor, Department of Exercise Science, University of South Carolina, 915 Greene St, Suite 403, Columbia SC 29208

Clinical Trial Registration: clinicaltrials.gov Identifier: NCT00017953

See Online Supporting Information for full listing of Look AHEAD Research Group.

Data Sharing Plan: For participants who provided informed consent, their de-identified data from the Look AHEAD trial are available through the NIDDK Central Repository (https://repository.niddk.nih.gov/pages/archive/). This site includes the study protocol, the analysis plan, study forms, and detailed descriptions of the data.

Molly Gee, MEd, RD, LD,
Behavioral Medicine Research Center, Baylor College of Medicine, Houston, TX USA

Maria Cassidy Begay, BSND, RND,
NIDDK and Indian Health Service, Shiprock, NM

Look AHEAD Research Group

Abstract

Objective: To characterize weight loss, treatment engagement and weight control strategies utilized by African-American, Hispanic and non-Hispanic White participants in the Look AHEAD Intensive Lifestyle Intervention by race/ethnic-sex subgroup.

Methods: Weight losses at 1-, 4- and 8-years among 2,361 adults with obesity and type 2 diabetes randomized to intervention (31% minority; 42% men) are reported by subgroup. Multivariable models within subgroups examine relative contributions of treatment engagement variables and self-reported weight control behaviors.

Results: All subgroups averaged weight losses ≥5% in Year 1 but experienced regain; losses ≥5% were sustained at Year-8 by non-Hispanic whites and minority women (but not men). Session attendance was high (≥86%) in Year 1 and exceeded protocol-specified-minimum levels into Year 8. Individual session attendance had stronger associations with weight loss among Hispanics and African Americans than non-Hispanic Whites at 4-years (p=0.04) and 8-years (p=0.001). Daily self-weighing uptake was considerable in all subgroups and was a prominent factor associated with Year-1 weight loss among African-American men and women. Greater meal replacement use was strongly associated with poorer 1-year weight losses among African-American women.

Conclusions: Experiences of minority men and women with diabetes in lifestyle interventions fill important gaps in the literature which can inform treatment delivery.

Keywords

lifestyle; African American; Hispanic; sex; weight loss

Introduction

High rates of type 2 diabetes mellitus (T2DM) evident among some U.S. minority groups may be driven by high obesity rates in these same groups.[1] African-American women have the highest rates of obesity (57.2%), and 38.3% of African-American men have obesity.[2] Rates are also high among Hispanic women (46.6%) and men (38.8%). Weight loss remains the frontline treatment for individuals who experience the dual burden of obesity and T2DM.[3] The Look AHEAD Intensive Lifestyle Intervention (ILI) for individuals with overweight/obesity and T2DM produced clinically-significant and sustained weight losses,[4] which resulted in improved glycemic control, reduced diabetes complications,[5] enhanced quality of life,[6] and reduced medical costs.[7] The ILI is noteworthy in that it successfully produced weight loss over 8 years in a diverse sample of individuals with diabetes, with over a third of individuals self-identifying as a member of a race/ethnic minority group. Further, 40% of participants were male, which contrasts with most previous weight control studies which

enrolled few men.[8] The Look AHEAD trial, therefore, offers a unique opportunity to explore the weight loss experiences of racial and ethnic minority men and women with T2DM. Although the aggregate weight outcomes for the race/ethnic groups within the Look AHEAD trial have been published previously,[9,10] a detailed description of the weight change of men and women within these groups has not. Furthermore, behavioral weight control practices which distinguish those successful in achieving long-term weight control within the ILI cohort overall have been reported,[10] but to date no analyses have examined associations between utilization of weight control strategies and weight loss outcomes within individual race/ethnic-sex groups. The current descriptive report seeks to fill these gaps in the literature by providing data on weight change by race/ethnic-sex subgroups, as well as a characterization of the treatment engagement and weight control strategies within subgroups.

Methods

Look AHEAD Study Overview

A full description of the Look AHEAD study protocol and methods has been published[11] and therefore is reviewed only briefly. A multi-layered, culturally-appropriate recruitment approach[12] enrolled adults aged 45 to 76 with a BMI ≥25kg/m^2 (≥27kg/m^2 if taking insulin) and T2DM (N=5145, 40% male; 36.7% minority) and randomized them to either intensive lifestyle intervention (ILI) or diabetes support and education (DSE). Participants were followed for up to 13.5 years, with major assessments at 1-, 4- and 8-years. The study was approved by the Institutional Review Board of each clinical center, and all participants gave informed consent. The current report includes only participants randomized to ILI because our focus was on intervention participation.

Intensive Lifestyle Intervention (ILI)

The ILI provided individual participants with a weight loss goal of 10% to be achieved through decreased calorie and fat intake and increased physical activity. Weekly group and individual counseling sessions were provided for the first 6 months (3 group and 1 individual session per month), followed by 3 sessions per month (2 group and 1 individual meeting) for the second 6 months. Structured meal plans and meal replacements were provided at no cost to facilitate weight loss goals. Participants were prescribed ≥ 175 minutes/week of moderate intensity, unsupervised physical activity (e.g., brisk walking). Participants were instructed to record dietary intake, calculate calorie and fat consumption, and monitor physical activity daily in paper diaries. Behavioral strategies included goal setting, problem solving, social support, and relapse prevention. A toolbox approach was incorporated which provided structured assistance to address barriers to behavior change for those experiencing difficulties achieving weight loss or activity goals and provided funds for additional resources as needed. The intervention was developed to meet the needs of a culturally-diverse participant group, with materials translated into Spanish, multi-ethnic intervention personnel at sites, and training in culturally-sensitive delivery of the evidence-based intervention. After the initial 1-year weight loss induction phase, a comprehensive behavioral maintenance program was offered during Years 2 through 4, with a protocol-specified goal of twice-monthly contact (at least one in-person), as well as regular refresher

programs and campaigns. After Year 4, participants were offered monthly individual meetings, as well as annual refreshers and campaigns; attendance was strongly encouraged but only two visits annually were specified as required by protocol. Greater detail on the ILI and evidence to support it have been published.[13]

Measures

Sociodemographic information, including self-identified racial and ethnic group, was reported at baseline. Body weight was measured at baseline and annually thereafter using a digital scale. Height was measured annually using a wall-mounted stadiometer. Weight change was calculated as both kg lost and % weight loss from baseline at Years 1, 4, and 8. Proportions of individuals who achieved ≥ 5% and ≥ 10% weight loss were also calculated.

Treatment engagement was characterized by session attendance (individual and group) and self-monitoring behaviors, which were recorded by interventionists into an electronic tracking system. Number of expected visits was calculated from the protocol-specified-minimum number of visits for each period. Specifically, 42 session visits were expected during months 0-12 (weight loss induction), 36 sessions during months 13-48 (weight maintenance), and 8 sessions during months 49-96 (extended treatment). Because protocol-specified visits represented a minimum number of sessions, attendance could exceed 100% if participants attended all campaigns and refreshers and other optional visits. Number of days on which participants recorded exercise and dietary intake was tracked by interventionists.

Self-reported utilization of behavioral weight control strategies during the year prior to assessment was measured using a 28-item checklist administered at baseline and Years 1, 4 and 8.[14] Participants reported the number of weeks over the previous year in which they weighed themselves (daily and weekly), used meal replacements, increased their exercise, decreased their calorie intake and reduced fat intake to promote weight management.

Analyses

All descriptive statistics for baseline characteristics, retention, weight change, and treatment engagement are presented by sex within race/ethnic subgroups. To explore the relative importance of treatment engagement and specific self-reported weight control practices, we examined multivariable regression models for each race/ethnic-sex subgroup using markers of engagement (session attendance and self-monitoring), and weight control practices (daily self-weighing, calorie/fat reduction, exercise and meal replacement use), with covariate adjustment for age, baseline BMI, education level, and clinical site. Separate models were fit for Years 1, 4, and 8. We also examined whether there were differences in the strength of associations between daily weighing, attendance at intervention sessions, and weight change between sexes and among race/ethnic groups using tests of interaction, selecting these markers of treatment engagement based on their prominence in the literature and factors emerging in our own analyses. We describe associations using standardized regression coefficients to provide information on the direction and strength of observed associations. Analyses were conducted using SAS Version 9.4 PROC GLM.

Results

Baseline Characteristics

The trial randomized 2570 participants to the ILI; 16% self-identified as African American, 13% as Hispanic and 63% as non-Hispanic White. An additional 8% self-identified as another minority group (e.g., Asian, American Indian, other),[15] but the numbers in these groups were too small to include in our analyses. Therefore, data from 2361 participants were examined. Table 1 presents baseline characteristics of the individual race/ethnic-sex subgroups. Retention rates in each subgroup were high throughout the trial.

Weight Losses

Weight loss within each race/ethnic-sex subgroup is shown in Table 2. Noteworthy are the high proportions of individuals in each subgroup who achieved ≥ 5% weight loss at Year 1; well over two thirds of Hispanic and non-Hispanic White individuals achieved this benchmark weight loss, as did over half of African-American participants. Weight loss trajectories followed a similar pattern within all race/ethnic-sex subgroups, with greatest weight losses achieved at Year 1 and some regain observed at Years 4 and 8. Nonetheless, approximately half of participants within all subgroups had sustained ≥5% weight loss at Year 8. Further, within each subgroup, a notable proportion achieved ≥10% weight loss at both Year 1 (ranging from 24%-47% within subgroups) and Year 8 (ranging from 20-32%). There was no significant interaction between sex and race/ethnic group in weight change over time.

An increased proportion of individuals achieved the 5% and 10% benchmark weight losses at Year 8 compared to the 4-year assessment, particularly among women within race/ethnic minority groups. Similarly, average weight losses among women in these minority groups were higher at Year 8 than at Year 4. Given the lack of a significant interaction between sex and race/ethnic group, however, any apparent differences between groups should be viewed with caution.

Treatment Engagement

Session attendance data (Table 3) demonstrate high engagement in Year 1 in all race/ethnic–sex groups, with 86-90% of expected visits attended. Attendance in Years 2-4 was also high (81-97% of expected visits), although fewer absolute number of sessions were attended since fewer were protocol-required. Even in years 5-8, total attendance remained high, with average session attendance greater than required by protocol in all race/ethnic-sex groups. Group attendance was higher in Year 1 when the ILI emphasized group sessions. Attendance at individual sessions was higher relative to group attendance in later years.

Self-monitoring of exercise and diet was most frequent in the initial year and declined markedly afterward. Within each subgroup, self-monitoring of diet and physical activity were comparable during Year 1. However, in Years 2-4, physical activity self-monitoring was more frequent than dietary self-monitoring, and this pattern was consistent within all subgroups.

Self-Reported Behavioral Weight Control Strategies

Weight control behaviors reported by race/ethnic-sex subgroups are described in Table 4. Self-weighing was strongly recommended within the self-regulation framework of the ILI and, by the end of Year 1, most ILI participants (88-98%) reported engaging in this behavior at least weekly. Self-weighing decreased over subsequent years, but rates remained higher than baseline within all subgroups. Similarly, the number of weeks in which participants reported that they had reduced their calorie and fat intake and increased their exercise had markedly increased at Year 1, but in subsequent years decreased within all subgroups. None of the participants reported using meal replacements at baseline, but there was significant uptake of self-reported use during Year 1 in all subgroups. However, self-reported meal replacement use declined within all subgroups at subsequent assessments, likely reflecting, at least in part, a decrease in the number of meal replacements provided starting in Year 2.

Contributions of Treatment Engagement and Weight Control Behaviors to Weight Loss

Multivariable models examining predictors of weight loss (Table 5) indicate that traditional treatment engagement variables explained substantial variance in most subgroups, but the fully-adjusted models which included both treatment engagement measures and self-reported weight control practices accounted for the largest proportion of weight loss variance across subgroups at each time point. Therefore, we focused on the fully-adjusted models. Noteworthy is the high proportion of variance accounted for in the models among minority men; the prediction models are strong within these subgroups even into Year 8.

Among African-American men, daily self-weighing frequency was the strongest predictor of weight loss at Year 1. At Year 8, the strongest predictors were individual session attendance and self-reported reductions in calorie intake. Among African-American women, self-reported use of meal replacements and daily self-weighing had the strongest relationships with weight loss at Year 1, with more frequent self-weighing associated with better weight losses but greater meal replacement use associated with poorer weight losses. Daily self-weighing remained strongly associated with weight loss at Year 8 among African-American women, and group session attendance emerged as an additional robust predictor.

Year 1 models among Hispanic men and women were also robust, with R^2 values of 44-45% in the fully-adjusted models. Individual session attendance and increased self-reported exercise were the stronger predictors of weight loss among Hispanic men. Among Hispanic women, both individual and group session attendance were strongly associated with weight loss in Year 1. By Year 8, factors most strongly predictive of weight loss among Hispanic men were self-weighing and self-reported reduced fat intake, with 50% of the weight loss variance explained in the fully-adjusted model. Among Hispanic women, higher rates of dietary self-monitoring emerged as the strongest predictor of Year-8 weight loss.

Models for White men and women explained the smallest proportion of variance in weight loss observed, with only 16% and 19% of variance accounted for at Year 1 among men and women, respectively. Exercise self-monitoring was prominent for both sexes among the variables predicting Year 1 weight loss, and group session attendance also emerged as a strong factor among women. In Year 8, self-weighing was the strongest behavioral factor

associated with weight loss among both sexes, but meal replacements also were strongly related to weight loss outcomes in men.

Multivariable models examining the relative importance of daily weighing and session attendance (group and individual) with weight change indicated that both intervention session attendance measures and daily weighing were significantly ($p<0.001$) and independently associated with weight change at each assessment. We also examined whether there were differences in the strength of associations these markers had with weight changes between sexes and among race/ethnicity groups using tests of interaction. No interactions were significant at Year 1. At Year 4 ($p=0.04$) and Year 8 ($p=0.001$), there was some evidence that individual session attendance had stronger relationships with weight changes among Hispanics (both Years 4 and 8) and African Americans (only at Year 8) than among non-Hispanic whites. Associations between self-weighing and weight changes did not vary significantly among sexes and race/ethnicity groups at Years 4 and 8.

Discussion

These descriptive analyses provide unique insights into the lifestyle intervention experiences of minority men and women with T2DM and shed light on long-term behavioral practices and weight loss outcomes within these under-characterized groups. Significant differences in weight loss after one year in the ILI have been reported previously such that non-Hispanic whites lost more than Hispanics and African Americans,[9] as has the observation that these weight loss differences had abated by Year 8.[10] The current data extend these earlier reports by providing specific weight loss outcomes by race/ethnic-sex subgroups, following in the tradition of other notable multi-site trials.[16-18] These data begin to redress the “serious deficiency of published research” on weight loss outcomes among minority ethnic groups in general[19] and the specific void with respect to weight losses achieved in long-term lifestyle programs by minority populations with diabetes.[20]

Few process data on engagement in long-term behavioral weight control programs are available for minority individuals with T2DM. Session attendance and other process data such as self-monitoring rates are often reported, but typically are not presented by sex and race/ethnic group, despite frequent calls for data on these important parameters.[21] The lack of implementation data in diabetes management programs has been noted as well.[20] The current process data are the first of which we are aware that provide attendance and self-monitoring data for minority individuals with diabetes in a weight loss program, such that specific engagement patterns of men and women can be identified. Samuel-Hodge and colleagues report attendance rates for African-American adults (predominantly women) with T2DM engaged in a 6-month culturally-adapted, family-centered behavioral weight loss program; attendance averaged 75% of group sessions, but data do not differentiate between sexes and self-monitoring data are not reported.[22]

Weight losses achieved at Year 1 among African-American men (−6.8%) and women (−6.8%) are among the best reported in the literature to date, with other lifestyle interventions conducted in African-Americans with diabetes reporting weight losses of ≤ 4% after one year or less.[22-24] Indeed, the weight losses achieved at 1-year in other studies of

African-American individuals with diabetes were smaller, in many cases, than the weight losses sustained at 8-years among African-American men (−3.6%) and women (−6.3%) in the ILI, suggesting that the ILI is well-suited for African Americans. Daily self-weighing played a salient role in achieving these clinically-relevant weight losses for both African-American men and women. Given the paucity of research and outcome data on African-American men engaged in weight control,[21,25] information on the experiences of this subgroup fills a critical gap in the clinical literature. Similarly, these long-term data on weight control strategies among African-American women with T2DM extend our knowledge on factors associated with successful behavioral weight control.

Process data for Hispanic men and women with diabetes enrolled in behavioral weight control are lacking as well, particularly for Hispanic men. Studies that report attendance data for Hispanics with T2DM in weight management programs indicate low-to-modest attendance over 6-12 months.[26,27] In the ILI, session attendance was high in Year 1 among both Hispanic men and women, and Hispanic women had the highest average attendance of all the subgroups. Individual session attendance emerged as one of the stronger predictors of weight loss in the first 4 years for Hispanic men; among Hispanic women both group and individual session attendance were independent predictors of weight loss early in the ILI and group attendance continued to play a central role at Year 4. These data underscore suggestions that intervention delivery approaches effective for men may differ from those effective for women,[8] and individual sessions might be preferable for Hispanic men but Hispanic women appear to benefit from a combination of group and individual delivery.

The question of whether individual or group intervention sessions produce better weight loss is an important clinical matter with few data to guide program decisions. Earlier research suggested group behavioral weight control sessions achieved better outcomes than individually-delivered programs for individuals without diabetes,[28] but not all studies support this.[29] Group sessions (with other family members) may produce slightly greater weight losses than individual sessions for Hispanic women without diabetes, although the difference was not statistically significant and both group and individual sessions produced better weight losses than a comparison condition.[30] No other studies of which we are aware have explored the contributions of individual compared with group sessions for minority individuals with diabetes; thus, our finding about the differentially greater impact of individual sessions on extended weight loss outcomes among minority participants compared with Non-Hispanic Whites expands the existing literature, and suggests that individual sessions may be particularly important to incorporate into weight control programs for minority populations. This is borne out in the race/ethnic-sex-specific models exploring predictors of weight loss; individual sessions emerged as a key predictor among African-American and Hispanic men. Our findings align with suggestions that individual sessions which allow intervention content tailoring may be particularly beneficial for minority men.[8]

Behavioral weight control practices used by minority individuals in a lifestyle program are not well-documented, although cross-sectional national data suggest that the strategies utilized may be similar to those reported by non-Hispanic Whites, at least when broad-stroke classifications are employed (e.g., diet alone, exercise alone, or the combination); however,

the narrow range of strategies assessed in these studies precluded a detailed assessment of the specific practices used.[31] Self-weighing has been shown to be an effective weight management strategy in populations without diabetes, but these studies lack men and minorities.[32] Overall, less than half of individuals entered the ILI self-weighing at least weekly, but those who did tended to weigh less at study entry.[14] The current report suggests that daily self-weighing has potential for good uptake among minority men and women, and the behavior promotes successful weight loss in some subgroups, particularly African-American men and women with diabetes. Other intervention studies have reported low rates of self-weighing among African-American men,[33] suggesting more detailed exploration of this practice may be warranted.

Meal replacement use was another weight-control practice with strong initial uptake that was similar across the race/ethnic-sex subgroups. The contribution of meal replacements to sustained weight control in the aggregate ILI group has been reported previously.[10] The current data extend earlier reports to document utilization patterns within the race/ethnic–sex groups. Although there are reports of promising results using meal replacements in predominantly minority patient groups,[34] concerns about the acceptability of meal replacements, shakes and prepackaged foods within minority groups have been raised.[35,36] In the ILI, however, uptake was strong across all the subgroups in Year 1 and utilization continued to be high through Year 4. Utilization waned over time, however, despite continued provision. Given evidence that the use of liquid and portion-controlled meal replacements increases weight loss by 2-4 kg,[37] it is surprising that we observed diminished weight loss/weight gain with greater self-reported use of meal replacements among African-American women in Year 1. This novel and unexpected finding has not been reported previously, although we know of no studies which examine the unique contribution of meal replacements to understanding weight losses among African-American women. Further investigation of meal replacement use in minority populations is required to confirm these patterns and inform discussions of whether meal replacements should be emphasized in weight loss programs for African-American women.

Self-monitoring of dietary intake and physical activity is another established correlate of successful weight loss,[32] but did not emerge as a strong independent predictor of weight loss across all subgroups. Among Hispanic men, White men, and White women, self-monitoring of exercise was a key factor in weight loss at varying points in treatment. However, these associations may reflect exercise frequency as much as the actual self-monitoring practice. Those who had accrued moderate-to-vigorous physical activity minutes may have been more likely to provide self-monitoring data and, thus, self-monitoring may have been confounded with exercise patterns.

This study adds substantially to what is known about the outcomes and treatment engagement of individuals with T2DM enrolled in a long-term behavioral weight management program, and the specific weight management strategies associated with weight loss for individual race/ethnic-sex subgroups. These data characterize the largest sample of African-American and Hispanic men and women with T2DM in a behavioral obesity intervention studied to date and provide a springboard for considering approaches to tailor interventions to these populations. However, the study has limitations that must be

considered. Participation in the ILI required substantial commitment and burden; therefore, trial volunteers may differ from the general population of individuals with diabetes in important ways such that findings are generalizable only to a subset of the general population. Further, critical data on weight control practices are self-reported and subject to bias and recall error. Another important study limitation is that only the ILI treatment group is considered. There was also substantial weight loss in the comparison DSE group,[10] presumably due to aging and increasing duration of diabetes. Therefore, the full magnitude of weight loss reported here cannot be attributed solely to ILI treatment effects. In addition, although this report begins to address important gaps in the research on weight loss, treatment engagement and weight control strategies using data from the largest sample of minority men with diabetes studied to date, the numbers of African-American and Hispanic men are relatively modest in absolute terms (≤100 individuals). Finally, these are post-hoc, exploratory analyses which remain to be confirmed prospectively by experimental studies. Nonetheless, these data can spur important conversations about the experiences of minority populations in behavioral obesity treatment programs and how to design interventions to optimize outcomes in these high-risk subgroups.

Conclusions

As the prevalence of T2DM increases among racial/ethnic minority men and women, diabetes management approaches effective in these populations are critical and the need to understand the treatment engagement patterns and behavioral weight control practices of these understudied groups becomes more pressing. Race/ethnicity-sex-specific process data from the Look AHEAD ILI begin to address these gaps in the literature. The weight losses in the largest racial/ethnic minority sample to date are among the best reported, with excellent attendance at both group and individual sessions in Year 1, and continued engagement above protocol-specified thresholds throughout. Attendance at individual sessions were particularly important for treatment success among Hispanic and African-American men. Daily self-weighing emerged as a pivotal weight management strategy for initial weight loss among African-American men and women and continued to be associated with weight maintenance in African-American women but was not as critical among Hispanic men and women. Meal replacement use, though robust in the first year, was not a strong, independent predictor of weight loss among Hispanics or African-American men, but was a strong factor associated with poorer weight losses among African-American women. These data markedly expand what is known about the weight loss experiences of minority men and women with diabetes, particularly minority men, and provide insights for intervention design.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Study Importance

What is already known about this subject?

- Racial/ethnic minority men and women have high rates of obesity and diabetes, but few studies of lifestyle interventions provide data on weight losses, treatment adherence and weight control practices by sex within race/ethnic group to shed light on the weight loss experiences of these individual subgroups.
- The Look AHEAD trial Intensive Lifestyle Intervention (ILI) successfully produced weight losses over 8 years of follow-up in a diverse cohort of participants, including substantial numbers of African-American and Hispanic men and women.

What does your study add?

- Minority men and women have high rates of engagement in both individual and group sessions of an intensive lifestyle intervention, and individual session attendance appears to be particularly influential on weight loss outcomes among Hispanic and African-American men
- Daily self-weighing uptake among individuals with overweight/obesity and type 2 diabetes is strong and contributes to weight loss success for up to 8 years, particularly among African-American men and women
- Uptake of meal replacements among minority participants was strong but may not contribute uniquely to the variance in weight loss, except among African-American women for whom greater self-reported utilization was associated with poorer weight losses

Table 1.

Baseline characteristics and retention of Intensive Lifestyle Intervention Group by race/ethnic-sex subgroups

		Non-Hispanic White N=1,621 (63%)		African American N= 400 (16%)		Hispanic N= 340 (13%)	
	Total Sample	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Randomized to ILI (% of intervention group) *	2570	786 (31%)	835 (32%)	97 (4%)	303 (12%)	100 (4%)	240 (9%)
Age (mean years±SE)	58.6±0.1	60±0.2	58.5±0.2	58.7±0.7	57.6±0.4	57.9±0.7	56.4±0.4
Weight (mean kg±SE)	100.6±0.4	110±0.7	96.9±0.6	112.9±1.9	98.0±1.0	100.4±1.7	86.9±1.1
BMI, N (%)							
<30 kg/m^2	403 (15.7)	115 (14.6)	115 (13.8)	13 (13.4)	45 (14.9)	17 (17.0)	46 (19.2)
30-34.99 kg/m^2	918 (35.7)	328 (41.7)	263 (31.5)	32 (33.0)	89 (29.4)	47 (47.0)	92 (38.3)
≥35 kg/m^2	1249 (48.6)	343 (43.6)	457 (54.7)	52 (53.6)	169 (55.8)	36 (36.0)	102 (42.5)
Education (years)							
<13 years	509 (19.8)	73 (9.3)	152 (18.7)	19 (19.6)	51 (17.2)	37 (37.8)	132 (55.5)
13-16 years	947 (36.8)	245 (31.4)	318 (39.1)	39 (40.2)	147 (49.5)	36 (36.7)	69 (29.0)
>16 years	1067 (41.5)	463 (59.3)	343 (42.2)	39 (40.2)	99 (33.3)	25 (25.5)	37 (15.5)
Attended outcome data collection visit, N (%)							
1 year	2475 (96.3)	758 (96.4)	807 (96.6)	95 (97.9)	295 (97.4)	93 (93.0)	224 (93.3)
4 years	2351 (91.5)	719 (91.5)	776 (92.9)	91 (93.8)	275 (90.8)	81 (81.0)	208 (86.7)
8 years	2218 (86.3)	669 (85.1)	733 (87.8)	87 (89.7)	260 (85.8)	77 (77.0)	201 (83.8)

*The percentages add to less than 100% because other race/ethnic groups were omitted from these analyses.

**Attended follow-up data collection visit

Table 2.

Weight change by race/ethnic-sex subgroups within Weight change by race/ethnic-sex subgroups within Intensive Lifestyle Intervention (ILI)

		Non-Hispanic White		African American		Hispanic	
		Men	Women	Men	Women	Men	Women
		N=786	N=835	N= 97	N=303	N=100	N=340
Average (±SE) percent weight change from baseline							
	1 year	−10.0±0.3	−9.1±0.3	−6.8±0.5	−6.8±0.3	−7.5±0.6	−8.1±0.4
	4 years	−5.6±0.3	−4.5±0.3	−3.2±0.6	−4.3±0.5	−4.1±0.8	−5.0±0.6
	8 years	−5.1±0.3	−5.5±0.4	−3.6±0.9	−6.3±0.6	−2.7±1.2	−5.8±0.7
Average (±SE) weight change (kg) from baseline							
	1 year	−11.1±0.3	−8.9±0.3	−7.7±0.7	−6.7±0.3	−7.4±0.6	−7.0±0.4
	4 years	−6.4±0.3	−4.5±0.3	−3.5±0.7	−4.4±0.5	−3.7±0.9	−4.5±0.5
	8 years	−5.9±0.4	−5.6±0.4	−3.7±1.1	−6.5±0.6	−2.3±1.3	−5.1±0.6
Proportion of Subgroup Achieving ≥ 5% Weight Loss [N (%)]							
	1 year	559 (73.7)	574 (71.1)	53 (55.8)	184 (62.4)	62 (66.7)	152 (67.9)
	4 years	349 (49.1)	342 (44.5)	38 (41.8)	116 (42.3)	31 (39.2)	102 (50.5)
	8 years	321 (48.6)	386 (53.3)	41 (47.7)	146 (56.4)	31 (41.9)	106 (54.4)
Proportion of Subgroup Achieving ≥ 10% Weight Loss [N (%)]							
	1 year	353 (46.6)	327 (40.5)	25 (26.3)	71 (24.1)	25 (26.9)	95 (42.4)
	4 years	190 (26.7)	172 (22.4)	8 (8.8)	55 (20.1)	18 (22.8)	53 (26.2)
	8 years	174 (26.4)	219 (30.2)	17 (19.8)	82 (31.7)	19 (25.7)	61 (31.3)

Table 3.

Treatment Engagement in ILI by race/ethnic-sex subgroups [Median(P25-P75)]

	Non-Hispanic White		African American		Hispanic	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Total Session Attendance						
0-12 months (42 expected by protocol)	38(33-41)	37(32-41)	37(33-40)	37(31-41)	36(31-39)	36(30-40)
13-48 months (36 expected by protocol)	35(22-49)	34(20-47)	33(21-42)	32(20-44)	29(12-44)	35(23-49)
49-96 months (8 expected by protocol)	23(11-39)	20(8-37)	21(10-37)	19(10-33)	20(9-37)	29(14-51)
Group Session Attendance						
0-12 months (30 expected by protocol)	27(22-30)	26(22-29)	26(22-29)	26(21-29)	25(20-28)	26(21-28)
13-48 months *	7(2-17)	8(2-17)	5(2-13)	7(2-15)	4(1-17)	9(3-22)
49-96 months *	1(0-8)	3(0-11)	2(0-7)	2(0-9)	1(0-11)	5(0-17)
Individual Session Attendance						
0-12 months (12 expected by protocol)	11(10-12)	11(9-12)	11(10-12)	11(10-12)	10(9-12)	11(9-12)
13-48 months *	27(18-34)	25(15-32)	29(19-33)	24(15-30)	23(10-30)	25(17-29)
49-96 months *	18(8-31)	14(6-27)	16(8-29)	14(8-23)	17(8-32)	23(12-36)
Self-Monitored Exercise (sum total days within period)						
0-12 months	156(91-204)	132(77-189)	121(66-189)	123(63-176)	178(96-219)	164(101-220)
13-48 months	63(20-132)	45(15-98)	42(18-115)	38(13-83)	69(20-130)	103(29-153)
49-96 months	19(4-60)	12(2-42)	23(7-71)	14(4-35)	30(11-82)	78(19-139)
Self-Monitored Diet (sum total days within period)						
0-12 months	167(88-226)	158(91-214)	123(61-199)	139(80-203)	181(71-242)	187(120-244)
13-48 months	32(5-106)	26(4-78)	7(0-60)	18(0-67)	52(7-131)	90(12-173)
49-96 months	4(0-21)	0(0-20)	0(0-12)	0(0-14)	7(0-63)	56(0-155)

* The protocol did not specify type of contact expected (individual or group sessions) during months 13-48 nor for months 49-96; total contact was the only parameter specified. Optional group sessions were offered at least monthly and individual sessions could be scheduled at the request of participants. One campaign and one refresher were conducted annually and could be administered by either group or individual sessions, depending upon participant preference.

Table 4.

Self-reported behavioral weight control strategy use among ILI participants by race/ethnic-sex subgroups

		Non-Hispanic White		African American		Hispanic	
		Men	Women	Men	Women	Men	Women
Weighed Self Daily [N(%)]							
	Baseline	120 (15.3)	112 (13.4)	8 (8.2)	24 (7.9)	9 (9.0)	19 (7.9)
	1 year	425 (56.7)	415 (51.7)	44 (47.3)	100 (34.6)	33 (35.9)	70 (32.0)
	4 years	335 (47.4)	287 (37.4)	30 (34.9)	71 (26.5)	22 (27.2)	35 (17.1)
	8 years	283 (42.4)	284 (39.0)	26 (30.2)	67 (26.1)	18 (23.7)	33 (16.5)
Weighed Self Weekly [N(%)]							
	Baseline	376 (47.8)	392 (46.9)	41 (42.3)	85 (28.1)	31 (31.0)	63 (26.3)
	1 year	714 (95.3)	760 (94.6)	91 (97.8)	266 (92.0)	81 (88.0)	203 (92.7)
	4 years	603 (85.4)	603 (78.5)	67 (77.9)	186 (69.4)	56 (69.1)	130 (63.4)
	8 years	527 (78.9)	546 (74.9)	57 (66.3)	168 (65.4)	42 (55.3)	111 (55.5)
Reduced calorie intake (number weeks/year) Median(P25-P75)							
	Baseline	0(0-10)	4(0-14)	0(0-12)	2(0-12)	0(0-8)	0(0-10)
	1 year	50(40-52)	48(37-52)	45(30-52)	46(30-52)	51(38-52)	52(36-52)
	4 years	16 (0-50)	12(0-40)	20 (4-50)	20(3-50)	7(0-48)	15(0-52)
	8 years	8(0-30)	8(0-30)	15(0-40)	10(0-40)	9(0-49)	13(0-52)
Reduced fat (number weeks/year) Median(P25-P75)							
	Baseline	0(0-12)	4(0-20)	4(0-22)	4(0-24)	5(0-26)	10(0-50)
	1 year	50(40-52)	48(40-52)	50(36-52)	48(36-52)	52(40-52)	52(40-52)
	4 years	24(0-52)	16(0-50)	26 (4-50)	25(4-50)	20(2-52)	30(4-52)
	8 years	7(0-45)	9(0-44)	13(0-50)	18(0-49)	26(0-52)	26(0-52)
Used meal replacements (number weeks/year) Median(P25-P75)							
	Baseline	0(0-0)	0(0-0)	0(0-0)	0(0-0)	0(0-0)	0(0-0)
	1 year	48(36-52)	45(32-52)	44(35-52)	48(31-52)	51(33-52)	52(33-52)
	4 years	30(1-52)	24(0-50)	25(2-45)	20(2-45)	24(0-52)	26(1-52)
	8 years	8(0-40)	8(0-30)	8(0-40)	10(0-36)	11(0-40)	12(0-52)
Increased exercise (number weeks/year) Median(P25-P75)							
	Baseline	2(0-15)	4(0-16)	0(0-10)	4(0-15)	0(0-18)	3(0-24)
	1 year	45(30-52)	40(30-52)	40(25-50)	40(26-50)	42(26-52)	48(26-52)
	4 years	4 (0-26)	4(0-26)	4 (0-14)	4(0-26)	0(0-26)	0(0-21)
	8 years	0(0-20)	0(0-16)	0(0-14)	3(0-24)	0(0-30)	0(0-20)

Table 5.

Multivariable Models of Predictors of Weight Loss (% Weight Change) Among ILI Participants by Race/Ethnic-Sex Subgroups with Standardized Regression Coefficients

Year 1												
	White				**African American**				**Hispanic**			
	Men (N=786)		**Women (N=835)**		**Men (N=97)**		**Women (N=303)**		**Men (N=100)**		**Women (N=240)**	
Model Number:	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Model R^2 value:	**0.139**	**0.164**	**0.178**	**0.186**	**0.369**	**0.444**	**0.228**	**0.265**	**0.396**	**0.441**	**0.453**	**0.453**
Treatment Engagement Measures												
0-12 Month Group Session Attendance	−2.12	−2.02	−3.10	−3.00	−0.71	−0.71	−0.32	−0.48	−0.96	−0.81	−1.76	−1.66
0-12 Month Individual Session Attendance	−1.02	−1.03	−2.35	−2.05	0.21	0.23	−1.63	−1.53	−2.17	−1.72	−2.09	−1.80
0-12 Month Self-Monitored Diet (sum total days/wk)	−2.46	−1.19	−2.33	−1.78	−0.93	−1.17	−3.41	−1.38	−0.24	−0.32	−1.94	−1.28
0-12 Month Self-Monitored Ex (sum total days/wk)	−4.09	−2.15	−2.81	−2.38	−1.36	−1.23	−1.14	−1.08	−0.54	0.30	−0.48	−0.07
Self-Reported Behavioral Weight Control Practices*												
Year 1 Daily Self Weighing (%)		−1.64		−2.17		−2.30		−1.88		−0.22		−0.89
Year 1 Reduced kcal (number wk/year)		−1.14		−1.17		0.29		−1.75		0.90		−0.01
Year 1 Reduced fat (number wk/year)		−0.05		−0.86		1.06		−1.08		−0.87		0.19
Year 1 Increased exercise (number wk/year)		−3.29		0.36		−0.71		−0.33		−1.24		−1.13
Year 1 Used Meal Replacements (number wk/year)		0.80		1.49		−0.78		2.23		−0.22		0.16
Year 4												
Model Number:	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Model R^2 value:	**0.172**	**0.210**	**0.126**	**0.152**	**0.234**	**0.409**	**0.128**	**0.155**	**0.314**	**0.363**	**0.256**	**0.305**
Treatment Engagement Measures												
13-48 Month Group Session Attendance	−1.85	−1.49	−1.48	−1.37	1.14	0.76	−0.23	−0.40	−0.15	0.08	−2.17	−1.69
13-48 Month Individual Session Attendance	−1.61	−0.75	−0.67	0.08	−2.31	−1.25	−0.08	−0.01	−2.13	−1.85	−0.17	−0.39
13-48 Month Self-Monitored Diet (sum total days/wk)	−1.39	−1.06	−1.03	−1.11	0.51	0.89	−1.27	−0.66	−0.24	0.03	−0.45	−0.06
13-48 Month Self-Monitored Ex (sum total days/wk)	−4.83	−3.58	−3.46	−2.99	−0.62	0.44	−1.18	−1.13	−0.39	−0.41	−2.17	−1.80
Self-Reported Behavioral Weight Control Practices*												
Year 4 Daily Self Weighing (%)		−3.96		−4.56		−1.66		−1.45		0.76		−2.42

Year 1												
	White				African American				Hispanic			
	Men (N=786)		Women (N=835)		Men (N=97)		Women (N=303)		Men (N=100)		Women (N=240)	
Model Number:	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Model R^2 value:	**0.139**	**0.164**	**0.178**	**0.186**	**0.369**	**0.444**	**0.228**	**0.265**	**0.396**	**0.441**	**0.453**	**0.453**
Year 4 Reduced kcal (number wk/year)		0.94		−0.38		1.07		0.51		−1.90		−1.23
Year 4 Reduced fat (number wk/year)		−0.66		1.18		−1.39		−1.96		1.16		−1.29
Year 4 Increased exercise (number wk/year)		−1.00		−0.75		−2.16		1.01		0.24		0.42
Year 4 Used Meal Replacements (number wk/year)		−3.43		−0.19		−0.09		0.34		−0.77		1.27
Year 8												
Model Number:	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Model R^2 value:	**0.080**	**0.114**	**0.095**	**0.115**	**0.250**	**0.300**	**0.157**	**0.182**	**0.254**	**0.500**	**0.234**	**0.219**
Treatment Engagement Measures												
49-96 Month Group Session Attendance	−1.12	−0.81	−1.65	−1.50	−0.25	−0.50	−1.68	−1.41	−0.49	0.92	−0.31	−0.23
49-96 Month Individual Session Attendance	−0.19	0.32	−0.52	−0.38	−1.93	−1.54	−0.45	0.05	−0.37	0.03	0.04	0.05
49-96 Month Self-Monitored Diet (sum total days/wk)	−0.81	−0.54	0.97	1.37	−0.23	0.00	0.46	0.49	−0.46	0.80	−3.31	−2.54
49-96 Month Self-Monitored Ex (sum total days/wk)	−2.69	−1.72	−1.88	−1.29	0.19	0.18	−1.44	−1.07	−1.30	−0.79	−0.24	0.69
Self-Reported Behavioral Weight Control Practices *												
Year 8 Daily Self Weighing (%)		−2.83		−2.65		−0.68		−2.05		−2.09		−0.79
Year 8 Reduced kcal (number wk/year)		−0.65		0.08		−1.21		−0.18		−0.54		−1.27
Year 8 Reduced fat (number wk/year)		1.58		−1.52		1.06		−0.26		−3.66		0.53
Year 8 Increased exercise (number wk/year)		−1.97		−1.25		0.03		0.48		1.39		1.41
Year 8 Used Meal Replacements (number wk/year)		−2.46		0.88		−0.86		−0.84		0.34		−0.48

All models adjusted for age, baseline BMI, education and clinical site. The standardized coefficients we report can be interpreted as z-statistics, with those exceeding ±1.96 being bounded away from 0 with respect to 95% confidence intervals, those exceeding ±2.58 being bounded away from 0 with 99% confidence intervals, and those exceeding ±3.32 being bounded away from 0 with 99.9% confidence intervals.

Model 1 includes treatment engagement measures

Model 2 includes treatment engagement measures + self-reported behavioral weight control practices

* Behavioral weight control practices were self-reported for the year prior to weight measurement as the number of weeks over the previous year the participant engaged in that behavior.