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Mobile Health Technology Can Objectively Capture Physical Activity (PA) Targets Among African-American Women Within Resource-limited Communities – Washington, D.C. Cardiovascular Health and Needs Assessment

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Abstract

Background—Little is understood about using mobile health technology to improve cardiovascular (CV) health among African-American women in resource-limited communities.

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Methods—We conducted the Washington, D.C. CV Health and Needs Assessment in predominantly African-American churches in city Wards 5, 7 and 8 with the lowest socioeconomic status based on community-based participatory research (CBPR) principles. The assessment measured CV health factors: body mass index (BMI), fasting blood glucose and cholesterol, blood pressure, fruit/vegetable (F/V) intake, physical activity (PA), and smoking. Participants were trained to use a PA-monitoring wristband to measure 30 days of PA, wirelessly upload the PA data to hubs at the participating churches, and access their data from a church/home computer. CV health factors were compared across weight classes.

Results—Among females (N=78; 99% African-American; mean age= 59 years), 90% had a BMI categorized as overweight/obese. Across weight classes, PA decreased and self-reported sedentary time (ST) increased ($p \leq 0.05$). Diastolic blood pressure and glucose increased across weight classes ($p \leq 0.05$); however, cholesterol, glucose, and BP were near intermediate CV health goals.

Conclusions—Decreased PA and increased ST are potential community intervention targets for overweight and obese African-American women in resource-limited Washington D.C. areas. mHealth technology can assist in adapting CBPR intervention resources to improve PA for African-American women in resource-limited communities.

Keywords

cardiovascular health disparities; obesity; mHealth technology; women

Introduction

Cardiovascular disease (CVD) remains the leading cause of death in the U.S.(1), with stark disparities in CVD morbidity and mortality across racial and ethnic groups(2). These disparities are of particular salience among African-American women living in resource-limited communities, or neighborhood environments limited by greater socioeconomic deprivation(3), lower prevalence of appropriate facilities for healthcare, physical activity or healthful diet, or safety(4, 5). To address preventable factors leading to CVD, the American Heart Association (AHA) advocates for shifting current health measures towards ideal levels for body mass index (BMI), blood pressure, cholesterol, blood glucose, physical activity (PA), healthy diet and smoking status(6).

Interventions designed using community-based participatory research (CBPR) methods may serve as favorable approaches to improving CV health among African-American women in resource-limited communities(7). CBPR focuses on an important research topic to the community and ensures that designed intervention strategies are compatible with cultural and life circumstances of the target community(8). In accordance with CBPR principles, previous studies have conducted health and needs assessments prior to the design of a CBPR focused intervention to identify the barriers to proper implementation and attrition. However, these prior health and needs assessments targeted heterogeneous populations (9) and relied only on self-reported data(10). Few health and needs assessments have simultaneously used emerging mobile health (mHealth) technology to objectively measure PA and assess CV health factors.

Although a growing body of knowledge suggests that mHealth technology can potentially increase community members' engagement in managing their health(11), little evidence demonstrates its capacity and efficacy in gathering objective measures during a community-based health and needs assessment designed using CBPR principles. Thus, further investigation is needed to understand the applicability of mHealth devices for improving level of activity, particularly among African-American women in resource-limited communities.

In partnership with community leaders, we conducted a CV health and needs assessment using mHealth wearable devices in churches from resource-limited communities in Washington D.C., particularly wards 5, 7 and 8 of the eight D.C. wards. These three wards have a higher obesity prevalence and lower median household income as compared to the remaining five wards that comprise Washington D.C.(12), putting them at a higher risk for CVD morbidity and mortality disparities. We hypothesized that within the context of CBPR-based health and needs assessment, mHealth devices could capture objective PA data among African-American women. This analysis is designed to assess the AHA-defined CV risk factors, including objectively-measured PA, across weight classes within a community-based population of African-American women.

Methods

The Washington, D.C. Cardiovascular Health and Needs Assessment

The Washington, D.C. CV Health and Needs Assessment was a CBPR-designed, observational study to evaluate CV health factors, psychosocial factors, cultural norms, and neighborhood environment characteristics in a predominantly African-American faith-based population in at-risk Washington, D.C. communities; psychosocial, cultural and neighborhood factors were measured using validated survey tools. The health and needs assessment also evaluated the feasibility and acceptability of using mHealth technology in this population for objectively measuring PA. The Washington, D.C. CV Health and Needs assessment serves as a preliminary step in the development of a community-based behavioral change intervention to improve CV health in this community.

As a CBPR study, this project engaged community members at each stage of study design and coordination. To consult on planning, implementation, and data dissemination for the assessment, our research team partnered with a community advisory board (CAB) or the D.C. Cardiovascular Health and Obesity Collaborative (D.C. CHOC) comprised of a diverse group of community leaders, church leaders, and co-investigators(13). The Washington, D.C. CV Health and Needs Assessment was approved by the National Heart, Lung, and Blood Institute (NHLBI) Institutional Review Board (ClinicalTrials.gov NCT01927783). Informed consent was obtained from all individual participants included in the study.

Participant Recruitment and Data Collection

Four churches located in the targeted areas participated in the study voluntarily. The only criterion for churches' participation was internet accessibility. Participants were recruited at these churches and at health-related community events in the targeted areas. Participants attended one of the participating churches, were aged 19–85, and possessed sufficient English language proficiency to carry out study tasks. Recruited participants attended one of the six data collection events. Each event accommodated no more than 30 participants.

The data collection events were held at each of the four churches in Washington, D.C. wards 5, 7, and 8, during the period of September 2014 through February 2015. Participants rotated through six stations: 1) registration and informed consent; 2) blood pressure measurement, blood sample collection, and anthropometric measures; 3) survey completion; 4) mHealth device training; 5) CV risk assessment with the principal investigator; and 6) debriefing.

CV Health Factor Measurements

Blood pressure was measured using the protocol established by the JNC-VII guidelines(14). The average of up to three blood pressure measurements was taken using a recently calibrated automatic blood pressure cuff (Welch-Allyn Inc., Skaneateles Falls, NY).

Participants fasted for 12 hours prior to their participation in the data collection event. A fingerstick capillary blood sample was collected from each participant. The blood sample was analyzed for fasting plasma lipids and blood glucose using a Cholestech LDX point-of-care analyzer (Alere, Inc., Waltham, MA) and for hemoglobin A1c (HgbA1c) using a DCA Vantage Analyzer (Siemens, Inc. – Laboratory Diagnostics, Tarrytown, NY).

Anthropometric Measures—Height was measured using a stadiometer (Seca Corp, Chino, CA). Weight was measured using a calibrated scale (Seca Corp, Chino, CA). BMI was calculated on the basis of height and weight recorded by study investigators and divided into clinically relevant categories on the basis of National Heart, Lung, and Blood Institute criteria: normal weight (BMI <25 kg/m^2), overweight (BMI 25–29.9 kg/m^2), Class-I obese (BMI 30–34.9 kg/m^2), Class-II obese (BMI 35–39.9 kg/m^2), and Class-III obese (BMI ≥40 kg/m^2) (15). Waist circumference (at the level of the iliac crest) and hip circumference (at the maximum protuberance of the buttocks) were measured in triplicate with a flexible tape measure.

Physical Activity: Objective Measurement

This study utilized a two-part PA-monitoring system: an electronic activity monitoring wristband (Dynamo Activity Tracker, Oregon Scientific, Tualatin, OR) with a centralized hub for data upload in each participating church, and a secure online account for manual tracking of CV health factors (Vignet Corp, McLean, VA). In February 2014, the proposed PA data collection system was piloted, and a post-use focus group was conducted with a similar, community-based population prior to implementation in the CV Health and Needs Assessment in September 2014. Changes were made to the PA-monitoring system based on findings in our team's initial mixed-methods study, such as changes to the training and technical support. For instance, after the focus group, each church had a "super user", a participant who volunteered to communicate hub issues to investigators and help church participants with syncing wristband data. Detailed information regarding the PA-monitoring system and participants' training and technical support provided for the PA-monitoring wristband, the wireless hub and secure online account have been reported elsewhere(13).

Participant engagement with using the wireless PA monitoring system was based on compliance with wearing the wristband and downloading PA data. A participant was considered compliant if PA data was synced with the hub at least once during the 30-day assessment period; participants could provide up to 14 days of stored data from the PA-monitoring wristband with each sync with the hub. The daily compliance percentage was calculated as the number of participants who provide PA data for each day divided by the total number of participants; this daily compliance percentage was calculated for the 30-day assessment period. Daily compliance percentage among women with obesity was compared to the daily compliance percentage among the overall population of women.

CV Health Behavior Measurements

Health behaviors (i.e. physical activity, dietary habits, tobacco use, and alcohol consumption) were evaluated using questions abstracted from the 2011 Behavioral Risk Factor Surveillance System (BRFSS)(16) and the 2009–2010 National Health and Nutrition Examination Survey (NHANES) dietary screener questionnaire(17) To assess fruit and vegetable(F/V) consumption, participants recorded the number of times per day, per week, or per month they consumed a F/V group (e.g. fruit juice, fruit, green leafy salad, orange-colored vegetables, other vegetables, beans). To calculate consumption in times per day, daily frequencies were maintained, weekly frequencies were divided by seven, and monthly frequencies were divided by 30. Total daily F/V consumption (times/day) was the sum of each F/V group frequency.

Participants reported time spent performing different PA types in a typical week in addition to sedentary time spent sitting and/or reclining in a typical week. “Moderate-intensity activities” were defined as activities that require moderate physical effort and cause small increases in breathing or heart rate, while “vigorous-intensity activities” were defined as activities that require hard physical effort and cause large increases in breathing or heart rate. Leisure-time and work-related activity were assessed separately.

Current smokers were defined as those who had smoked at least 100 cigarettes (i.e. 5 packs) during their lifetime and, at the time of the survey reported smoking every day or some days. Former smokers were defined as those who reported smoking at least 100 cigarettes during their lifetime but, at the time of the survey, did not smoke.

Statistical Methods

The Jonkheere-Terpstra test was used to compare continuous (age, PA as measured by steps/day, sedentary time, TV-watching, F/V intake, blood glucose, total cholesterol, LDL, HDL, Triglycerides, SBP and DBP) and categorical (education, yearly household income, percentage of participants with < 5000 steps per day or > 10,000 steps/day and smoking status) variables across BMI categories. The Jonkheere-Terpstra test is a nonparametric test for ordered differences in which the exposure is an ordinal variable; the test is not restrictive to looking at linear trends across categories (19). McNemar’s test was used in a post-hoc analysis to compare the daily compliance rate of using the hub-based PA monitoring system among women with obesity to the compliance rate of the overall population of women over the 30-day period. Two-sided p-values ≤0.05 were considered statistically significant.

Analyses were done using the Statistical Analysis Software (version9.2, SAS Institute, Inc. Cary, NC).

Results

Among women in the Washington, D.C. CV Health and Needs Assessment (N=78, 99% African-American), 90% had a BMI categorized as overweight or obese, with 30% having Class-I obesity, 19% having Class-II obesity, and 17% having Class-III obesity. Mean age decreased as weight categories increased (mean age = 65.8±8.8 years for normal weight women versus mean age = 57.7±9.6 years for women with Class-III obesity (p-trend=0.05) (Table 1). Women with Class- III obesity were less likely to have a college education as compared to women in other weight categories (p-trend=0.05). There were no significant differences in income levels across the weight categories among women in the study.

With regard to physical activity (Table 2), mean steps per day were significantly lower among women with Class-II (6751±6134 steps/day) and Class-III obesity (5131±4378 steps/day) as compared to the normal weight women (7698±3603 steps/day) (p-trend=0.05). Among women with Class-III obesity, 15% took 10,000 or more steps per day as opposed to 25% of normal weight women. Mean sedentary time was significantly higher among women with obesity; the mean sedentary time among normal weight women was 5.6±3.5 hours/day as compared to women with Class-I obesity (5.7± 2.1 hours/day), Class-II obesity (7.0±3.3 hours/day) and Class-III obesity(7.30±4.32 hours/day) (p-trend=0.04). Similar trends were seen in reported television screen time across the weight categories (p-trend=0.04).

Across weight classes, mean fruit and vegetable intake was below the recommended ≥4.5 servings/day (Table 3). There were no significant differences across weight categories for cigarette smoking. Blood glucose and diastolic blood pressure (DBP) were the only CV health factors with significant differences across weight classes. Fasting blood glucose increased from 89.0± 23.7 mg/dl among normal weight women to 96.3± 14.3 mg/dl among Class III obese women (p-trend=0.05). DBP increased from 71.7± 15.1 mg/dl among normal weight women to 81.9± 10.5 mg/dl among Class III obese women (p-trend=0.02). Fasting glucose, cholesterol and blood pressure appeared to be relatively well controlled among the women; across weight classes, mean measures for glucose, cholesterol and blood pressure were consistent with ideal or intermediate levels per the AHA CV health cut-points.

Overall compliance with using the hub-based PA monitoring system for women in the study slightly decreased from 75% in the beginning to 70% by the end of the assessment period. Compliance rates among women with obesity over the 30-day assessment period were similar to those seen for all women in the study (p=0.8).

Discussion

This study describes the utility of mHealth technology within a CBPR-based health and needs assessment for identifying targets for improved CV health among African-American women in resource-limited areas. Our analysis revealed that physical activity, as measured by a wearable mHealth wristband, and self-reported sedentary time were CV health behaviors with significant differences across weight classes. In particular, mean steps decreased and sedentary time increased with greater obesity severity. With regards to CV health factors, blood glucose and diastolic blood pressure increased across weight classes, though all CV health factors appeared moderately well-controlled for women in the population. Over two-thirds of women in the study complied with using the PA-monitoring wristband, with similar compliance among women with obesity over the 30-day study period. Our findings suggest that a wearable mHealth device may be an efficient tool for identifying and monitoring PA as a part of a tailored, community-based intervention, particularly PA levels among at-risk African-American women with overweight/obesity.

Past studies have demonstrated that when CBPR principles are used in collaboration with community partners, they serve as sustainable methods of targeting lifestyle factors(18, 19). Prior studies suggest that technology-driven interventions may succeed in community-based settings(20); however, few intervention studies investigating use of wearable mHealth tools to target lifestyle factors in urban areas have been guided by CBPR principles. Since technology-dependent interventions may pose unique challenges for resource-limited community-based populations, designing mHealth-based interventions in concert with CBPR guiding principles ensures that intervention strategies are compatible with the social, cultural, and economic circumstances of those they target(8).

Recent data demonstrate a CVD risk increase for women aged 35–54, and African American women, in particular, have exhibited the lowest CVD mortality decline among age, sex, and race classes(21). Moreover, younger women are less likely than their older counterparts to seek medical evaluation for CVD risk(22), suggesting a need for novel public health prevention strategies that extend beyond the health care system and meet individuals in the communities in which they live(23). Recently, wearable PA-monitoring devices have been cited as a promising modality for promoting behavior change(24, 25). However, few prior studies have tested them in a community-based setting(26). Though there is an increased use of mHealth tools as a means to monitor CV health factors, particularly blood glucose level, blood pressure and cholesterol, an aim of the current study was to highlight the potential of wearable PA-monitoring tool within a health and needs assessment in faith-based organizations guided by CBPR principles. Promotion of PA within a CBPR and faith-based setting among African-Americans presents mixed results, as described in a recent review(27). Some studies focused mainly on the use of PA surveys(28–31). However, no interventions described in this recent review assessed objectively measured PA using mHealth technology. Our study addresses a major gap in the present mHealth-based intervention research by utilizing CBPR-guiding principles to target a racial/ethnic minority and socioeconomically disadvantaged population in a resource-limited community-based setting. This is one of the first CBPR studies to utilize wearable mHealth technology to objectively measure PA while designing a CBPR-based intervention in resource-limited communities. This study is among the first to describe the accuracy of wearable mHealth devices for objectively capturing PA, among at-risk women in a resource-limited community-based setting. Wearable activity monitors, are dually beneficial in this arena, offering an opportunity to gather objective measures on multiple behaviors continuously and possessing a platform to intervene in real-time, all within an individual's natural environment. Furthermore, our study fills a significant gap in CVD prevention literature—evaluating mHealth-based CVD prevention among those who bear the greatest burden of obesity-related CVD: racial/ethnic minority and socioeconomically disadvantages populations(32). With 70% of our female population largely at-risk for developing chronic disease, our findings highlight a critical opportunity to gather objective CV health measures and to deliver CV behavioral interventions to at-risk African-American women in a resource-limited, community-based setting.

A recent review of mHealth-based CVD interventions pointed to sustained user engagement, or compliance, as a serious limitation of existing studies and ranked it a key priority moving forward(32). Though declining engagement and attrition appears characteristic of mHealth-based interventions, it is unclear whether they impact health outcomes(33). Our study is among the first to assess daily compliance with a wearable mHealth PA monitor. Conventional behavioral interventions often rely on self-report to measure the participants' compliance or engagement. This limitation lends an opportunity for mHealth devices to capture objective measurement of engagement during interventions. Objective, real-time measures of engagement and adherence during an intervention may allow for tailoring and reengagement opportunities that could result in more sustainable, personalized interventions. Our findings on compliance may also point to the necessity for reengagement strategies in using mHealth technology in this community-based population of women. Our past work demonstrated that engaging community members and leaders in design and implementation of the mHealth-based health and needs assessment aids in early identification of potential issues, suggestions, and preferences regarding the technology(13). Both our past and present findings are particularly relevant for larger-scaled behavioral interventions that stem from this observational study, as the incorporation of CBPR principles during intervention development has been shown to improve sustainability of the intervention and potentially improve retention and attrition of study participants(18, 19, 34).

Though the focus on this population is timely given the current needs in the field, it limits the generalizability of our findings to predominantly African-American women in resource-limited urban settings. Our study was able to reach women with at least some college education. However, additional strategies targeting the participants with lower levels of education within a church-based population are needed to improve their enrollment in CV health interventions. Future work would benefit from extension of this study to a larger and more diverse sample and a longer study period to gauge user engagement factors. Our study did not evaluate the effectiveness of the mHealth PA-monitor to modify behaviors or improve health outcomes (e.g. weight reduction, increase in PA). However, such preliminary user data enables behavioral interventionists to identify potential barriers and evaluate feasibility of mHealth devices within a particular context before implementing an intervention. Moreover, while a recent study highlighted the potential of mHealth interventions for addressing obesity in racial/ethnic minority adults, it called first for evidence to inform the development of mHealth-based interventions(35). Our present study provides such evidence that can inform future mHealth-based interventions in resource-limited Washington, D.C. communities.

Conclusions

Mobile health-based PA-monitoring using wearable technology and a wireless, community-based hub appears to be an effective modality for assessing targets for improved CV health among at-risk, African-American women in resource-limited, Washington, D.C. communities. The objective PA measurements captured by the wearable PA monitoring device demonstrate a link between increased obesity severity and decreased PA, suggesting that wearable mHealth technology serves as a tool that can identify CV health behaviors, particularly PA and sedentary time, in this population. However, further work is needed to evaluate the effectiveness and sustainability of this mHealth-based PA-monitoring. For African-American women with overweight/obesity in resource-limited Washington, D.C. areas, this study identifies a wrist-worn PA monitor as an efficient tool for monitoring CV health targets and suggests that inadequate physical activity is a potential target that can be addressed through a CBPR-based, mHealth behavioral intervention tailored to the needs of the community.

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Table 1

Demographic characteristics among women participants (n=78) across obesity categories[a] in Washington D.C. Health and Needs Assessment (2014–2015).

	All women	Normal weight	Overweight	Class-I Obesity	Class-II Obesity	Class-III Obesity	p-trend*
Female, N (%)	78 (100)	8 (10)	19 (24)	23 (30)	15 (19)	13 (17)	
Mean Age, Years (SD)	59.1 (12.1)	65.8 (8.8)	59.8 (14.5)	58.8 (13.8)	56.8 (15.1)	57.7 (9.6)	0.05
Mean BMI, kg/m^2 (SD)	32.6 (7.0)	22.5 (1.7)	27.4 (1.5)	32.1 (1.3)	36.9 (1.2)	45.5 (4.1)	
Education, N(%)[b]							
<High School	7 (9)	0 (0)	2 (11)	2 (9)	1 (7)	2 (15)	0.3
High School	9 (12)	2 (25)	0 (0)	3 (13)	1 (7)	3 (23)	0.3
Some College	26 (34)	3 (37.5)	3 (17)	9 (39)	7 (46)	4 (31)	0.2
College	35 (45)	3 (37.5)	13 (72)	9 (39)	6 (40)	4 (31)	0.05
Yearly Household Income, N(%)[b]							
<$60,000	31 (40)	4 (50)	8 (42)	8 (35)	5 (33)	6 (46)	0.4
$60,000–99,999	24 (31)	2 (25)	5 (26)	8 (35)	6 (40)	4 (31)	0.3
$100,000+	11 (14)	1 (13)	2 (11)	4 (17)	3 (20)	1 (8)	0.5

*p-trend using the Jonckheere-Terpstra test.

[a] Normal: BMI <25 kg/m^2; Overweight: BMI= 25–29.9 kg/m^2 ; Class-I Obesity: BMI 30–34.9 kg/m^2; Class-II Obesity: BMI = 35–39.9 kg/m^2 ; Class-III Obesity: BMI ≥ 40 kg/m.

[b] Participants with missing data (out of N=78): N=1 for Education, N=12 for Yearly Household Income.

Table 2

Level of activity among women participants (n=78) across obesity categories[a] in Washington D.C. CV Health and Needs Assessment (2014–2015).

	All women	Normal	Overweight	Class-I Obesity	Class-II Obesity	Class-III Obesity	p-trend*
PA (steps/day), Mean (SD)[b]	7050 (5311)	7698 (3603)	7036 (5774)	8114 (5418)	6751 (6134)	5131 (4378)	0.05
< 5000 steps per day, N (%)	28 (36)	2 (25)	7 (37)	7 (30)	6 (40)	6 (46)	0.2
> 10,000 steps/day, N (%)	26 (33)	2 (25)	7 (37)	12 (52)	3 (20)	2 (15)	0.12
Sedentary time (hours/day), Mean (SD)[b]	6.4 (3.5)	5.6 (3.5)	6.3 (4.4)	5.7 (2.1)	7.0 (3.3)	7.3 (4.3)	0.05
TV-watching (hours/day), Mean (SD)[b]	3.3 (1.4)	3.2 (1.8)	2.8 (1.6)	3.3 (1.2)	3.3 (1.4)	4.0 (1.0)	0.04

*p-trend using the Jonckheere-Terpstra test.

[a]Normal: BMI <25 kg/m^2; Overweight: BMI= 25–29.9 kg/m^2 ; Class-I Obesity: BMI 30–34.9 kg/m^2; Class-II Obesity: BMI = 35–39.9 kg/m^2 ; Class-III Obesity: BMI ≥ 40 kg/m.

[b]Participants with missing data (out of N=78): N= 15 for PA, N= 10 for Sedentary time, N= 1 for TV-watching.

Table 3

Cardiovascular (CV) health factors[f] among women participants (n=78) across obesity categories[a] in Washington D.C. CV Health and Needs Assessment (2014–2015).

	All women	Normal	Overweight	Class-I Obesity	Class-II Obesity	Class-III Obesity	p-trend*
Diet (F/V servings/day)							
Mean (SD)	3.35 (2.8)	3.23 (2.1)	3.63 (3.5)	3.5 (3.0)	2.97 (1.9)	3.10 (3.3)	0.33
Smoking (N, %)							
Never	58 (74)	4 (50)	16 (84)	18 (82)	10 (67)	10 (77)	0.42
Former Smoker	16 (21)	2 (25)	3 (16)	4 (18)	4 (27)	3 (23)	0.32
Current Smoker	3 (4)	2 (25)	0 (0)	0 (0)	1 (6)	0 (0)	0.1
Blood glucose (mg/dL)							
Mean (SD)[b]	93.9 (27.5)	89.0 (23.7)	87.2 (25.1)	99.2 (26.4)	94.6 (40.9)	96.3 (14.3)	0.05
Total cholesterol (mg/dL)							
Mean (SD)[c]	200.9 (44.7)	182.6 (35.5)	210.9 (55.8)	199.3 (40.3)	212.6 (38.8)	185.3 (42.0)	0.4
LDL (mg/dL)							
Mean (SD)	113.5 (46.5)	89.1 (29.9)	121.5 (62.6)	115.5 (40.9)	125.6 (47.3)	102.8 (35.3)	0.33
HDL (mg/dL)							
Mean (SD)	55.5 (16.5)	69.0 (19.1)	57.69 (18.1)	49.5 (15.4)	56.8 (15.1)	54.2 (12.5)	0.11
Triglycerides (mg/dL)							
Mean (SD)	176.5 (139.0)	122.4 (75.9)	201.5 (173.6)	200.3 (168.4)	164.1 (92.7)	137.6 (69.0)	0.5
BP (mmHg)							
SBP, Mean (SD)[d]	131.8 (14.8)	127 (15.5)	131.5 (19.1)	132.4 (13.3)	130.7 (15.2)	135.3 (9.13)	0.14
DBP, Mean (SD)[e]	78.7 (12.2)	71.7 (15.1)	76.2 (9.92)	81.0 (12.6)	79.4 (13.4)	81.9 (10.5)	0.02

* p-trend using the Jonckheere-Terpstra test

[a] Normal: BMI <25 kg/m^2; Overweight: BMI= 25–29.9 kg/m^2 ; Class-I Obesity: BMI 30–34.9 kg/m^2; Class-II Obesity: BMI = 35–39.9 kg/m^2 ; Class-III Obesity: BMI ≥ 40 kg/m.

[b] Ideal: <100 mg/dL with no history of diabetes mellitus; Intermediate: 100–125 mg/dL, or treated to goal; Poor: ≥ 126 mg/dL.

[c] Ideal: 200 mg/dL untreated; Intermediate: 200–239 mg/dL, or treated to goal; Poor: ≥240 mg/dL.

[d] Ideal: <120 mm Hg; Intermediate: 120–139 mm Hg, or treated to goal; Poor: ≥ 140 mm Hg.

[e] Ideal: <80 mm Hg; Intermediate: 80–90mm Hg, or treated to goal; Poor: ≥90 mm Hg.

[f] Participants with missing data (out of N=78): N=18 for Diet(Fruit/Vegetable servings/day), N= 1for Smoking, N=2 for Blood Glucose, Total Cholesterol, LDL, HDL, Triglycerides, BP.