Better Together? A Pilot Study of Romantic Partner Influence on Exercise Adherence and Cardiometabolic Risk in African-American Couples

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Abstract

Background African-Americans (AAs) have higher rates of inactivity, obesity, and cardiometabolic risk compared to other races/ethnicities. Romantic partners can positively influence health habits, yet whether or not couples have to exercise together in order to adopt regular exercise remains unclear. This study examined whether exercising together influences exercise adherence and cardiometabolic risk in AA couples.

Methods Nine AA romantic couples (age 62.8 ± 7.7 years; body mass index 31.0 ± 4.4 kg/m^2; 6105 ± 1689 average steps/day) completed a 12-week walking (≥ 30 min, 3 days/week) plus resistance training (RT; 2 days/week) pilot intervention. Couples were randomized to either exercise together (ET) or separately (ES). Waist and hip circumferences, iDXA-measured body composition, blood pressure, and blood biomarkers (glucose, hemoglobin A1c (HbA1c), total cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, C-reactive protein, and fibrinogen) were assessed pre- and post-intervention. Independent-sample t tests and generalized linear mixed models, controlling for gender, were used to analyze data. Significance was accepted at $P < 0.05$.

Results There were no significant group × time interactions for any outcome. However, ET trended toward more walking (86.5 ± 57.7 min/week) than ES (66.1 ± 31.7 min/week). There were also significant overall time effects for waist circumference ($P < 0.001$), body fat ($P = 0.020$), fat mass ($P = 0.007$), gynoid fat ($P = 0.041$), HbA1c ($P = 0.020$), and HDL ($P = 0.047$), where all variables decreased.

Conclusions Trends showed exercising together may promote walking prescription adherence, although more research is needed in a larger sample. This intervention may also improve cardiometabolic risk factors in this population. These pilot data will inform the current investigators' future exercise intervention research in AA adult dyads.

Keywords Intervention · Marriage · Resistance training · Walking · Older adults · Cultural relevance

Introduction

Recent data show that only 20% of African-American (AA) adults in the United States meet national guidelines for both aerobic and muscle-strengthening physical activity (PA), and 53% do not meet guidelines for either of these modalities [1]. NHANES data in AA adults also show that 46% of men 40–59 years, 34% of men ≥ 60 years, and 58% of women ≥ 40 years of age are obese [2]. These statistics are particularly alarming as it is widely recognized that both physical inactivity and obesity are associated with an increased risk of cardiovascular and metabolic disease, as well as all-cause mortality [3, 4]. In addition, AA adults are disparately affected by obesity, cardiovascular disease, hypertension, diabetes/poor glycemic control,

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and age-adjusted cardiovascular and cerebrovascular deaths compared to other races/ethnicities [1, 2].

Identifying strategies to promote long-term exercise adherence may translate into much-needed improvements in the health and well-being of middle-aged and older AA adults. A promising yet underutilized method for addressing health disparities in this population may involve capitalizing on a key person in their lives. Romantic partners play a uniquely positive role in supporting exercise habits [5], which could facilitate long-term exercise adherence that could in turn decrease the risk of cardiometabolic disease. Theories of social support and control suggest that having a supportive partner invested in one's health can yield long-term health benefits [6–8]. Though research has shown that individuals' health habits may be improved simply by having an invested partner who is cognizant of health and health-promoting behaviors [9], benefits are enhanced when partners work together on their health [10]. Working together is thought to be especially effective for PA interventions with older adults, as it both activates partners' reciprocal exercise support and reduces the likelihood that partners provide ineffective support [10]. Thus, it is critical to evaluate whether teaching couples how to effectively provide and receive support yields sustained health benefits for both partners, especially as couples begin to age and transition into caregiving roles. Although currently there are limited romantic partner-based PA intervention studies, those examined have shown modest success in improving PA [11]. However, whether such a dyadic approach would be similarly effective for older AA adults is unknown, as none of the existing dyadic interventions targeted AA couples. Promoting exercise in couples could be effective in AA adults given previously suggested barriers to PA including lack of social support, lack of a PA partner, and the desire to participate in activities with family members (including spouses) [12–14].

Although exercise and PA interventions in AAs have been successful in improving PA [15–19], there are still important understudied areas that remain. Namely, existing literature shows a growing number of PA and exercise intervention studies specific to AA women [15, 17, 19]. While this is encouraging, AA men remain underrepresented in exercise trials despite the persistence of physical inactivity, a modifiable risk factor for several chronic diseases afflict them [16, 18, 20]. Another gap is the exclusion of resistance training (RT) as an intervention modality in AA adults. Research has shown important health benefits of RT including optimal physical functioning and independence with aging, reduced cardiometabolic risk, improved bone health, and reduced all-cause mortality [21–23]. Even so, recent data show only 23% of AA adults meet current national recommendations for RT [1] and there have been few exercise intervention efforts that incorporate chronic RT while examining cardiometabolic outcomes specifically in middle-aged and older AA adults [24, 25]. Finally, research

has shown a clear need to incorporate multiple levels of cultural relevance in health-focused interventions when working with underrepresented and underserved communities [26], yet intervention designs often neglect this critical factor. These research gaps need to be addressed in the design of PA and exercise trials in AA adults.

Therefore, the purpose of this study was to examine an innovative way to increase PA in middle-aged and older AA adults in an effort to reduce health disparities in this population. We conducted a pilot study to determine the preliminary efficacy of a walking plus RT intervention in AA couples who exercised together (ET) and those who exercised separately (ES). The ET group received supplemental education about how to be effective support providers and recipients [27], whereas the ES group did not. Study outcomes included overall study adherence and adherence to the exercise prescription, body composition variables, and biomarkers for cardiometabolic disease risk. The investigators hypothesized that couples who exercised together would have better exercise adherence during the intervention and therefore, greater improvements in body composition variables and biomarkers for cardiometabolic disease risk compared to the couples who completed the exercise training separately (i.e., training where partners were not in direct contact during exercise).

Methods

Integrative Frameworks and Community Engagement

This multilevel study employed overarching guidance from the social ecological framework, as it targeted both the individual and their interpersonal social support network (i.e., romantic partner) [28]. The social ecological model posits that behavior affects and is affected by the social environment. The current study then integrated theories of social support and control to enhance the social ecological model [6–8]. These theories are particularly relevant for the current study, as they elucidate how romantic partners work to promote each other's health and well-being, whether it be through reinforcing the partner's efforts to initiate and maintain needed health behavior changes (support) or attempting to modify the partner's health behaviors to reach the desired goal (control). Since the benefits of support have been found to be more uniform than those found for control [29, 30], these theories provide invaluable information about how to more effectively utilize romantic partners as agents of health behavior change. Investigators also utilized a conceptual framework for the development of culturally relevant PA programs conceived by Joseph et al. [31]. Although this framework was suggested for AA women, it used a life course perspective that specified developmental considerations and intervention delivery strategies for older AA women. As such, investigators found

multiple tenets of this framework also relevant for older AA men given supporting literature that older AA women and men have identified similar barriers to PA and exercise [12, 13].

Evidence has shown that community-engaged health interventions in underrepresented groups benefit many health outcomes [32]. To this end, investigators found it essential to collaborate with the local community to assist in the development of the current pilot intervention since a key focus of the study was exercise adherence. Details about the current study's process for community engagement and a summary of the community feedback have been published elsewhere [33].

Participants

This study was a cluster randomized trial where self-identified AA couples were assigned to one of two groups (ET or ES). Building off previous dyadic intervention work targeting husbands and wives [11], male-female romantic dyads who were married and/or cohabiting were recruited. Both partners were required to be between 40 and 80 years of age and accumulate < 8000 steps/day per average baseline activity monitor measurement. This objective step count cutoff was established based on evidence that has shown < 8000 steps/day poses increased risk for metabolic syndrome in older Japanese adults [34] and its approximate alignment with Tudor-Locke and Bassett's "low active" step category (7500 steps/day) [35]. Biracial couples where at least one partner was AA were also eligible. Participants were recruited from the general public in and around Knoxville, TN by local radio and newspaper advertisements, speaking engagements at civic group meetings and churches, flyer distribution, and recommendations from existing participants.

Upon initial contact with the study team, interested participants underwent an initial telephone screening for inclusion and exclusion criteria. Along with study-specific inclusion inquiries (partner status, age, self-identified race, self-reported physical activity, etc.), the Physical Activity Readiness Questionnaire+ (PAR-Q+) was administered. If participants answered "yes" to any of the initial PAR-Q+ questions, the PAR-Q+ follow-up questions were completed. If study staff had any safety concerns due to the status of a health condition after completing the follow-up questions, medical clearance was required prior to study entry. Participants were excluded for self-reported uncontrolled cardiovascular or pulmonary disease, signs or symptoms of cardiovascular or pulmonary disease, uncontrolled hypertension or diabetes, pregnancy, smoking within the past 6 months, or any orthopedic limitations in ambulatory physical activity or the ability to complete walking or RT. If participants selected "no" for all initial PAR-Q+ answers or when study staff identified no reason for exclusion, they were scheduled for their

first laboratory appointment. All study methods were reviewed and approved by the University of Tennessee, Knoxville Institutional Review Board.

Pre-Intervention Testing

Laboratory Testing

Participants reported to the University of Tennessee, Knoxville Applied Physiology Laboratory for initial testing in the morning (before 12:00 pm). If taking a blood pressure medication, participants were asked to postpone taking this medication to standardize the measurements. All participants signed an informed consent form prior to any testing, which was followed by a medical history questionnaire. Next, an indirect digital blood pressure measurement was taken after at least 5 min of seated rest using standard guidelines outlined by the American Heart Association and the manufacturer's instructions. Body height without shoes and body weight in indoor clothing were measured using a wall-mounted stadiometer and a digital scale, respectively. Body mass index (BMI) was calculated from measured height and weight. Waist circumference was measured at the narrowest part of the torso (typically beneath the xiphoid process and above the umbilicus). Hip circumference was measured at the maximum circumference of the buttocks. Measurements were taken while the participant stood erect with the abdomen relaxed and feet together using a fiberglass measuring tape with a tension handle. Two to three measurements were taken at each site and the average of two measures within 5 mm (~ 0.5 cm) of each other were used as the dependent variable [36].

One-repetition maximum (1-RM) strength tests for the upper and lower body were then conducted using chest press and leg press machines, respectively. After a warm-up, participants were progressed toward the maximum weight they could lift one time through a full range of motion. Maximal measurements were recorded within approximately 5 attempts [36]. This test was repeated for validation in lieu of the chest and leg press exercises at the first RT session. The highest measurements of the two 1-RM tests were used.

Finally, wrist-mounted activity monitors (Fitbit Alta or Inspire; Fitbit, Inc.; San Francisco, CA) and baseline activity logs were distributed to all participants with instructions on how to complete the 7-day objective physical activity assessment. At this time, the Fitbit application was downloaded (with permission) to each participant's smartphone, study staff created a Fitbit account, and the tracker was synced via Bluetooth to the mobile application. In order to reduce the likelihood of reactive behavior to the activity monitor, participants were blinded to steps on the monitor and the mobile application by hiding activity tiles within the mobile application, and were instructed not to make any changes to their typical daily routine during the baseline measurement period.

One week after the initial appointment, study staff retrieved daily step counts accumulated during the assessment period electronically by logging into the participants' account. Investigators contacted participants via telephone to confirm study eligibility. If not eligible based on average steps/day, the couple was informed at that time and study staff made arrangements to collect activity monitors.

On a separate pre-intervention visit, eligible participants reported back to the laboratory for body composition measurements via dual X-ray absorptiometry (GE Lunar iDXA; Chicago, IL). A certified medical X-ray technologist conducted all measurements per the manufacturer's instructions. A total body scan was obtained to determine total body fat, lean mass, and regional body fat distribution.

Blood Analyses

Eligible participants made an appointment to report to a specified Laboratory Corporation of America (LabCorp) Patient Service Center. Participants were asked to report to this appointment in the morning after a 12-h fast (excluding water). If taking a prescribed blood pressure or cholesterol medication, participants were asked to postpone taking these medications that morning to standardize the measurements. Resting blood pressure measurements were repeated prior to the blood draw in the same manner as the previous study measurement. Venous blood samples were collected by a trained phlebotomist, then processed and analyzed by LabCorp. Baseline blood analyses included glucose, insulin, glycosylated hemoglobin, high-density lipoprotein (HDL) cholesterol, total cholesterol, triglycerides, C-reactive protein (CRP), and fibrinogen. The homeostasis model assessment of insulin resistance (HOMA-IR) method was used to calculate insulin resistance using fasting glucose and insulin [37, 38]. Although variation data were not made available for blood analyses, all samples were drawn at the same LabCorp location and therefore routed to the same laboratory for testing. Investigators were also assured that instrument calibration was performed regularly, and that quality controls were performed for every testing run and had to be within the manufacturer's limits in order for results to be released.

Intervention

Exercise Prescription

All couples who entered the 12-week exercise intervention were randomly assigned to adopt a walking plus RT prescription together (ET: complete planned walks and RT sessions together) or separately (ES: complete planned walks and RT sessions separately). To ensure even distribution of the two treatments, a block randomization strategy was used with each block equal to six. The walking prescription specified purposeful walking for exercise for ≥ 30 min on ≥ 3 days/week. No walking speed/intensity was prescribed. The walks could occur at the convenience of the couple or the individuals and any preferred modality could be used (e.g., neighborhood streets, tracks, trails, treadmills). Participants were asked to complete an activity log on which they recorded adherence to the walking prescription which included daily bout completion, daily walking time, and whether or not walks occurred with their partner. To provide an additional objective measure of ubiquitous daily PA, participants were asked to wear wrist-mounted activity monitors daily during all waking hours except when bathing or participating in water-based activities. For analyses, post-intervention steps/day were averaged from weeks 11 and 12. Step data were screened prior to summary and analyses for extremely low values. Two days for two different participants (equating to 74 and 150 steps/day) were excluded as investigators deemed they were unrealistically low.

Participants were also prescribed a progressive, total body RT program on 2 non-consecutive days/week. All RT took place at the University of Tennessee, Knoxville Exercise and Fitness Promotion Laboratory and were supervised by trained study staff that included graduate and senior-level undergraduate students in kinesiology. All RT sessions began with a 5–10 min general warm-up using the participants' choice of modality (e.g., treadmill, stationary bike, rowing machine). The RT protocol included 10 machine exercises (leg press, leg extension, leg curl, chest press, shoulder press, seated row, biceps curl, triceps press, abdominal crunch, lower back extension) selected to engage all major muscle groups. Participants progressed from 2 sets (weeks 1–2) to 3 sets (weeks 3–12) of 8–12 repetitions for each exercise in a circuit style with 1–2 min rest between sets. Remaining mindful of safe progressions, participants were encouraged to increase intensity (i.e., lift heavier weight for less repetitions) during weeks 9–12. Each RT session was followed by 5–10 min of upper- and lower-body stretching led by the trainer. ET participants had partner stretches incorporated into their post-RT session stretching. Trainers encouraged participants to perform each stretch to the point of tightness or slight discomfort, and frequently reminded participants to stretch on their own after walking.

Participants assigned to the ET group also received education during their RT sessions on how to facilitate partner support and receptivity to partner health influence. The structure of this educational component was adapted with permission from an existing program, Exercising Together®, which is a partnered strength training program designed to maximize outcomes and improve teamwork in married couples coping with prostate cancer [27]. Although the exercise prescriptions used in the current study and Exercising Together® are quite different, the current study used selected tactics from Exercising Together® to teach partners how to take on

reciprocal roles of "exerciser" and "coach" during exercise sessions. The overarching purpose of this education was to maximize effort during training and encourage exercise maintenance when couples were no longer working in a supervised setting. All ET couples were provided this additional educational component by a designated exercise trainer who had been trained to deliver this support. To maintain the integrity of the groups, this trainer only interacted with the ET participants and ET couples did not train with ES couples. This educational component was delivered at standardized time points throughout each RT session to ensure that all couples received similar guidance. Specifically, couples were coached to assist their partner with technical aspects of the exercise (form, body position, etc.) and recognize and applaud effort and achievements. Further, the study exercise trainer provided prompts to encourage positive interactions between partners and to reinforce one another's support efforts (e.g., "You two work really well together"; "Your partner is really dedicated to helping you through this program"). The ES group did not receive an educational component.

Exercise Adherence

Exercise adherence was measured for both walking and RT. Walking adherence was assessed from two viewpoints: (1) adhering to the exact prescription (i.e., ≥ 30 min on at least 3 days/week with (ET) or without (ES) the study partner); and (2) obtaining the prescribed walking volume regardless of partner participation. RT adherence was measured by session attendance.

Cultural Relevance

In an effort to answer calls in recent literature for more culturally relevant strategies to promote PA in AAs [19, 26], investigators incorporated both surface and deep level components of cultural relevance into this pilot intervention [39, 40]. This strategy can be particularly valuable in AAs, who have been shown to have collectivist values [31]. Surface level components included targeted messaging (e.g., placing an emphasis on overall health when recruiting, leveraging blood pressure and body composition screenings at a community health fair for PA and study promotion, pictures of AA couples on study flyers), as well as having a principal investigator plus the majority of the study staff (including all assigned exercise trainers) who were AA. Further, engaging a community advisory board prior to launching the pilot study [33] and conducting focus groups with study participant post-intervention to assist with the intervention development were surface level components utilized in the current study. A deep structure strategy used was the active involvement of spouses (i.e., family members). This study leveraged pre-existing romantic relationships to intervene on exercise participation in a

way that incorporated familial social support. In addition, potential participants with childcare concerns were invited to bring self-sufficient children to RT sessions whenever needed. Although the study was not able to provide care for the children, study staff felt supporting participants with this option was important. There were very few concerns of this nature given the participant age group; however, two couples did occasionally take advantage of this option and one other inquired about it when a potential time conflict with caring for a grandchild was presented.

Post-Intervention Testing

All pre-intervention laboratory testing was repeated within 3–10 days after the 12-week intervention had been completed using identical procedures. Participants were also asked to report back to LabCorp within 3–7 days post-intervention to repeat the venous blood draw. Samples were analyzed for the same biomarkers as those measured pre-intervention using the same methods for processing and analyses. For intervention completion, participants received cash incentives of $50/person ($100/couple) and were given their study activity monitors.

Statistical Analyses

Baseline participant characteristics were summarized using descriptive statistics (mean ± SD). Outcomes were analyzed using generalized linear mixed models with an auto regressive (AR1) covariate structure, controlling for gender. Group × time interactions and time main effects were assessed. Marginal means ± SE and confidence intervals from the general linear mixed models are presented. Independent-sample t tests were run for comparison of baseline characteristics and exercise prescription adherence between groups. Statistical analyses were completed using the IBM SPSS statistical analysis software version 22 (IBM Corporation; Armonk, NY). Significance was accepted at $P \leq 0.05$.

Results

Participants and Study Retention

Figure 1 shows the flow of participants through the study. One partner from 64 couples responded to study recruitment tactics. Of these, 25 couples (39%) were screened out and 20 couples (31%) excluded themselves largely due to non-responsiveness after initially contacting the study. Nineteen couples underwent initial pre-intervention testing and five of those couples were ultimately excluded because one partner exceeded the maximum objective PA threshold. Of the 14

couples that were randomized (*n* = 28; 22% enrollment rate), four couples (*n* = 8) had their study participation stopped prematurely at 5½ weeks by social distancing mandates secondary to the COVID-19 pandemic. Table 1 presents descriptive characteristics of all participants who entered the intervention, including the couples affected by the pandemic. In general, participants who entered the study were average age 62.0 ± 9.4 years, obese (BMI 31.6 ± 4.8 kg/m^2), low active (5974 ± 1557 average steps/day) [35], and had multiple risk factors for cardiometabolic disease. Although not required, all couples who entered the study were married. These 14 couples reported an average of 35.4 ± 11.4 years together with their current partner. Of those who entered the study, one participant identified as Caucasian with all others identifying as AA. All study completers were AA.

Of the 10 couples (*n* = 20) that were randomized and had no disruption to their opportunity to complete the intervention and post-intervention testing, nine couples (*n* = 18) remained in the study (10% dropout). Only one ES couple discontinued participation, due to a non-study-related injury sustained by one partner. A different participant reported a minor groin strain that required temporary weight reduction for the lower body RT exercises. The issue did not affect the participant's RT session attendance or study retention. All other participants were fully compliant with the prescribed RT exercise. There was no significant difference in age between completers in the ET (62.4 ± 8.4 years) and ES (63.3 ± 7.4 years) groups. There was also no significant difference in relationship duration between completers in the ET (40.4 ± 9.8 years) and ES (32.5 ± 15.2 years) groups.

Exercise Adherence

In general, adherence to the prescribed home-based walking per the exact prescription was low (35.1 ± 3.3%) and RT session adherence was high (91.7 ± 7.8%). Table 2 summarizes exercise adherence by group in participants who completed the study. Although there were no significant differences between groups for any measure of exercise prescription adherence, ET data showed a trend of more self-reported walking compared to ES. When examining walking adherence overall, the ET group achieved a higher percentage of the total prescribed walking

Table 1 Baseline descriptive characteristics of participants who entered the study (*n* = 28)

Variables	Women (*n* = 14)	Men (*n* = 14)	All (*n* = 28)	Range
Age (years)	61.2 ± 9.5	62.9 ± 9.6	62.0 ± 9.4	40.6–74.8
Height (m)	164.8 ± 5.9	180.5 ± 9.2	172.7 ± 11.0	154.5–195.0
Weight (kg)	85.8 ± 15.4	103.4 ± 19.2	94.6 ± 19.3	57.0–147.0
Body mass index (kg/m^2)	31.4 ± 4.6	31.7 ± 5.2	31.6 ± 4.8	23.1–42.7
Waist circumference (cm)	93.5 ± 8.2	104.4 ± 9.7	98.9 ± 10.4	78.8–121.8
Hip circumference (cm)	113.9 ± 12.0	113.7 ± 11.2	113.8 ± 11.4	93.8–144.3
Body fat (%)	44.1 ± 4.5	34.4 ± 5.8	39.3 ± 7.1	24.8–50.8
Total fat mass (kg)	38.3 ± 9.2	36.3 ± 11.2	37.3 ± 10.1	17.8–59.5
Total lean mass (kg)	99.5 ± 15.3	140.4 ± 21.6	119.9 ± 27.8	75.3–186.1
Android fat (%)	51.8 ± 6.7	46.0 ± 8.1	48.9 ± 7.9	29.9–60.9
Gynoid fat (%)	46.4 ± 5.0	34.6 ± 6.0	40.5 ± 8.1	25.7–57.8
Systolic BP (mmHg)	139.5 ± 17.0	136.8 ± 14.3	138.1 ± 15.5	115.3–169.8
Diastolic BP (mmHg)	84.9 ± 11.2	82.6 ± 6.5	83.7 ± 9.1	68.5–104.5
Glucose (mg/dL)	95.1 ± 17.0	101.8 ± 15.8	98.4 ± 16.5	71.0–142.0
Insulin (μIU/mL)	15.2 ± 9.1	17.1 ± 11.5	16.1 ± 10.2	3.8–38.6
HOMA-IR	3.3 ± 1.9	3.4 ± 2.4	3.3 ± 2.1	0.7–8.2
Hemoglobin A1c (%)	5.8 ± 0.7	6.5 ± 3.8	6.1 ± 2.7	0.6–18.5
Triglycerides (mg/dL)	98.8 ± 56.5	106.8 ± 44.9	103.0 ± 50.0	32–212
HDL cholesterol (mg/dL)	69.5 ± 17.2	51.8 ± 14.2	60.3 ± 17.9	34–91
Total cholesterol (mg/dL)	177.7 ± 27.9	200.5 ± 52.9	188.7 ± 42.6	129–313
C-reactive protein (mg/L)	6.7 ± 9.7	3.1 ± 3.1	4.9 ± 7.3	0.3–30.3
Fibrinogen (mg/dL)	336.3 ± 45.2	325.6 ± 67.4	331.0 ± 56.6	223–436
Average baseline steps/day	6021 ± 1342	5927 ± 1797	5974 ± 1557	2131–7942

Values presented as mean ± SD

Baseline steps were averaged over a 7-day period at the beginning of the study

BP blood pressure; *HOMA-IR* homeostatic model assessment-estimated insulin resistance; *HDL* high-density lipoprotein
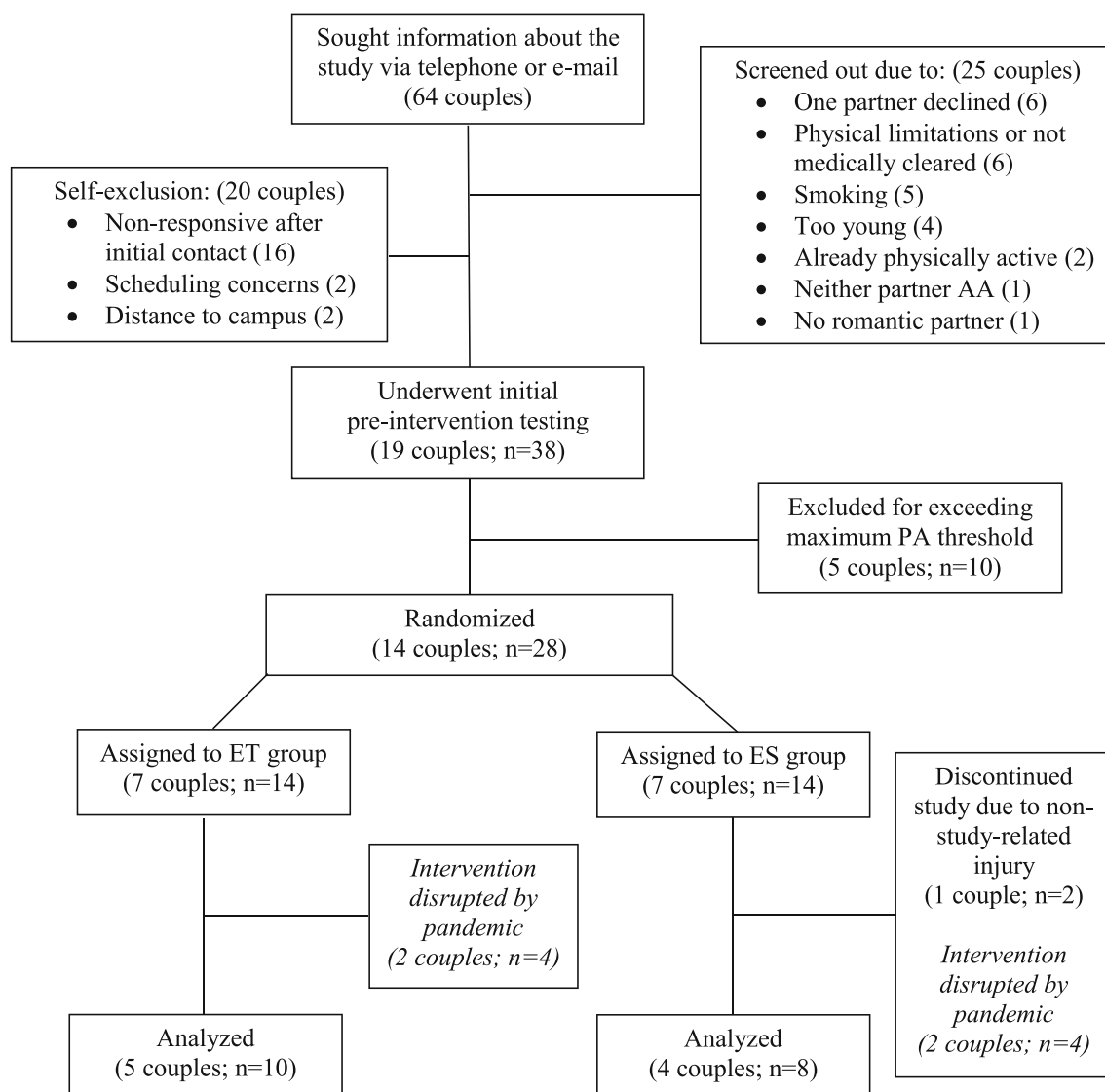
Fig. 1 Flow diagram of participant progression through the study. AA = African-American; PA = physical activity; ET = group exercised together; ES = group exercise separately

time (17.5% difference), walked 20 more average minutes/week, and walked 241 more total minutes over 12 weeks compared to the ES group.

On average over the 12 weeks, those who completed the study performed three sets (except weeks 1 and 2 where 1–2 sets were completed) of 10.8 ± 1.8 repetitions for each exercise during RT sessions, and trained at $72.0 \pm 11.4\%$ of their baseline upper body 1-RM (chest press) and $68.1 \pm 11.8\%$ of their baseline lower body 1-RM (leg press). Actual RT intensity progressively increased from $58.8 \pm 10.0\%$ (weeks 1–4) to $86.1 \pm 14.5\%$ (weeks 9–12) of initial 1-RM in the upper body and from $55.9 \pm 9.3\%$ (weeks 1–4) to $80.1 \pm 13.7\%$ (weeks 9–12) of initial 1-RM in the lower body. Strength gains by group are presented in Table 3 and showed a significant time effect (increase) for both upper and lower body over the 12-week intervention. There was no significant group ×

time interaction for strength. The ET group attended marginally fewer RT sessions (89%) than the ES group (95%; $P = 0.070$).

Body Composition and Cardiometabolic Risk Factors

Table 3 shows comparisons in study completers for body composition and several biomarkers for cardiometabolic disease. For body composition variables, there were significant time effects for waist circumference ($P < 0.001$), percentage of body fat ($P = 0.020$), total fat mass ($P = 0.007$), and gynoid fat ($P = 0.041$). All variables showed a decrease in both groups, and there were no significant interactions between groups. For cardiometabolic risk factors, there were significant time effects for hemoglobin A1c ($P = 0.020$) and high-density lipoprotein (HDL) cholesterol ($P = 0.047$), where both variables

Table 2 Summary of exercise adherence in study completers (n = 18)

Variables	Exercised together (n = 10)	Exercised separately (n = 8)
Self-reported walking		
Exact prescription[a]		
Average percent of weekly adherence (%)	39.1 ± 32.9	30.2 ± 35.3
Average walking (minutes/week)	86.5 ± 57.7	66.1 ± 31.7
Total walking time over 12 weeks (minutes)	842.3 ± 285.4	722.8 ± 427.8
Overall[b]		
Average percent of weekly adherence (%)	55.0 ± 32.0	37.5 ± 35.4
Average walking (minutes/week)	85.5 ± 58.1	65.0 ± 31.5
Total walking time over 12 weeks (minutes)	1009.8 ± 275.7	768.4 ± 435.7
Resistance training		
Percent resistance training session attendance out of 24 sessions (%)	88.7 ± 6.7	95.4 ± 7.8

There were no significant differences between groups (P < 0.05)

[a] Exact walking prescription defined as ≥ 30 min on at least 3 days/week with (ET) or without (ES) the study partner

[b] Overall walking prescription defined as ≥ 90 min, regardless of partner participation

Discussion

decreased. The group × time interaction for hemoglobin A1c approached significance (P = 0.070). There were no significant interactions for any other variable.

This study intervenes with a vulnerable population (overweight and obese, elevated waist circumferences, hypertension, impaired glucose disposal) that can achieve a variety of health benefits from adopting regular exercise. As such, testing new strategies designed to promote and maintain exercise habits is critical. To the current investigators' knowledge, this study was the first to pilot test a couple-based exercise intervention in AA adults. There were no group × time interactions for any outcomes, but these data showed significant overall time effects for multiple body composition variables and hemoglobin A1c. Despite the current data showing no significant differences between the ET and ES treatment groups, the exercise prescription may have important health effects in this population. In addition, investigators note walking adherence trends that show the ET group accumulated more walking than the ES group. This may suggest the need for further research that examines these couple-based approaches in a larger trial to clarify whether or not future recommendations should encourage exercising with a partner to promote exercise adherence and improve health, or if simply having an active partner is sufficient to achieve these benefits.

Dyadic approaches enable investigators to take advantage of the built-in support of existing relationships in order to optimize exercise intervention efforts and potentially have a greater impact on communities. As AA women are becoming increasingly represented in exercise and PA intervention literature [15, 17, 19], one of the current investigators' motives for employing a romantic couple-based dyadic approach in AA adults was to assist in the recruitment and retention of AA men in the pilot intervention. Ultimately, the goal was to contribute to the representation of AA men in intervention literature related to physical health so their data are considered when developing interventions in AA communities. Two recent systematic literature reviews confirmed low availability of PA and exercise intervention data in AA men [16, 18]. Though the studies available showed beneficial results (i.e., improvements in PA and health measures) and several were culturally tailored to AAs, there is still a need for interventions to utilize tailoring that is appropriate for the intersection of race and male gender. Even though the current study was guided in-part by a conceptual framework developed for older AA women, facilitating the reciprocal coach-type interaction with partners (partners encouraging each other to exercise and supporting each other during exercise) and choosing RT as a key exercise modality were designed to help attract men and retain them in the intervention [41]. The current study did not measure the reasons why participants were interested in participating; however, this is an aspect of mixed-gender dyadic research that should be explored in the future. That said, the current study's overall retention and RT adherence were both excellent.

Targeting couples for PA promotion has been encouraged and it is acknowledged that partners, especially spouses, can be remarkably influential in older age when social circles tend

Table 3 Variable comparisons of study completers adjusted by gender (n = 18)

Variables	Exercised together (n = 10)		Exercised separately (n = 8)		Overall	
	PRE	POST	PRE	POST	PRE (95% CI)	POST (95% CI)
Strength and objective physical activity						
Upper body strength (kg)	37.0 ± 4.1	45.5 ± 4.1	40.1 ± 4.6	47.2 ± 4.6	38.6 ± 3.1 (32.0–45.1)	46.3 ± 3.1 (39.8–52.8) **
Lower body strength (kg)	104.5 ± 7.3	122.3 ± 7.3	110.2 ± 2.6	118.0 ± 8.5	107.4 ± 5.4 (96.1–118.6)	120.0 ± 5.6 (108.6–131.7) *
Average steps/day	6172 ± 567	6184 ± 567	6013 ± 634	6403 ± 754	6092 ± 425 (5210–6975)	6293 ± 472 (5322–7264)
Body composition variables						
Weight (kg)	94.9 ± 4.7	94.8 ± 4.7	85.8 ± 5.2	86.4 ± 5.2	90.4 ± 3.5 (82.9–97.8)	90.6 ± 3.5 (83.2–98.1)
Body mass index (kg/m^2)	31.9 ± 1.4	31.9 ± 1.4	29.7 ± 1.6	29.9 ± 1.6	30.7 ± 1.1 (28.5–33.1)	30.9 ± 1.1 (28.6–33.2)
Waist circumference (cm)	98.0 ± 2.6	96.6 ± 2.6	96.2 ± 2.9	94.6 ± 2.9	97.1 ± 2.0 (92.9–101.2)	95.6 ± 2.0 (91.4–99.8) **
Hip circumference (cm)	114.4 ± 3.0	113.1 ± 3.0	108.3 ± 3.4	107.6 ± 3.4	111.3 ± 2.2 (106.6–116.1)	110.3 ± 2.2 (105.5–115.1)
Body fat (%)	39.5 ± 1.7	39.2 ± 1.7	37.0 ± 1.9	35.9 ± 1.9	38.3 ± 1.2 (35.6–40.9)	37.6 ± 1.2 (34.9–40.2) *
Total fat mass (kg)	37.6 ± 2.8	37.0 ± 2.8	31.9 ± 3.1	31.0 ± 3.1	34.7 ± 2.1 (30.3–39.2)	34.0 ± 2.1 (29.6–38.4) **
Total lean mass (kg)	53.3 ± 2.3	54.5 ± 2.3	51.0 ± 2.6	51.9 ± 2.6	52.1 ± 1.8 (48.4–55.8)	53.2 ± 1.8 (49.5–56.9)
Android fat (%)	49.2 ± 2.5	49.9 ± 2.5	46.3 ± 2.8	45.1 ± 2.8	47.7 ± 1.9 (43.8–51.7)	47.5 ± 1.9 (43.6–51.5)
Gynoid fat (%)	41.1 ± 1.5	40.7 ± 1.5	37.5 ± 1.6	36.7 ± 1.6	39.3 ± 1.1 (37.0–41.7)	38.7 ± 1.1 (36.3–41.0) *
Cardiometabolic risk factors						
Systolic BP (mmHg)	141.2 ± 5.2	138.4 ± 5.2	140.1 ± 5.9	136.5 ± 5.9	140.6 ± 3.9 (132.4–148.9)	137.5 ± 3.9 (129.2–145.7)
Diastolic BP (mmHg)	83.3 ± 3.5	82.2 ± 3.5	84.7 ± 4.0	83.3 ± 4.0	84.0 ± 2.7 (78.4–89.6)	82.7 ± 2.7 (77.1–88.4)
Glucose (mg/dL)	91.1 ± 4.2	94.9 ± 4.2	97.3 ± 4.7	94.5 ± 4.7	94.2 ± 3.2 (87.6–100.8)	94.7 ± 3.2 (88.1–101.3)
Insulin (μIU/mL)	14.4 ± 2.8	15.0 ± 2.8	14.3 ± 3.1	14.2 ± 3.1	14.4 ± 2.1 (10.0–18.7)	14.6 ± 2.1 (10.3–19.0)
HOMA-IR	3.2 ± 0.8	3.5 ± 0.8	3.7 ± 0.8	3.5 ± 0.8	3.5 ± 0.6 (2.3–4.6)	3.5 ± 0.6 (2.3–4.6)
Hemoglobin A1c (%)	5.8 ± 0.1	5.8 ± 0.1	6.0 ± 0.6	5.7 ± 0.6	5.9 ± 0.1 (5.7–6.1)	5.7 ± 0.1 (5.5–6.0) *
Triglycerides (mg/dL)	96.8 ± 14.6	109.4 ± 14.6	80.5 ± 17.0	93.3 ± 16.3	88.7 ± 11.2 (65.3–112.0)	101.3 ± 11.0 (78.5–124.2)
HDL cholesterol (mg/dL)	59.2 ± 4.7	54.2 ± 4.7	64.2 ± 5.5	57.8 ± 5.3	61.7 ± 3.6 (54.2–69.2)	56.0 ± 3.5 (48.6–63.4) *
Total cholesterol (mg/dL)	182.2 ± 13.9	190.0 ± 13.9	185.0 ± 15.6	182.3 ± 15.6	183.6 ± 10.4 (161.7–205.6)	186.1 ± 10.4 (164.2–208.1)
C-reactive protein (mg/L)	2.4 ± 1.6	2.2 ± 1.6	4.9 ± 1.7	4.1 ± 1.7	3.6 ± 1.2 (1.2–6.1)	3.1 ± 1.7 (0.7–5.6)
Fibrinogen (mg/dL)	337.3 ± 17.4	324.7 ± 17.9	319.9 ± 19.5	307.3 ± 19.5	328.6 ± 13.1 (301.2–356.0)	316.0 ± 13.2 (288.3–343.7)

Values presented as estimated marginal means ± SE adjusted by gender

Baseline steps were averaged over a 7-day period at the beginning of the study. Post-intervention steps were an average of weeks 11 and 12 of the intervention

There were no significant differences between groups at baseline for any variable

There were no significant group × time interactions

PRE pre-intervention/baseline; *POST* post-intervention, 12 weeks after baseline; *BP* blood pressure; *HOMA-IR* homeostatic model assessment-estimated insulin resistance; *HDL* high-density lipoprotein

*Statistically significant time effect from pre- to post-intervention (P < 0.05)

**Statistically significant time effect from pre- to post-intervention (P < 0.01)

to decrease [42]. Previous work incorporating couple-based PA and exercise interventions conducted in other populations (e.g., multiple varieties of clinical patients and their partners, couples compared to individuals in Japan) show promising results with significant improvements in PA that were maintained over time [11, 43]. That said, few incorporated RT as an exercise modality [43, 44] and none used a machine-based RT program. Further, there are currently few exercise interventions that examine cardiometabolic effects after chronic RT in middle-aged and older AA adults [24,

25]. As such, the current couple-based study used a dual-modality exercise prescription to examine and ultimately promote the importance of both cardiovascular and muscle-strengthening exercise in a population that could greatly benefit from participation in both. This could have greater long-term benefit on health and functionality in a population at risk for a myriad of physical declines.

Although the current walking prescription (≥ 30 min on at least 3 days/week) was not sufficient to meet current national physical activity guidelines (≥ 150 min/week) [45], the

approach was designed taking into account that low active individuals were being recruited and remaining cognizant of participants' time given the dual-modality protocol (i.e., RT 2 days/week was also prescribed). Despite this gradual incorporation of walking into the weekly routine, self-reported adherence to the home-based walking prescription was generally low (ET: 39% and ES: 31%). This aligns with previous data from Hornbuckle et al. [24] that also showed poor adherence to a home-based walking prescription in middle-aged AA women. That said, the current results showed a trend that was hypothesized by investigators where the ET group had better prescription adherence and accumulated more walking overall compared to the ES group. It is also notable that even though ET participants only adhered to the exact walking prescription 39% of the time, they nearly met the total prescribed weekly walking time with their partner (86.5 of 90 prescribed minutes) compared to the ES group's 30% adherence and 66 of 90 min achieved without their partner. Data show this occurred because ET couples had a tendency to complete a lower number of walking bouts for longer durations. This may suggest that occasional direct partner involvement (i.e., exercise bouts completed together) can affect overall exercise accumulation; however, more research is needed to explore this theory. This trend aligns with previous research by Osuka et al. [43] in older Japanese adults that showed significantly higher walking adherence in married couples who exercised together versus individuals who participated in the same 8-week intervention and exercised alone. Adherence in that study was measured over the 6 months following an 8-week active intervention (which included group walking and body weight RT classes once per week), indicating long-term promise for exercising with a spouse. This study, combined with the current results, suggests that focusing on couples' sustained changes, even if they are gradual and not yet meeting guidelines, still represents an important first step to addressing physical inactivity.

The current data showed no changes in objectively measured PA, which was discouraging given the relatively low step counts at baseline. As study completers reported an average daily monitor wear time of 14 h and 26 min across 12 weeks, investigators speculate that participants could have compensated for the added exercise with extra rest, as rest has been previously been cited as a priority in AAs, particularly after involvement in physical labor [46]. Wrist-worn activity monitors have also been found to undercount steps when walking speed is slower than 2 mph [47], when gait is altered (e.g., shuffling or soft gait/reduced impact forces) [48], and when walking with assistance (e.g., holding handrails during treadmill walking) [47, 49]. As the walking part of the program was unsupervised and these walking characteristics are common in older individuals, these may have contributed to the lower step counts achieved during the study. Further,

increases in walking speed and intensity were not goals of the current program, so a change in steps may have been difficult to capture given the limitations of wrist-worn monitors.

Consistent with previous studies in couples and AA women and men [24, 25, 43], this study had high RT adherence. This is not particularly surprising given the accountability provided by the exercise trainers, however does speak to the acceptance and feasibility of RT as an exercise modality in this population. As part of a follow-up to the current study, participants were given free access to a partner commercial fitness facility after the supervised intervention ended. As such, investigators will be able to assess this sample's long-term RT adherence in subsequent research, which will hopefully inform future intervention plans and long-term RT recommendations for partner involvement.

The significant positive time effect observed in multiple body composition variables (waist circumference, body fat, total fat mass, gynoid fat) and hemoglobin A1c across both groups is promising. These results align with a previous study by Hornbuckle et al. [24] conducted in middle-aged AA women that showed significantly greater improvements in waist circumference, total fat mass, and gynoid fat after walking plus RT compared to the group that walked only. As a surrogate marker for visceral fat (which drives many negative metabolic effects and is linked to a poor metabolic profile) [36], the authors speculate that the small but significant decrease in waist circumference could have positive implications for cardiometabolic risk if exercise participation and gradual decreases continue. Similarly, continued walking plus RT could elicit further improvements in body composition (increased muscle mass and decreased fat mass) which would likely have positive and important basal metabolic implications over time [50].

Hemoglobin A1c, a marker of long-term glycemic control, has consistently shown improvements after chronic RT in men and women, particularly when training at higher intensities (approximately 70–90% of the 1-RM) [21]. This metabolic benefit was the main reason the current program encouraged higher RT intensities in its latter weeks. The current study's overall average training intensity of 72.0% for upper body 1-RM and 68% of lower body 1-RM is at the lower end of the suggested intensity range for improvements in glycemic control, which may explain the significant yet modest clinical improvements in hemoglobin A1c. Further, average HOMA-IR values in this study were above suggested insulin resistance thresholds for cardiometabolic risk (2.0–2.5) [51] and showed no improvements. The current study also showed a significant time effect for HDL cholesterol where it decreased. Although this was an undesirable effect and difficult to explain, post-intervention values remained high enough to not place participants at any additional risk for

cardiovascular disease (< 40 mg/dL) [36]. Triglycerides in both groups and total cholesterol in the ES group also showed increasing trends. However, similar to HDL cholesterol, none of these values reached abnormal levels for any group (triglycerides ≥ 150 mg/dL and total cholesterol ≥ 200 mg/dL) [36].

Also notable is the hypertensive status (≥ 130/80 mmHg) of both groups both pre- and post-intervention [52]. Although post-intervention values did not reach normal (< 120/80 mmHg) or even pre-hypertensive levels, the downward trend in both groups was encouraging and like other variables discussed, may indicate the possibility for further improvements if regular exercise continues. C-reactive protein at baseline and post-intervention were normal in ET and elevated in ES (> 3.0 mg/L) [53], yet baseline differences were not statistically significant nor were the changes over the intervention. C-reactive protein is an indicator of chronic inflammation that is also linked to atherosclerosis. Fibrinogen, a thrombotic marker and cardiovascular risk factor when elevated, was normal at baseline (≥ 350 mg/dL) [54] and showed non-significant decreases pre- to post-intervention for both groups. Together, these findings offer preliminary evidence that encouraging partner involvement in exercise—either directly (as in the ET group) or indirectly (as in the ES group)—may yield meaningful improvements in the health and well-being of older AA couples. Although power issues may have led to the minimal group differences found here, it could also reflect that getting both partners on the same page about the importance of exercise is the key idea, whether that be as a team working together or simply two equally health-conscious partners.

This study had several strengths. As mentioned above, this study fills several documented gaps in AA exercise research by investigating of AA men, promoting RT as an important exercise modality in this aging population, and incorporating culturally relevant strategies in an effort to optimize the program's success. The combination of these strategies in one program may help address multiple documented barriers to PA in AA women and men including lack of social support, lack of a PA partner, lack of PA role models, and the need/desire to prioritize spending time with family [12, 13]. Lack of time is also a well-documented barrier to PA cited by this population and many others. Exercising with a romantic partner can help mitigate many of these barriers, and may be more acceptable in this population due to dual benefit of spending time with a partner and engaging in exercise.

The investigators recognize this study also had limitations. Although it is possible there could have been some differences between couples that were not accounted for in our statistical model, the authors do not feel there was enough unique variation within each couple to warrant this type of examination due to the speculation that differences within couples are likely greater than those between couples (i.e., any reasons for

physiological variations are not necessarily shared reasons). Preliminary higher-level analyses of this sample showed that accounting for couple did not add anything to the model as there was no consistent variability that could be accounted for by couple membership. In a larger scale study, investigators could confirm whether or not including couple improves the model. In addition, the small sample size could have affected the results overall and the ability to detect differences between groups. However, these data will be used to estimate power and sample size when making plans to launch the intervention on a larger scale and explore the effect of the intervention on various outcomes. When participants are in a free-living environment, a lack of environmental control must be acknowledged. Specifically, factors such as diet, overall health status, medications, sleep, and general lifestyle habits could have affected the study's results. Investigators attempted to control for some of this variability by requesting to be notified of any medication changes (none were reported post-intervention) and requesting that participants keep their diet consistent and not begin any regimens (e.g., restrictive dieting, supplementation, exercise not prescribed by the study) that would elicit weight loss or other physiological changes that could interfere with study results. Participants could have also executed the at-home walking prescription outside of their prescription; however, the study walking log was designed to detect this and it was reported. Last, it is notable that walking adherence results were self-reported, which invites the potential for reporting errors.

Despite the aforementioned limitations, this study is significant because it lays important groundwork for a novel method to disseminate exercise interventions in the AA community. In addition to its promising outcomes, this study proves that this protocol was feasible and safe for this demographic. Investigators will combine data previously collected from the study's community advisory board [33], the current data on adherence and cardiometabolic risk outcomes, and qualitative data collected post-intervention to inform future dyadic intervention plans in AA adults. Using this comprehensive approach to develop a community-engaged, culturally relevant strategy for exercise intervention could help the current investigators cultivate an innovative plan to produce lasting exercise behavior change in AA adults. This work is essential as it addresses critical health concerns in the AA community (physical inactivity, obesity, cardiometabolic risk) that contribute to persistent health disparities. If successful on a larger scale, these methods could also be translated to additional types of dyads, expanding the reach of the current efforts to design a sustainable, positive effect on physical activity.

Compliance with Ethical Standards

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