4-1-2014

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HHS Public Access

Author manuscript

J Acad Nutr Diet. Author manuscript; available in PMC 2015 April 01.

Published in final edited form as:

J Acad Nutr Diet. 2014 April ; 114(4): 603–612. doi:10.1016/j.jand.2013.11.020.

HUB City Steps: A 6-month lifestyle intervention improves blood pressure among a primarily African American community

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Abstract

The effectiveness of community-based participatory research (CBPR) efforts to address the disproportionate burden of hypertension among African Americans remains largely untested.

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The objective of this 6-month, non-controlled, pre- post- experimental intervention was to examine the effectiveness of a CBPR intervention in achieving improvements in blood pressure (BP), anthropometric measures, biological measures, and diet. Conducted in 2010, this multicomponent, lifestyle intervention included motivational enhancement, social support provided by peer coaches, pedometer diary self-monitoring, and monthly nutrition and physical activity education sessions. Of 269 enrolled participants, most were African American (94%) females (85%). Statistical analysis included generalized linear mixed models using maximum likelihood estimation. From baseline to 6-months, systolic BP [126.0 (SD=19.1) to 119.6 (SD=15.8) mmHg; p=0.0002] and diastolic BP [83.2 (SD= 12.3) to 78.6 (SD=11.1) mmHg; p<0.0001] were significantly reduced. Sugar intake also decreased significantly as compared to baseline (by approximately three teaspoons; p<0.0001). Time differences were not apparent for any other measures. Results from this study suggest that CBPR efforts are a viable and effective strategy for implementing non-pharmacologic, multicomponent, lifestyle interventions that can help in addressing the persistent racial and ethnic disparities in hypertension treatment and control. Outcome findings help fill gaps in the literature for effectively translating lifestyle interventions to reach and engage African American communities to reduce the burden of hypertension.

Keywords

hypertension; community-based participatory research; nutrition; physical activity; behavior modification

Background

Epidemiological studies have consistently demonstrated that hypertension (HTN) is linked to increased risk for cardiovascular and cerebrovascular events.[1, 2] It is estimated that about one in three adults have HTN in the United States, yet racial and ethnic disparities are persistent with higher rates among African Americans (40.7%) when compared to whites (27.4).[3] Given that HTN can be asymptomatic, it is frequently undetected and untreated since individuals do not seek medical care for this ‘silent’ condition. It has been estimated that as many as two-thirds of those in the United States with HTN are undertreated or untreated.[4]

Numerous risk factors contribute to HTN (e.g., age, race, family history), including two modifiable factors: physical inactivity and poor dietary habits. The efficacy of non-pharmacological, lifestyle, and behavioral interventions delivered through clinical or primary care settings, and under highly controlled conditions, has been well documented.[5–7] Recently, there has been increased emphasis on translating these efficacious behavioral strategies into real-world clinical[8, 9] and community practice settings[10, 11], as well as scalable technology-based modes of dissemination.[12, 13] However, the ability to reach and effectively address the disproportionate HTN burden among African Americans remains largely unknown. In light of persistent racial and ethnic disparities in prevalence, treatment, and control of HTN,[4] development and implementation of culturally relevant, non-clinically based programs targeting at-risk minority communities is warranted. When targeting socio-economically disadvantaged and racial/ethnic communities, recent reviews highlight the importance of multicomponent and theoretically based interventions.[14, 15]

When developing health programs in minority communities that address numerous HTN risk factors (e.g. dietary patterns, physical activity, and weight related behaviors), engaging community members and attending to core social values are especially important.[16, 17] Community-based participatory research (CBPR) is one useful approach to equitably and collaboratively engage community-academic teams in all phases of the research process. While CBPR has been recognized as a culturally sensitive approach to translate research into practice and reduce health disparities, evidence related to the effectiveness of CBPR initiatives on health outcomes is lacking.[18–20] The primary aim of this paper is to examine the effectiveness of HUB City Steps (HCS), a 6-month, CBPR, multicomponent, lifestyle intervention, in achieving improvements in blood pressure (BP), anthropometric measures, biological measures, and diet in an African American population.

Methods

Targeted community

HUB City Steps targeted Hattiesburg, a mid-sized city in southeast Mississippi of approximately 45,000 residents, 53% African American and 42% White, with a median household income is $27,144.[21] Prevalence of HTN among non-Whites in Hattiesburg's public health district is estimated at 43%.[22]

Study design

The University of Southern Mississippi's Institutional Review Board approved all phases of this research, and written informed consent was obtained prior to study enrollment. The HCS community advisory board (CAB) was composed of 21 members from local city and county government agencies (including the city of Hattiesburg, the formal community partner) n=5), public and private health/medical clinics and agencies (n=9), educational organizations n=4), and private, non-profit organizations (n=3), as well as eight academic members and three community intervention staff. Complete details on the role of the HCS CAB and study methodology including design, conceptual framework, intervention description, delivery agents, and community engagement are published elsewhere.[23–25]

Driven by the CBPR approach, HCS used a two-phase research design. The first phase, a 6-month pre- post- experimental intervention targeting HTN risk factors, is the focus of this manuscript. This phase was executed January-August 2010.

Although not the focus of this paper, phase two was a 12-month maintenance intervention designed to test treatment effects of participants randomized to a low versus high (i.e., 4 versus 10) dose of telephone-delivered ME sessions. This study was powered (80% power; alpha of 0.05) to detect differences between treatment groups at 18-months on systolic BP (SBP), while controlling for 6-month intervention treatment effects. Anticipating a 20% attrition rate at 18-months, 267 participants were enrolled. The projected sample at 18-months provides 80% power to detect a moderate effect size of 0.4 [difference of 6 (SD=15) mmHg between groups].

In addition to applying the CBPR approach and building upon previous community-based lifestyle feasibility trials,[26–28] HCS integrated concepts from several theoretical frameworks

including social support,[29, 30] Self-Determination Theory,[31, 32] and the Transtheoretical Model of Change.[33] Furthermore, the intervention and feedback approach was consistent with motivational enhancement (ME), an adaptation of motivational interviewing.[34] Motivational enhancement is a manualized adaptation of motivational interviewing that focuses on using personalized feedback [35, 36] while motivational interviewing is a non manualized style of communication.[34] During the first 6-month phase, there was no control group, and hence no randomization. All enrolled participants were offered the same intervention which included ME provided by intervention staff, social support provided by walking group volunteer leaders (designated "coaches"), pedometer diary self-monitoring, and five education sessions. To promote intervention fidelity, manuals of procedures were developed and implemented.

At the conclusion of each of the three data collection time points (baseline, 3-months, and 6-months) participants engaged in an approximate 20 minute one-on-one ME session with a trained counselor. Training of ME counselors followed evidence-based procedures.[37, 38] Fidelity monitoring has been previously described and included client evaluations, counselor checklists and self-evaluation in conjunction with review by study investigators.[24] Participants received an individualized 'Know Your Numbers' card that illustrated their values for SBP, diastolic blood pressure (DBP), waist circumference, BMI, total cholesterol, low-density lipoprotein, high-density lipoprotein, blood glucose, and dietary intake (fruits and vegetables, fiber, sugar, calcium, dairy). This card served as a central point of the ME discussion, aimed at developing an individualized health behavior change plan.

Related to the social support and walking components, coaches were indigenous community members who were trained to recruit participant team members and serve as liaisons between walking group members and research staff. Coaches also provided support to encourage walking, goal setting, and submission of pedometer diaries. Participants received a pedometer (Yamax model SW-701, Yamax Corporation, Tokyo, Japan) and were instructed to wear it on the waist during waking hours and to reset it to zero each morning. Participants self-monitored and recorded their daily steps on weekly pedometer diary postage-paid postcards or by logging into the intervention's website.

The 90-minute monthly education sessions focused on the principles of the Dietary Approaches to Stop Hypertension (DASH) diet,[39] were guided by the processes of change[33] and included group physical activity and sharing of successes and challenges. The processes of change include experiential (e.g., consciousness raising, environmental reevaluation) and behavioral processes (e.g., helping relationships, counter-conditioning) used to progress participants through stages of change.[33] Six local community health professionals, including four health educators and/or registered dietitians as well as two fitness instructors, were trained to lead the education sessions. Research staff provided fidelity monitoring of education sessions.[24] To track education session attendance, all participants completed a sign-in form upon arriving at the session.

Recruitment & eligibility

HUB City Steps was broadly publicized using flyers and word of mouth and awareness was aided through efforts of community intervention staff, city staff, CAB members, walking

coaches, and other community stakeholders. Due to the variety of methods used to publicize the intervention, a precise count of targeted participants exposed to recruitment efforts is difficult to ascertain. Nonetheless, through a series of 12 different community events and documented attendance rates, an estimated 1,060 individuals were exposed to recruitment activities in the months preceding the intervention kick-off (i.e. July-December 2009). Recruitment efforts were primarily directed toward African American residents; however, race/ethnicity was not an exclusion criterion. Eligibility criteria included 18 years of age or older, English speaking, non-institutionalized, and resident of the Hattiesburg area. Screened individuals with BP >180/110 were directed to obtain immediate medical attention and were disqualified from participating; however, all other individuals were eligible for study participation regardless of BP status and medication regimen. The main method of recruitment was through the coaches, who were directed to recruit 10–12 participants for their team.

Outcome measures

The primary outcome was BP while secondary outcomes included a variety of anthropometric, biological, dietary, and psychosocial measures. Outcome measures were assessed at baseline, 3-months, and 6-months at a conveniently located community center. A data collection manual of procedures was developed to standardize assessment procedures. Trained university staff executed data collection. Protocol required participants to be free from caffeine, tobacco, and exercise for one hour prior to assessments. Blood pressure was measured with an OMRON HEM-907XL automatic inflation sphygmomanometer (Kyoto, Japan). Two BP measurements were taken 2 minutes apart. For each, the factory-set OMRON values were set at 2 measurements with a 1 minute interval. If within 10 mmHG, the lowest of the two readings was recorded; if not, a third measure was taken. A portable stadiometer, Tanita Body fat analyzer model TBF-310T (Arlington Heights, Illinois), and Cholestech LDX Lipid Analyzer (Waltham, Massachusetts) were used to measure height, weight and body composition, and non-fasting cholesterol and glucose, respectively. Fitness was assessed using the six-minute walk test.[40, 41] Dietary intake was assessed using the National Cancer Institute's (NCI) 18-item, Five-Factor Screener.[42, 43] Additional questionnaire data included demographics, medical history, medication use, fasting, and smoking. Participants were compensated $15, $20, and $25, respectively, for their time involved in data assessments at successive time points.

Data analyses

All statistical analyses were performed using SAS® software, version 9.3 (SAS Institute Inc., Cary, NC). The significance level was set at 0.05 (0.025 for multiple comparisons). Descriptive statistics were used to summarize demographics, participation rates, and outcome variables. Chi square tests of association or Fisher's exact tests (categorical variables) and two sample t-tests (continuous variables) were used to compare baseline demographic characteristics and anthropometric and biological outcomes between two participant subgroups: study completers and non-completers. Completers were defined as participants who provided baseline and 6-month follow-up measures.

Generalized linear mixed models, utilizing maximum likelihood estimation, were used to test for significant time differences in outcome measures. Maximum likelihood estimation is an approach for handling missing data in repeated measures.[44] Time (baseline, 3-months, and 6-months) was modeled as a repeated measure using a first-order autoregressive covariance matrix structure. Custom contrasts were used to test for significant differences between baseline and 3- month follow-up, and between baseline and 6-month follow-up using a Bonferroni correction to account for multiple testing. The influence of baseline covariates [i.e., age, gender, marital status (married vs. other), educational attainment (<high school degree vs. high school degree/GED vs. ≥ some college), income status ($5,000 increments), smoking status, BP, and BMI] on outcome findings were explored using multivariable linear regression models. Changes in antihypertensive medication throughout the duration of the study were examined. Coach status was also considered in the analyses.

Results

Figure 1 illustrates the CONSORT diagram. Of the 345 participants who expressed interest and were screened for the study, 269 (78%) were enrolled, 24 of whom were coaches.

Accounting for coach status did not influence findings. For this reason and since coaches received the same ME session with a trained counselor, pedometer diary self-monitoring, and monthly nutrition and physical activity education sessions as non-coach participants, coach and non-coach participants are reported as one aggregate, referred to as participants.

Average educational session attendance was 1.7 (SD = 1.9) classes, with 35% of participants attending at least three of the five sessions. Mean pedometer diary submission was 16.1 (SD = 10.1) weeks, with 60% of participants submitting diaries for at least 14 of the 27 intervention weeks. Of the 269 enrolled participants, 227 (84%) and 190 (71%) were assessed at 3- and 6-month time points, respectively. The number of participants completing the ME sessions was identical to those completing the data assessments. There were no study-related adverse events.

Table 1 illustrates the baseline characteristics of the enrolled sample as well as comparisons between study non-completers and completers. The majority were African American (94%) and female (85%), with a mean age of 44 (SD= 12.2) years. The enrolled sample was well representative of the targeted population, with the exception of males.[24] Over 90% of the participants were classified as overweight or obese. Diagnosed high BP was self-reported by 113 (42%) participants, of which 95 reported taking prescribed antihypertensive medication. Furthermore, 97 (36%) had no self-reported medical history of HTN, yet measured clinical diagnosis of pre-HTN or HTN. As illustrated, non-completers were significantly younger, had higher mean BMI, and lower mean triglycerides at baseline compared to completers.

Results of the mixed model linear regression analysis for time differences in BP, anthropometric, biological, and diet measures are presented in Table 2. Time differences were apparent for both SBP and DBP, with significant decreases observed at both 3- and 6-month time points. As compared to baseline, SBP decreased by approximately 6 mmHg at both follow-up times, while DBP decreased by approximately 3 and 4 mmHg at the 3- and

6-month time points, respectively. Sugar intake also decreased significantly (by approximately 3 teaspoons) at 3- and 6-month time points as compared to baseline. Time differences were not apparent in any other measures.

When considering baseline covariates, gender (p=0.0002), higher income status (p=0.0003), higher baseline SBP (p<0.0001) and higher baseline BMI (p<0.0001), but no other covariates, significantly predicted SBP reductions. Likewise, gender (p=0.0248) and higher baseline DBP (p<0.0001)—but no other covariates—significantly predicted DBP reductions. Specifically, significant decreases in females (SBP -7.7; DBP -3.9 mmHg) were greater than non-significant decreases in males (SBP -0.9; DBP -1.0 mmHg). Eight participants reported a change in antihypertensive medication at either the 3- or 6-month time points. When removed from the analysis, interpretation of BP did not change. Related to sugar intake, four baseline covariates including gender (p<0.0001), higher income (p=0.0310), higher baseline blood glucose (p<0.0001), and higher baseline BMI (p=0.0018) significantly predicted reductions in sugar intake. Specifically, the significant reduction in sugar intake observed in females (-3.7 teaspoon) was different from the significant increase observed in males (2.7 teaspoon).

Discussion

When controlling for baseline covariates among enrolled participants, SBP and DBP were reduced by 7.3 (SD=17.0) and by 4.2 (SD=10.9) mmHg, respectively. The statistical or clinical interpretations did not change after excluding the very low proportion of participants that reported changes in antihypertensive medication, suggesting that medication change did not confound the significant reductions in BP from this lifestyle trial. The overall mean BP reductions in HCS are both statistically significant and clinically meaningful, especially in a primarily African American population.[45, 46] These findings can be compared to the PREMIER trial[7] and other CBPR and community-based approaches to reduce HTN.[47–49]

The PREMIER trial, one of the largest multicenter clinical trials targeting lifestyle factors to reduce HTN, included 810 participants with pre-HTN or HTN, of which 34% were African American.[7] PREMIER compared three treatments including advice only (i.e., one 30-minute individual session at baseline), established behavioral intervention (composed of four individual counseling meetings, 14 group meetings, and food and physical activity diaries), and established behavioral intervention plus DASH diet. At the 6-month follow-up, participants reduced their SBP by 6.6 (SD=9.2), 10.5 (SD=10.1), and 11.1 (SD=9.9) mmHg in the advice only, established behavioral intervention, and established behavioral intervention plus DASH diet groups, respectively. Given that the HUB City Steps trial did not have HTN eligibility criteria, it is not surprising that the magnitudes of BP change are comparatively larger for PREMIER which had HTN eligibility criteria (i.e., SBP >120 and/or DBP > 80 mmHg).

Several other CBPR teams have intervened on cardiovascular risk factors (e.g., diet and physical activity); unfortunately, most lack BP outcomes. Of two known CBPR trials with BP outcomes, inconsistencies between data presented in the tables and text in one study make interpretation of effects on BP difficult.[47] In another 6-month CBPR school worksite-

based program that included physical activity promotion, SBP was significantly reduced by approximately 3 mmHg among 187 participants, although no significant effects on DBP[48] were reported. While not a CBPR trial, the Coronary Health Improvement Project examined a 30-day lifestyle modification program delivered by trained volunteers in community settings. Among the 5,070 participants, both SBP and DBP significantly decreased, by 6.5 and 4.2 mmHg, respectively.[49]

Contrary to the research hypotheses, anthropometric and biological outcomes did not improve, nor did fitness or dietary outcomes, with the exception of sugar intake. These null findings counter other lifestyle HTN trials that have demonstrated significant improvements in weight, fitness, and numerous dietary quality indicators.[7, 50] It is of interest that there were significant BP improvements without significant reductions in weight. While weight reduction has generally been recognized as a strategy for the prevention and treatment of HTN, inconsistencies in the literature concerning both short- and long-term influences of weight loss on BP exist.[51–53] After pragmatically evaluating the appropriateness of measures typically found in efficacy trials (e.g., multiple 24-hour recalls, sub-maximal exercise tests), measures for this CBPR study were carefully chosen based on feasibility for use in a community setting and respondent burden, as well as available validity data.[40–43] However, it is reasonable to suggest that the Five-Factor Screener and six-minute walk test did not have sufficient sensitivity to detect changes.

Perhaps the most notable limitation of this study is the lack of a controlled, randomized design. CPBR has historically lacked rigorous research designs.[18, 19] As is common in community-engaged interventions, community-academic teams must balance pragmatic and political factors with rigorous scientific methods.[54] Despite the lack of a control condition in Phase 1 of this trial, attempts were made to maximize other aspects of scientific rigor including balancing both internal and external validity factors. While BP was only assessed on a single day, use of the OMRON and standardized protocol increases the accuracy of the BP measurements.

Since little is known about optimal dose of motivational interviewing or enhancement,[54] phase two of this trial and the 18-month follow-up assessment will address these literature gaps through random assignment of ME dose conditions. This project also includes a capacity-building component, and future efforts will describe processes to build local capacity for health promotion in the African American community. Additionally, these findings suggest focused attention is needed to help identify and target individuals who are most likely to not complete the study (e.g. younger, higher BMI). Finally, to more fully understand BP changes, additional analyses are needed to explore variables (e.g., intervention engagement, weight, dietary intake, physical activity) that may be on the causal pathways.

Conclusion

In conclusion, this is one of the first CBPR studies to evaluate the effects of a lifestyle intervention targeting BP and related outcomes. Notwithstanding the very broad inclusion criteria, a high proportion of enrolled participants had a self-report diagnosis of HTN or

undiagnosed pre-HTN or HTN. To effectively reach and engage African Americans in community settings, the HUB City Steps methodology and findings can be used by nutrition and health practitioners and researchers to translate lifestyle interventions designed to address HTN risk factors. Importantly, this study suggests that CBPR efforts are a viable and effective strategy for implementing non-pharmacologic, multicomponent, lifestyle interventions to address the persistent racial and ethnic disparities in HTN treatment and control.

Acknowledgements

We are particularly grateful for contributions from all members of the H.U.B City Step Community Advisory Board and the walking coaches and participants of the HUB City Steps study. We further acknowledge the research support provided by Karen Zynda, Diana Cuy Castellanos, Melissa Bonnell, Sarah McMurtry, Jeremy Noble, Dr. Charkarra Anderson-Lewis, Mary Beard, Latessa Minor, Martha Resavy, Dr. Ann Beardshall and Elmer Beardshall. We also appreciate Dr. Wendy Stinson's role in securing funding.

This research was supported by the National Institute on Minority Health and Health Disparities Award Number R24MD002787. The views expressed are solely those of the authors and do not reflect the official policy or position of the US government.

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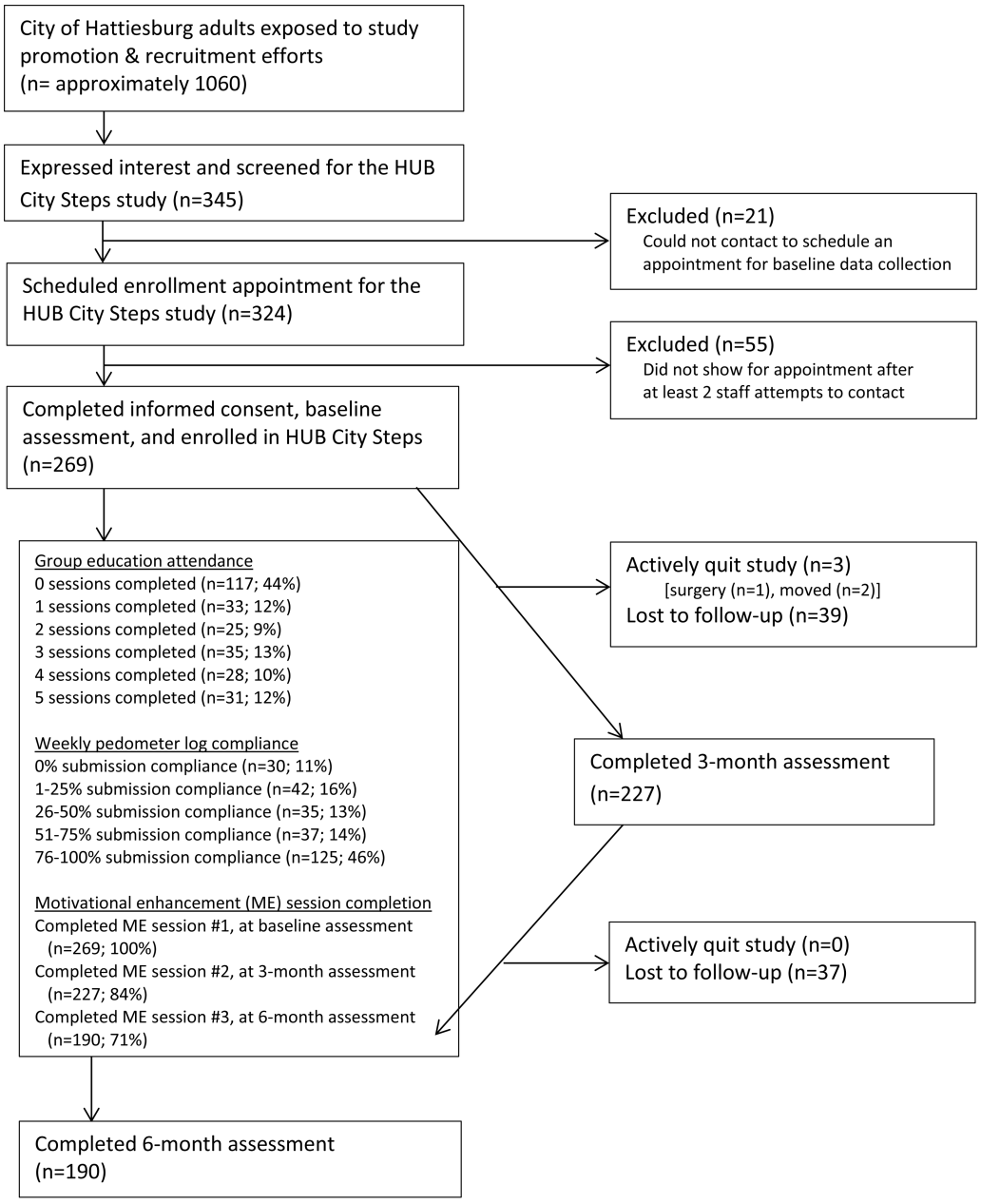

Figure 1. CONSORT diagram of screening, enrollment, and program participation rates for HUB City Steps

Figure 1.
CONSORT diagram of screening, enrollment, and program participation rates for HUB City Steps

J Acad Nutr Diet. Author manuscript; available in PMC 2015 April 01.

Table 1

Baseline characteristics of HUB City Steps participants and comparisons between 6-month study completers and non-completers

	All Participants (n=269)		Completers[a] (n=190)		Non-Completers[a] (n=79)		
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**p[b]**
Gender							NS
Male	40	14.9	29	15.3	11	13.9	
Female	229	85.1	161	84.7	68	86.1	
Race[c]							NS
African American	254	94.4	181	95.3	73	92.4	
White	14	5.2	9.0	4.7	6	7.6	
American Indian/Alaska Native	1	0.4	0.0	0.0	1	1.3	
Marital status[d]							NS
Married	113	42	81	42.6	32	40.5	
Widowed	12	4.5	11	5.8	1	1.3	
Divorced	47	17.5	34	17.9	13	16.5	
Separated	8	3.0	6	3.2	2	2.5	
Never married	89	33.1	58	30.5	31	39.2	
Education[e]							NS
Less than high school	12	4.5	10	5.3	2	2.5	
High school graduate/GED	41	15.2	29	15.3	12	15.2	
Trade or vocational school	13	4.8	7	3.7	6	7.6	
Some college	61	22.7	44	23.2	17	21.5	
College degree	76	28.3	50	26.3	26	32.9	
Some graduate/professional	19	7.1	15	7.9	4	5.1	
Graduate/professional degree	47	17.5	35	18.4	12	15.2	
Household income[f]							NS
<$10,000	40	14.9	30	15.9	10	12.7	
$10,000–$19,999	36	13.4	21	11.1	15	19.0	
$20,000–$29,999	54	20.1	42	22.2	12	15.2	

	All Participants (n=269)		Completers[a] (n=190)		Non-Completers[a] (n=79)		
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**p[b]**
$30,000–$39,999	37	13.8	25	13.2	12	15.2	
$40,000–$49,999	30	11.2	22	11.6	8	10.1	
>$50,000	71	26.5	49	25.9	22	27.8	
Current smoker	23	8.6	16	8.4	7	8.9	NS
Diagnosed high blood pressure	113	42.0	83	43.7	30	38.0	NS
Diagnosed high blood glucose	42	15.6	34	17.9	8	10.1	NS
Diagnosed high cholesterol	52	19.3	42	22.1	10	12.7	NS
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P**
Age (years)	44.3	12.2	46.5	11.6	39.0	12.1	<0.0001
Blood pressure (BP)							
Systolic BP (mm Hg)	126	19.1	126.9	19.6	123.8	17.9	NS
Diastolic BP (mm Hg)	83.2	12.3	82.9	12.1	84.0	12.7	NS
Anthropometric measures							
Waist circumference (cm)	102.1	18.1	100.7	16.3	105.3	21.6	NS
Body Mass Index (kg/m2)	34.7	8.1	33.9	7.6	36.5	9.1	0.0150
Body fat (%)	43.0	8.8	43.0	8.6	43.1	9.4	NS
Fat mass (kg)	42.5	17.5	41.4	16.5	45.2	19.6	NS
Lean body mass (kg)	53.2	11.1	52.3	10.2	55.4	12.9	NS
Biological measures							
Total cholesterol (mg/dL)	177.2	39.1	179.6	40.7	171.3	34.6	NS
High density lipoprotein (mg/dL)	51.9	15.0	52.3	14.5	51.2	16.1	NS
Low density lipoprotein (mg/dL)	100.2	35.4	101.4	36.7	97.3	32.0	NS
Triglycerides (mg/dL)	130.9	79.8	136.6	85.2	117.0	63.5	0.0389
Glucose (mg/dL)	104.5	37.4	104.0	34.4	105.7	43.9	NS
6-minute walk test (distance = m)	440.0	69.0	443.0	74.0	435.0	55.0	NS
Diet measures							
Calcium (mg)	635.4	420.9	606.9	349.8	703.7	552.1	NS
Dairy (cups)	1.0	0.7	0.9	0.6	1.1	0.7	NS

Characteristic	All Participants (n=269)		Completers[a] (n=190)		Non-Completers[a] (n=79)		P[b]
	n	%	n	%	n	%	
Fiber (g)	14.2	5.9	14.1	6.1	14.2	5.6	NS
Fruits & vegetables (cups)	2.6	1.3	2.6	1.3	2.6	1.2	NS
Sugar (tsp)	17.1	9.0	16.9	8.8	17.7	9.3	NS

[a] Status at 6 months.

[b] P-value for differences between completers and non-completers.

[c] Categories collapsed to African American vs. Others for comparison purposes.

[d] Categories collapsed to Married vs. Others for comparison purposes.

[e] Categories collapsed to Less than high school, High school, or Some college for comparison purposes.

[f] Treated as continuous variable (12 categories in $5,000 step increments).

Table 2

Mixed model linear regression analyses for time differences in outcome measures among HUB City Steps participants

	Baseline (N=269)		3 Months (N=227) [a]		6 Months (N=190) [a]		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p[b]**
Blood pressure (BP)							
Systolic BP (mm Hg)	126.0	19.1	120.3	17.9	119.6	15.8	0.0002
Diastolic BP (mm Hg)	83.2	12.3	80.2	11.6	78.6	11.1	<0.0001
Anthropometric measures							
Waist circumference (cm)	102.1	18.1	101.1	16.8	99.3	16.2	NS
Body Mass Index (kg/m^2)	34.7	8.1	34.0	7.7	33.5	7.4	NS
Body fat (%)	43.0	8.8	42.0	8.9	41.7	8.5	NS
Fat mass (kg)	42.5	17.5	40.7	16.9	39.6	15.6	NS
Lean body mass (kg)	53.2	11.1	53.3	10.6	52.8	10.4	NS
Biological measures							
Total cholesterol (mg/dL)	177.2	39.1	179.6	36.1	178.7	40.1	NS
High density lipoprotein(mg/dL)	51.9	15.0	51.3	14.3	49.8	15.0	NS
Low density lipoprotein(mg/dL)	100.2	35.4	102.4	31.7	103.4	36.2	NS
Triglycerides (mg/dL)	130.9	79.8	139.0	90.7	132.6	81.3	NS
Glucose (mg/dL)	104.5	37.4	104.9	44.0	103.6	43.5	NS
6-minute walk test (distance = m)	440.4	68.7	451.6	81.5	449.2	69.8	NS
Diet measures							
Calcium (mg)	635.4	420.9	600.6	355.0	582.3	322.3	NS
Dairy (cups)	1.0	0.7	1.0	0.7	1.0	0.6	NS
Fiber (g)	14.2	5.9	13.9	5.9	14.0	5.7	NS
Fruits & vegetables (cups)	2.6	1.3	2.6	1.2	2.6	1.3	NS
Sugar (tsp)	17.1	9.0	13.9	7.0	14.5	7.7	<0.0001

[a] Maximum likelihood estimation was used to account for missing repeated measures data.

[b] P-value for time difference test; pair-wise comparisons (baseline to 3 months and baseline to 6 months) were significant for all models with a significant time effect.