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Yoga lifestyle intervention reduces blood pressure in HIV-infected adults with cardiovascular disease risk factors

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Abstract

People living with human immunodeficiency virus infection (HIV) are at increased risk for developing cardiovascular disease (CVD). Safe and effective interventions for lowering CVD risk in HIV are high priorities.

Objective—We conducted a prospective, randomized, controlled study to evaluate whether a yoga lifestyle intervention improves CVD risk factors, virologic or immunologic status, or quality of life in HIV-infected adults more than in a matched control group.

Methods—Sixty HIV-infected adults with mild-moderate CVD risk were assigned to 20 wks of supervised yoga practice or standard of care treatment. Baseline and week 20 measures were; 2hr-oral glucose tolerance test with insulin monitoring, body composition, fasting serum lipid/lipoprotein profile, resting blood pressures, CD4+ T-cell number and plasma HIV RNA, and the Medical Outcomes Study SF-36 health-related quality of life inventory.

Results—Resting systolic and diastolic blood pressures were reduced more (p=0.04) in the yoga group (−5±2 and −3±1 mmHg) than in the standard of care group (+1±2 and +2±2 mmHg), despite no greater reduction in body weight, fat mass, proatherogenic lipids, or improvements in glucose tolerance or overall quality of life after yoga. Immune and virologic status was not adversely affected.

Conclusion—Among traditional lifestyle modifications, yoga is a low cost, simple to administer, non-pharmacological, popular behavioral intervention that can lower blood pressure in pre-hypertensive HIV-infected adults with mild-moderate CVD risk factors.

Keywords

complementary or alternative therapy; physical activity; cardiometabolic complications; hypertension

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Introduction

Infection with human immunodeficiency virus (HIV) and treatment with combination antiretroviral therapy (cART) have been associated with several metabolic and anthropomorphic alterations that increase cardiovascular disease (CVD) risk (1,2). These alterations include insulin resistance, dyslipidemia, visceral adiposity, subcutaneous lipoatrophy, and bone demineralization, and several are components of the cardiometabolic syndrome. cART has effectively reduced HIV-related morbidity and mortality, but HIV-infected people are living longer with significant CVD risk. HIV providers are confronted with the challenge of effectively addressing CVD risk, and specifically to identify traditional or alternative/complementary therapies that may reduce CVD risk in HIV.

People living with HIV, taking cART, and experiencing cardiometabolic syndromes often use alternative or complementary therapies to manage side-effects of HIV or cART (3–7). Recent surveys estimate that 47–74% of HIV-infected individuals in the U.S. have used some form of alternative-complementary therapy to improve general health and well being (7). One potentially safe, effective, low cost, and popular behavioral intervention that might be employed to manage HIV-associated cardiometabolic complications is the practice of yoga. Yoga is based on an ancient system of breathing exercises, postures, stretches, and meditations founded in Ayurvedic medicine and Indian philosophy and religion, and it is believed to help ‘detoxify’ the body, mitigate chronic fatigue, enhance endurance, and improve organ and immune functions (8).

Several reviews of published studies, in people without HIV, concluded that the practice of yoga may reduce insulin resistance and related CVD risk factors and improve clinical outcomes (8–11). Specifically, reports suggest that a yoga lifestyle intervention reduces body weight, blood pressures, glucose and cholesterol levels, and improves vascular function; adaptations that should reduce CVD risk and improve quality of life in HIV-infected people (8,11–33). Despite the popularity and potential benefits of yoga, no prospective, randomized, controlled trial has examined the cardiometabolic benefits of a yoga lifestyle in HIV-infected people with CVD risk factors. The purpose of this randomized, controlled study was to determine whether 20 wks of supervised instruction and practice in yoga asanas (postures) and pranayama (breathing exercises) improves CVD risk factors, including; oral glucose tolerance, lipid/lipoprotein levels, resting blood pressures, body composition, immune and virologic status, or health-related quality of life (QOL) in HIV-infected men and women more than that in a control group that received standard of care.

Methods

Participants

Participants were recruited from the Washington University AIDS Clinical Trials Unit and local Infectious Diseases Clinics. Sixty HIV-infected men and women (18–70 yr old) were randomly assigned (3:2) to receive 20 wk of individual and group instruction in the practice of yoga from a certified yoga instructor, or 20 wk of continued standard of care treatment (Fig 1). Eligibility criteria were; documented HIV-status, stable and with no plans to change current cART, CD4+ T-cell count >200 cells/μL, plasma HIV RNA <15,000 copies/mL, and at least one of the following CVD risk factors: dyslipidemia, central adiposity, glucose intolerance/insulin resistance, or hypertension. Dyslipidemia was defined as low HDL-cholesterol level (<1.0 mmol/L(men), <1.3 mmol/L(women)), or fasting hypertriglyceridemia (>1.7 mmol/L), or high LDL-cholesterol level (>2.6 mmol/L), or current use of a lipid-lowering agent. Central adiposity was defined as waist circumference >102 cm(men), >88 cm(women), or trunk/limb adipose ratio >1.0(men), >0.85(women)) using whole body dual energy x-ray absorptiometry. Glucose intolerance/insulin resistance were defined as fasting blood glucose 5.6–6.9 mmol/L,

or 2hr-blood glucose 7.8–11.0 mmol/L, or fasting insulin level >72 pmol/L, or current use of anti-diabetes agent. Hypertension was defined as resting systolic blood pressure >130 mmHg, or resting diastolic blood pressure >85 mmHg (on 3 occasions) or current use of anti-hypertensive agent. Exclusion criteria included; chronic hepatitis B or active hepatitis C virus infection, diabetes, male hypogonadism (<7.0 nmol/L), hypo- or hyperthyroidism (<0.2 or >12 μIU/mL), pregnant or plans to become pregnant, prior MI, unstable angina, heart failure, coronary artery disease, resting ST-segment depression >1mm, coronary artery bypass graft, or stroke, and active substance abuse. Both groups received monthly nutrition counseling (AHA guidelines; (34)) from a research dietician. Standard of care included regular routine visits to the participant's Infectious Disease physician, no added physical activity, no changes in cART, and no added medications for hyperglycemia, hyperlipidemia, or hypertension. All participants signed an informed consent document and the study was approved by the Human Research Protection Office at Washington University School of Medicine.

Measurements

At baseline and 20 wks, participants were examined by a physician-investigator. Waist circumference was measured at the midpoint between the costal margin and anterior superior iliac crest. After an overnight fast (8–10hr), resting EKG and blood pressures (average of 3 resting measures), serum lipid/lipoprotein levels (total-, HDL-cholesterol, triglyceride, and calculated LDL- and non-HDL-cholesterol levels), comprehensive metabolic panel (e.g., liver and kidney function tests), CD4+ T-cell count (flow cytometry), plasma HIV RNA level (Roche Amplicor™ HIV-1 Monitor Test; Branchburg, NJ), and a 75g, 2hr-oral glucose tolerance test with plasma glucose and insulin monitoring at 0, 30, 60, 90, and 120min were obtained. Whole body and regional body composition were quantified using enhanced-array whole body dual energy x-ray absorptiometry (Hologic Discovery (software v12.4; Waltham, MA). Participants completed the MOS SF-36 health-related quality of life (HIV-QOL) inventory and a 3-day diet record to evaluate energy, macro- and selected micro-nutrient intakes.

Fasting serum lipid/lipoproteins were quantified as described previously (35). The accuracy of these analytical methods is verified and standardized by participation in the CDC Lipid Standardization Program, the CDC Cholesterol Reference Method Laboratory Network, and the College of American Pathologists external proficiency program. Blood glucose levels were quantified using the glucose oxidase reaction (Yellow Springs Instruments, Yellow Springs, OH). Plasma insulin levels were quantified using a chemiluminescent immunometric method (Immulite; Siemens, Los Angeles, CA). The plasma insulin assay range is 12–1800 pmol/L and the inter-assay coefficient of variation is 4% in the low (63 pmol/L) and high insulin concentration range (331 pmol/L). The homeostasis model assessment for insulin resistance was calculated [baseline glucose (mmol/L) × baseline insulin (μU/mL)]/22.5 (36). The MOS SF-36 (37) inventory has been validated for assessing health-related quality of life in HIV-infected people (38,39). The 3-day diet records were processed and analyzed by a research dietician using Nutritionist Pro™ nutrient analysis software (Axxya Systems, Stafford, TX). For each participant, 3-day average intake for fat (incl. saturated, trans), protein, carbohydrate, fiber, cholesterol, vitamin D, sodium, calcium, and caffeine were calculated.

Yoga Intervention

Ashtanga Vinyasa (the coordination and integration of breath with movement) yoga was taught and practiced. This yoga style follows progressive steps that require adherence, self-control, mental focus, self awareness and physical resilience. It encourages body alignment and balance, is easily reproducible, adaptable to participants' limitations, can be delivered safely, and with optimal time for learning. All sessions emphasized the proper use of aligned postures (asanas), controlled breathing (pranayama), focused gaze (drishti), and the regulation of prana

(a source of energy that maintains the body) through the use of bandhas (stabilizing muscle locks), strength building, increased flexibility, large muscle movement, asymmetrical movements, and restorative relaxation. The practice was modified to accommodate participant's limitations (range of motion, spine or joint discomfort, peripheral neuropathy) by allowing for more time between position transitions and by linking breath to movement.

The yoga sessions were standardized to optimize consistency between participants. They were held 2–3 times/wk for ~60 min/session and participants were enrolled for 20 wk. As participants progressively improved, the respirations (Ujjayi) were used to adjust the timing and transitions of the sequences. The maximum rate of respirations would last 35–45 sec/static pose (asana). Participants initially received individualized instruction, but once familiarized and proficient (~9wk) they were encouraged to attend group sessions. In addition to participating in the structured sessions, participants were encouraged to practice at home (at least one session/wk). The yoga sequence was designed for people with no previous yoga exposure. Each session began with feedback from the participants about their previous session. Each session included:

1. Alignment of muscle locks (bandhas) and controlled breathing (Ujjayi)
2. Warm-up (5 min)
3. Sun Salute A x3, Salute B x1(Surya Namaskara) (7 min)
4. Standing Asanas (25 min)
5. Seated Asanas (10 min)
6. Lying Supine Asanas (5 min)
7. Cool-down (Restorative breathing techniques) (7 min)

Statistical Analyses

Mean ± SE are reported except where noted. For categorical variables, Chi-square tests were used to test between-group difference, or Fisher exact tests when cell count <5. For continuous variables, t-tests were used to test between-group differences. When baseline values differed between groups, analysis of covariance was used to adjust and make between group comparisons. Paired t-tests were used for within group comparisons. Non-normally distributed outcome variables (area under the curve for glucose and insulin) were log transformed before making any comparisons. Integrated insulin and glucose areas under the curve were measured using the trapezoidal method. All other outcomes were normally distributed. Spearman rank correlation coefficients were used to evaluate associations between variables. $p<0.05$ (two-tailed) was considered significant.

Results

Fifty participants completed the intervention, and at baseline the 2 groups were matched for age, gender, race, years known to be HIV-infected, immune and virologic status, current use of cART, past medical history of CVD, diabetes, hypertension, alcohol and tobacco use (Table 1). None of the participants changed cART during the study. At baseline, 38% of participants were using tobacco, 26% had a history of hypertension, 42% had pre-hypertension (120–139/80–89 mmHg; AHA criteria (40)), 24% had impaired glucose tolerance (ADA criteria; (41)), and although the average percent body fat was normal (23–24%), the average waist circumference was high (men= 97±21cm; women= 100±14cm), suggesting most of the body fat was located centrally. The baseline Framingham CVD risk score was similar between the groups, and indicated mild-moderate 10-yr CVD risk. But, 14% of the participants in each group had baseline Framingham CVD risk scores that were >10% (moderate-high risk).

On average, yoga participants attended 33±7 sessions during the 20 wk program; the minimum number of sessions attended was 14 and the maximum was 45 during the 20 wk yoga program. After 20 wk, CD4 T-cell number and HIV RNA levels were unchanged in the yoga (495±155 to 507±134 cells/μL; 90% to 83% undetectable) and standard of care groups (570±256 to 592 ±268 cells/μL; 90% to 90% undetectable).

Average baseline glucose and insulin levels and HOMA (Table 1) were normal and not different between groups. Oral glucose tolerance and insulin action were not improved after the yoga intervention (Fig 2). HOMA index, glucose, insulin levels and area-under-the-curves during the oGTT were not different between the groups and did not change in either group after the interventions. Insulin levels and area-under-the-curve during the oGTT tended to be lower after yoga (12%), but this was not statistically different from those in the standard of care group ($p=0.46$).

Baseline serum triglycerides, total- and non-HDL-cholesterol levels were higher in the yoga group than in the standard of care group (Fig 3; $p<0.04$). After adjusting for baseline differences between groups, reductions in these lipid/cholesterol parameters observed in the yoga group (5–24%) were not statistically greater than those in the standard of care group ($p>0.48$).

Baseline body weight, body fat and lean mass, and trunk and limb fat mass were not different between the groups (Table 2). Weight, fat and lean mass were not changed after either intervention.

Baseline resting systolic and diastolic blood pressures were not different between the groups (Fig 4). The yoga intervention reduced resting systolic (−5±2 mmHg) and diastolic (−3±1 mmHg) blood pressures more ($p=0.04$) than in the standard of care group (+1±2 and +2±2 mmHg). At baseline, eleven participants assigned to yoga had pre-hypertension and only 6 participants had pre-hypertension after yoga (45% decline).

For the MOS-SF36 inventory (Table 3), the yoga participants had a more favorable average baseline pain score than the standard of care group (81±21 v 63±31; $p=0.02$). The pain score improved more in the standard of care (+10±22) than in the yoga group (−6±27; $p=0.05$), suggesting a less favorable pain status at the end of the yoga program. But the absolute SF36 scores at wk 20 were equivalent between the groups (73±25 vs. 75±24). There was a trend ($p=0.06$) for a greater improvement in emotional well-being in the yoga vs. the standard of care group.

At baseline, average macro- and micro nutrient intakes were similar between the groups (Table 4), except for trans fat intake which was higher ($p=0.048$) in the yoga group, and decreased more in the yoga group after intervention (−1.6±2.8 v +1.3±3.3 g; $p=0.03$). Baseline differences in fasting total cholesterol and triglyceride levels (Fig 3) were not attributed to baseline dietary cholesterol, saturated fat or trans fat intake. Systolic and diastolic blood pressure reductions in the yoga group were not associated with reductions in trans fat intake ($p=$ NS; $r=0.12$).

Discussion

These findings suggest that practicing yoga for 20 wks may lower cardiovascular disease risk in HIV-infected men and women taking cART; a population at increased risk for cardiovascular disease. Specifically, the practice of yoga reduced resting systolic and diastolic blood pressures more than in the standard of care comparison group. These changes occurred in the absence of changes in glucose tolerance, insulin sensitivity, proatherogenic lipid levels, body weight, and central adiposity suggesting that yoga directly acts to lower blood pressure in people living with HIV. Despite these benefits, yoga participants did not perceive an improvement in overall health-related quality of life, except for a tendency for improved emotional well being. It is

likely that the perception of more pain at the end of the intervention was due to the challenging and strenuous nature of this form of yoga. Also, the participants were previously sedentary and unfamiliar with this form of physical activity; which likely contributed to this finding. Importantly, yoga did not adversely affect or improve immune or virologic status in these well controlled HIV-infected adults. Yoga appears to be a low cost, simple to administer, safe, non-pharmacological, popular, and moderately effective behavioral intervention for reducing blood pressures in HIV-infected people.

The reduction in blood pressures observed with the practice of yoga in these pre-hypertensive HIV-infected men and women is clinically relevant when considered in the context of anti-hypertension studies conducted in HIV-seronegative populations. Using tightly controlled dietary modification, the DASH study (Dietary Approaches to Stop Hypertension) reduced sodium intake in hypertensive participants who habitually consumed low, intermediate, or high sodium levels, and reduced SBP by 3.0, 6.2, and 6.8 mmHg (42); similar magnitude to that observed in the current yoga study. In the PREMIER study, the DASH intervention was combined with established behavioral modifications (weight loss by increased physical activity and reduced energy intake) in HIV-negative normo- and hyper-tensive African American and Caucasian men and women (mean age 50yrs), and after only 6-months, SBP was reduced 2.1–5.7 mmHg (43); similar to those observed for yoga. It is unlikely that changes in dietary salt affected our findings because baseline sodium intake in the HIV-infected participants was greater than AHA recommendations (1.5 g NaCl/day;(44)), but it was not different between groups and was not changed after either intervention. Our findings support the notion that among traditional lifestyle modifications, the practice of yoga can be used to lower and manage systolic and diastolic blood pressures in pre-hypertensive HIV-infected people.

The magnitude of the reduction in blood pressure observed here is similar to that observed in HIV-negative people with CVD risk factors who followed a yoga lifestyle intervention. Yoga tended to reduce blood pressure in studies of HIV-negative participants with ‘The Metabolic Syndrome’ (32), with and without previous coronary artery disease (25), and with hypertension (21). Perhaps the practice of yoga improves vascular function/tone, and this mediates the lowering of blood pressure (25). Conversely, in HIV-negative people with cardiovascular disease risk factors, the practice of yoga appears to reduce body weight, glucose, insulin, triglycerides, and proatherogenic lipoprotein levels (8–11); beneficial effects that were not observed in the current study of people living with HIV.

In these HIV-infected men and women, the practice of yoga reduced blood pressures similar in magnitude to other lifestyle/behavioral interventions, and if practiced for several years, would be predicted to reduce the incidence of subsequent hypertension and other cardiovascular events, without the added risk for anti-hypertensive drug-related adverse events (45). For example, when prehypertensive men and women (mean age 49 yrs) were randomized to receive an angiotensin II receptor antagonist (ARB) or placebo for 2 yrs, hypertension developed in 40% of the placebo recipients, and only 14% of the active drug recipients (66% relative risk reduction). When the active drug was discontinued and participants were followed for an additional 2 yrs, those who originally received ARB maintained significantly lower systolic (−2mmHg) and diastolic (−1.1mmHg) blood pressures, and maintained their lower relative risk for developing hypertension (15%) than the placebo recipients. This suggests that even small decrements in systolic and diastolic BP that can be maintained for prolonged periods can postpone the progression of hypertension. In another cohort study (46), normo-tensive men and women (<120/80 mmHg) with modest coronary artery disease who controlled their blood pressures using either an angiotensin-converting enzyme inhibitor or a calcium-channel blocker had the largest decrease in coronary atheroma volume (using intravascular ultrasound) after 2 yrs, while participants with baseline pre-hypertension or hypertension had no significant reduction or an increase in atheroma volume. This suggests that early anti-hypertensive

interventions, even in people with normal blood pressures, effectively reduce the progression of atherogenesis. In HIV-infected people with pre-hypertension and other cardiometabolic risk factors (e.g., tobacco use, central adiposity, dyslipidemia) it seems prudent to recommend lifestyle modifications (including yoga) to reduce blood pressures.

Randomized trials and observational studies are consistent in that a 10 mmHg reduction in systolic and a 5 mmHg reduction in diastolic blood pressure predict ~50–60% lower risk for death from stroke, and ~40–50% lower risk for death from coronary artery (or other vascular) disease (40,42). In the current study, average reductions in systolic/diastolic blood pressures were 5/3 mmHg. Assuming that HIV-infected people respond similarly to the general population, our findings suggest that the risk of death from stroke was reduced 25–30% and the risk of death from coronary artery disease was reduced 20–25% by this yoga intervention.

Yoga was selected as the intervention because complementary and alternative medicine advocates believe that yoga's approach to synchronizing breath inhalation, exhalation or held breath to movement in conjunction with focusing the mind on a specific region of the body optimizes the interaction between the autonomic nervous system and endocrine system (16, 47,48). We hypothesized that yoga would reduce body fat because energy expenditure during Hatha/Ashtanga yoga averaged 2.5 METS (3 kcal/min) and peak energy expenditure was 11 METS (14kcal/min;(49,50), however fat loss was not observed. In the current study, yoga practice maintained, but did not reduce body weight in HIV-infected adults.

There were some limitations. The sample size was relatively small, but adequately powered to detect the anticipated changes in glucose tolerance/insulin sensitivity. On average, the participant's baseline CVD risk was not high (Framingham 10-yr Risk score 4.3–4.8) and very few met NCEP ATPIII criteria for 'The Metabolic Syndrome". This may have limited our ability to show that yoga significantly reduced CVD risk, or improved metabolic or anthropomorphic variables more than standard of care. Regardless, blood pressure was reduced more by yoga practice, and hypertension is an independent CVD risk factor. The form of yoga utilized was physically demanding and other forms of yoga (restorative) might provide different results.

In HIV-infected adults with mild-moderate cardiometabolic syndrome, 20 wks of supervised yoga significantly reduced resting systolic and diastolic blood pressures, despite the absence of parallel improvements in oral glucose tolerance, body weight, trunk fat content, or proatherogenic lipid levels. These findings suggest that in HIV-infected people with pre-hypertension, the practice of yoga is another lifestyle/behavior intervention that can be recommended to safely reduce blood pressure; one component of the CVD risk profile.

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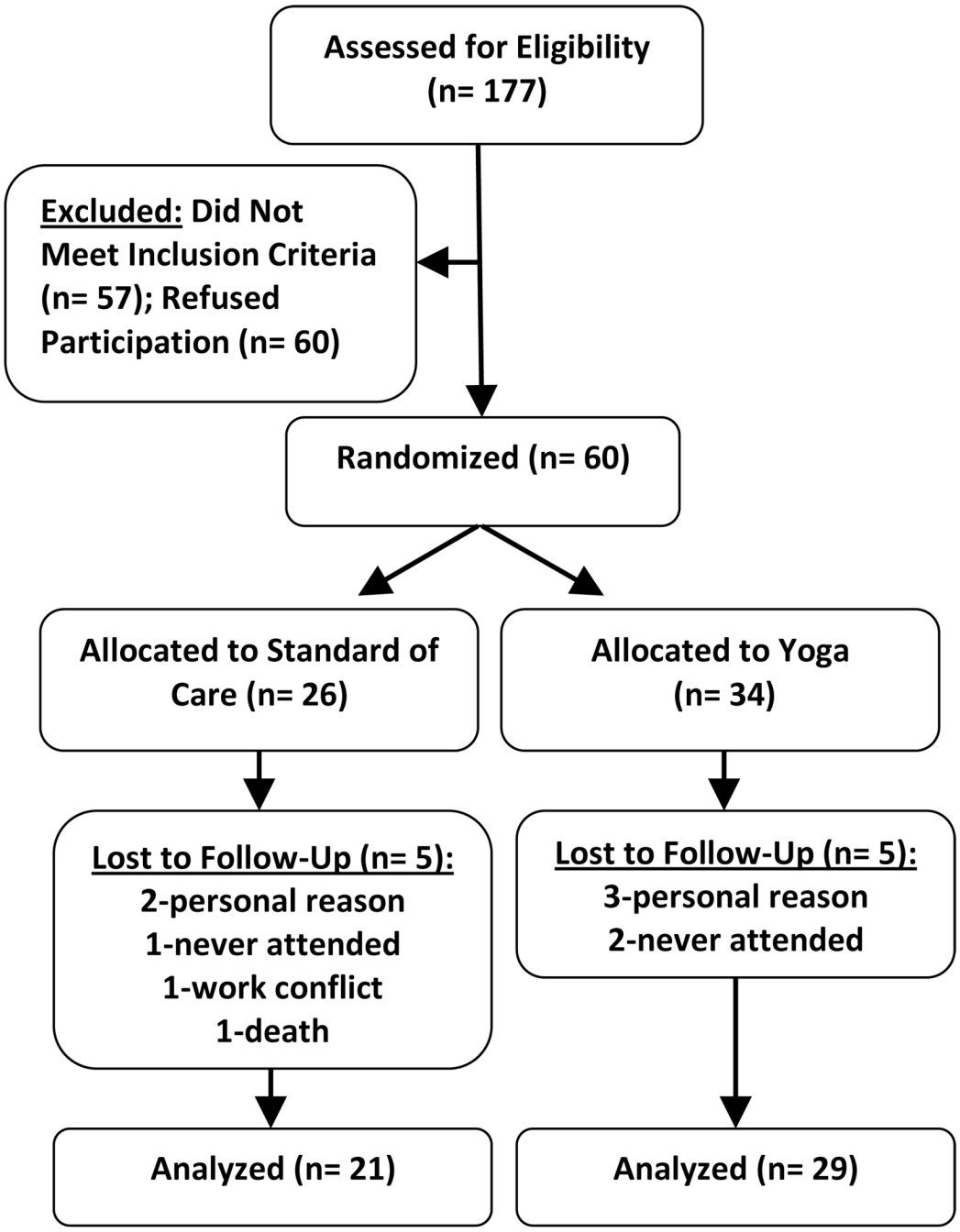

Figure 1.
Flow diagram for participant screening, exclusion, randomization, and data analysis.

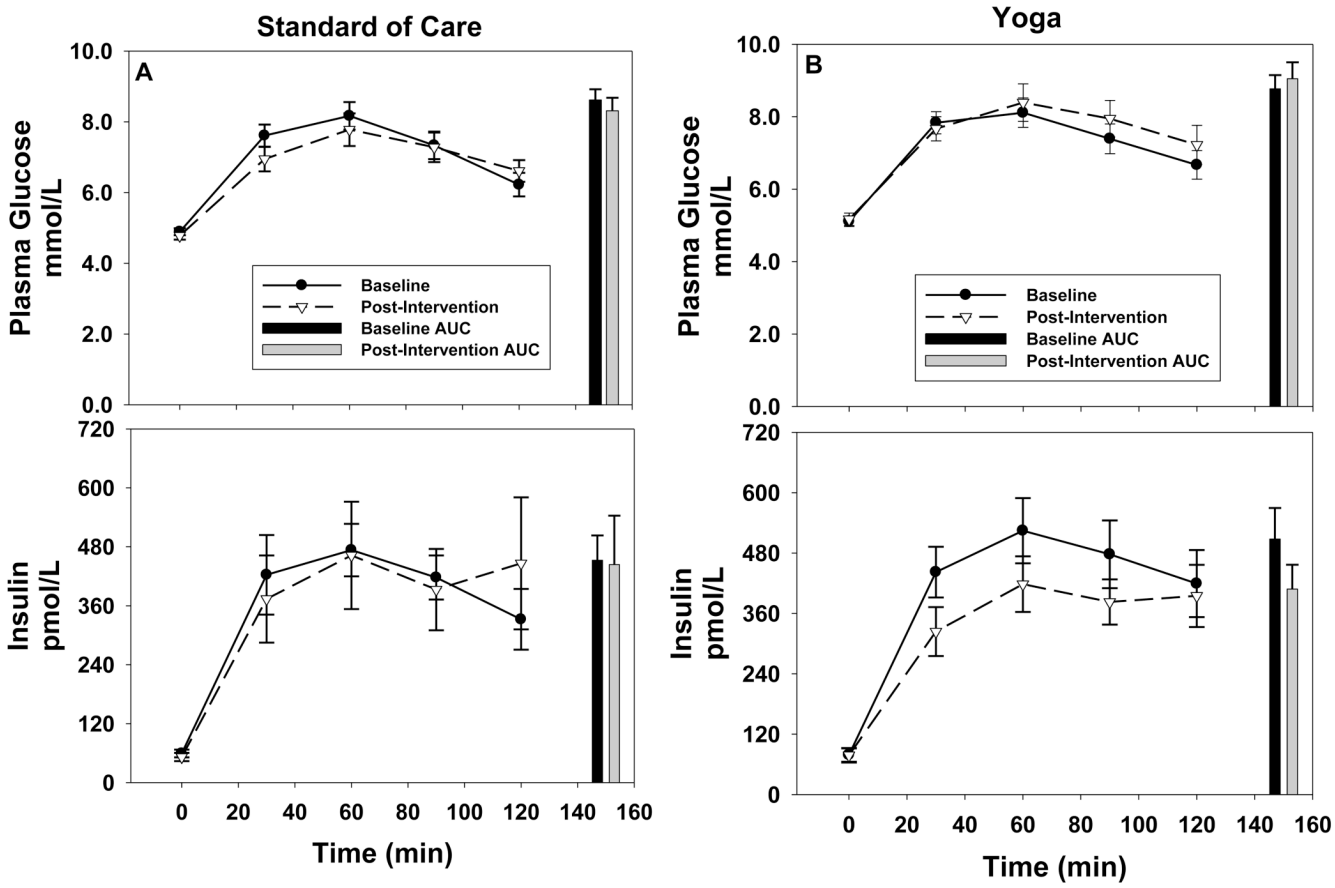

Figure 2.

Blood glucose, plasma insulin levels, and area-under-the-curves (AUC; Mean±SE) during a 75gr 2hr-oral glucose tolerance test conducted before and after standard of care (A) or yoga lifestyle intervention (B). No baseline differences in glucose or insulin levels were noted. Glucose and insulin levels and AUC during the oGTT were not different between the 2 groups, and the trend towards a lower insulin AUC after yoga intervention was not significantly different from that in the standard of care group (p=0.46).

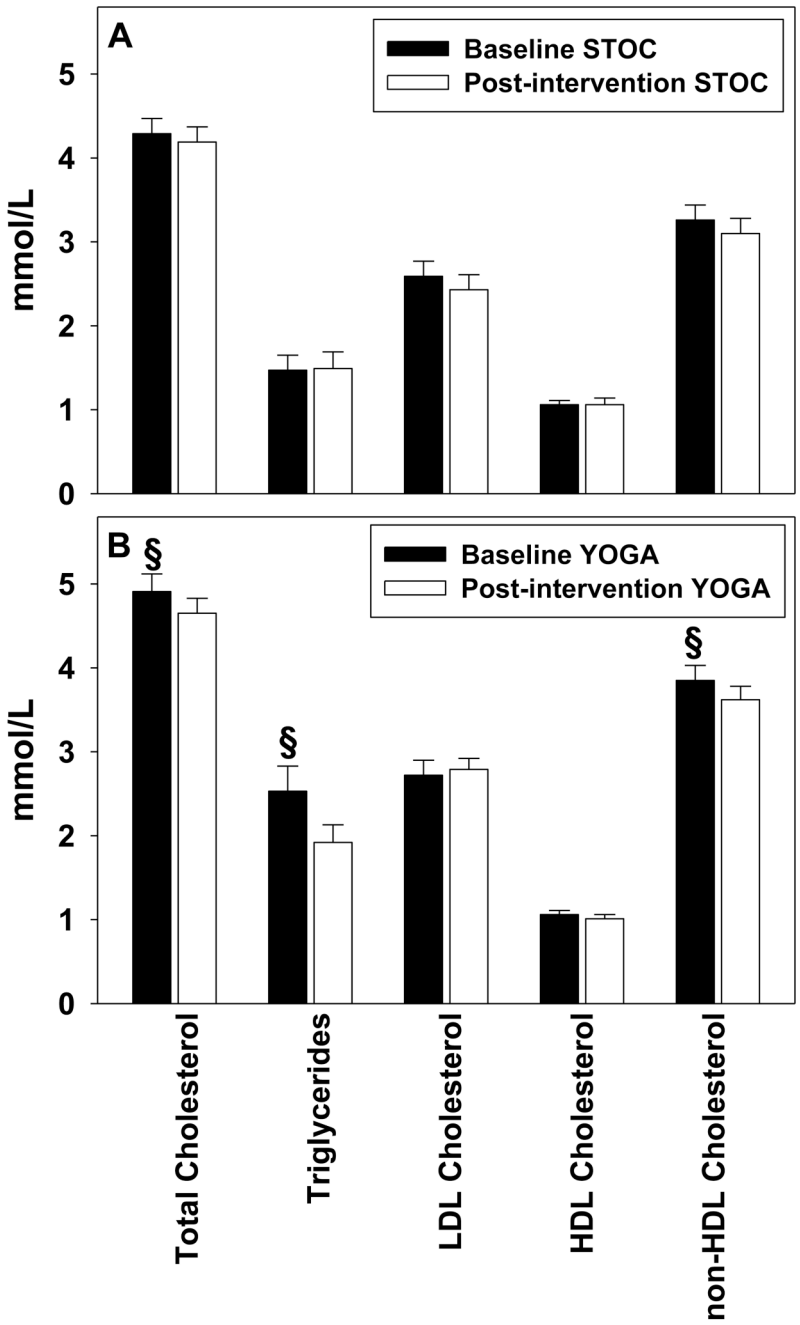

Figure 3.

Fasting serum triglycerides, total-, HDL-, calculated LDL- and non-HDL-cholesterol levels (Mean ±SE) before and after standard of care (A) or yoga lifestyle intervention (B). Baseline triglycerides, total- and non-HDL-cholesterol levels were higher in the yoga group than in the standard of care group (§ $p<0.04$). After statistical adjustment for baseline differences (ANCOVA), the between group changes in triglycerides, total- and non-HDL-cholesterol levels in the yoga group were not greater than those in the standard of care (STOC) group ($p>0.48$).

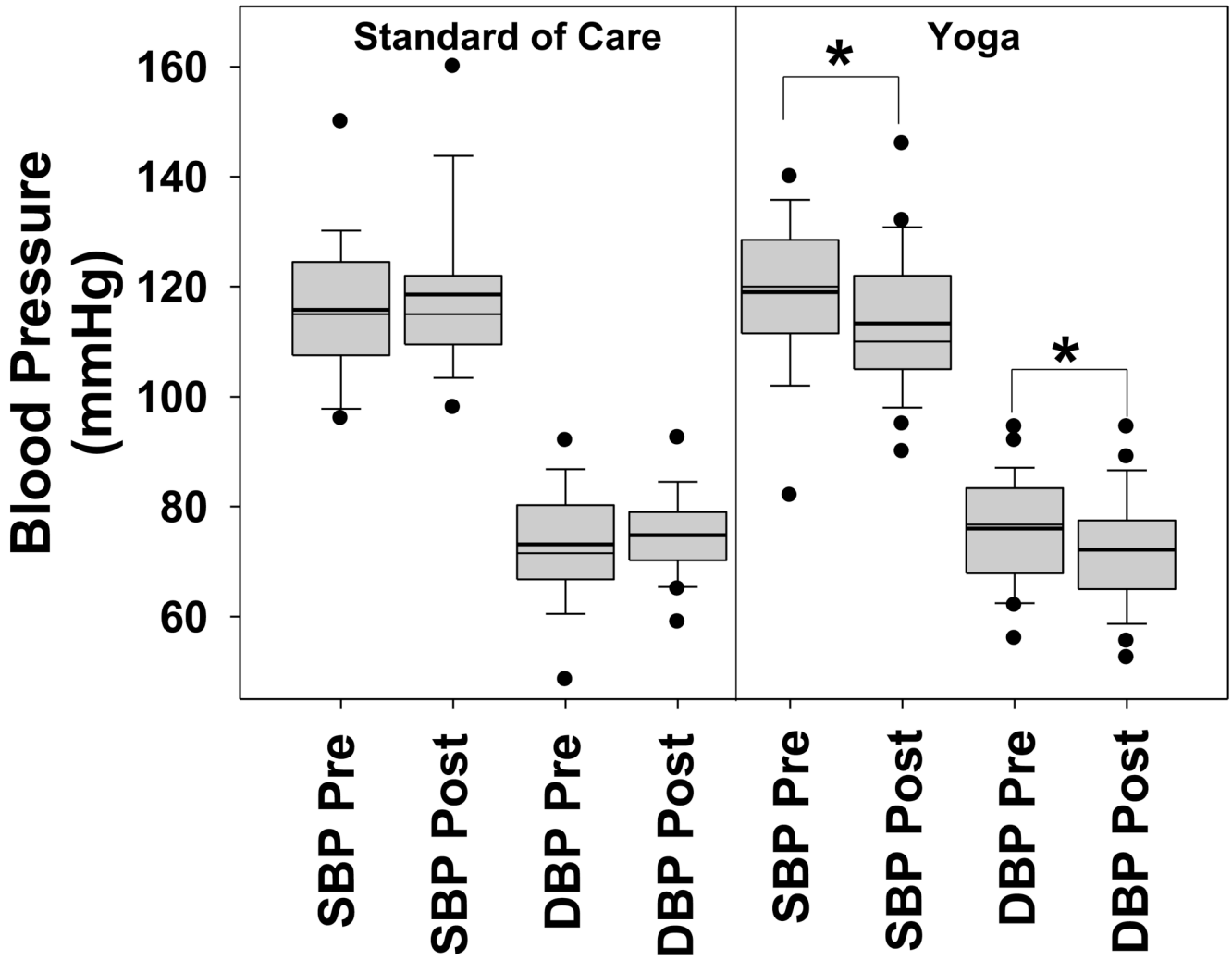

Figure 4.

Box plot representing baseline and post-intervention resting systolic (SBP) and diastolic blood pressures (DBP). The 25th and 75th percentiles are represented by the lower and upper border of the gray box. The dark line within the gray box represents the mean, and the lighter line the median. The whisker error bars represent the 10th and 90th percentiles, and any individual values outside the 10th and 90th percentiles are depicted by black circles. Baseline resting blood pressures were not different between the groups, but declined more in the yoga group than in the standard of care group (*p=0.04) after intervention.

Table 1

Baseline characteristics for participants who completed the trial.

Characteristic	Standard of Care	Yoga	P-value
N (% women)	21 (29)	29 (24)	0.72
Race (% AA)	52	35	0.21
Age (yr)	45 ± 10	45 ± 6	0.96
Waist Circ. (cm)	98 ± 25	98 ± 15	0.92
Yrs HIV+	11 ± 6	11 ± 5	0.92
HOMA index	2.1 ± 1.2	3.1 ± 3.4	0.21
CD4+ (cells/μL)	570 ± 256	495 ± 156	0.21
HIV RNA (% undetectable)	90	90	1.0
History HTN (%)	19	31	0.51
History DM (%)	5	7	1.0
Glucose intolerance (%)	24	24	1.0
History CVD (%)	0	3	1.0
History Tobacco Use:			
Past (%)	29	24	
Current (%)	33	41	>0.84
Pack/yr (range)	0.3–75	2–50	
History EtOH:			
Past (%)	10	21	>0.66
Current (%)	24	21	
Framingham 10-yr Risk	4.3 ± 5.6	4.8 ± 4.6	0.73
Current cART:			
% on NRTI	95	96	0.93
% on NNRTI	57	50	0.88
% on PI	48	65	0.72

Mean ± SD; Undetectable ≤400 copies HIV RNA/mL; cART= combination antiretroviral therapy; NRTI =nucleos(t)ide reverse transcriptase inhibitor, NNRTI= non-nucleoside reverse transcriptase inhibitor; PI =protease inhibitor; EtOH = alcohol; HTN= hypertension, CVD= cardiovascular disease; DM= diabetes mellitus. Glucose intolerance includes impaired fasting glucose (5.6–6.9 mmol/L) and impaired glucose tolerance at 2hr (7.8–11.0 mmol/L) during the oral glucose tolerance test.

Table 2

Body composition parameters.

	Standard of Care		Yoga		*p-value* Between group change
Variable	**Baseline**	**Post**	**Baseline**	**Post**	
Body Weight (kg)	78.4 ± 3.4	78.0 ± 3.6	80.9 ± 3.1	80.4 ± 3.2	0.85
Body Fat (kg)	19.9 ± 2.2	19.5 ± 2.3	19.6 ± 2.1	19.4 ± 2.1	0.74
Limb Fat (kg)	8.4 ± 1.3	8.3 ± 1.2	7.5 ± 1.0	7.4 ± 1.0	0.98
Trunk Fat (kg)	11.5 ± 1.1	11.2 ± 1.3	12.1 ± 1.2	12.0 ± 1.2	0.64
Lean Mass (kg)	57.5 ± 1.8	57.5 ± 2.1	60.3 ± 2.1	57.7 ± 2.8	0.25
Limb Lean (kg)	24.9 ± 1.0	24.8 ± 1.0	25.9 ± 1.0	26.4 ± 1.1	0.39

Mean ± SE

Table 3

MOS-SF36 Health-related quality of life assessment.

	Standard of Care			Yoga			*p-value* Between group change
Domain	**Baseline**	**Post**	**Change**	**Baseline**	**Post**	**Change**	
Physical functioning	80±22	78±23	−2±26	85±17	85±18	−0.5±12	0.86
Role limitations due to physical health	66±43	74±36	7±33	70±40	76±35	6±38	0.95
Role limitations due to emotional problems	65±48	80±38	15±50	68±42	74±40	6±47	0.54
Energy-fatigue	51±27	55±22	4±14	56±27	64±20	8±13	0.37
Emotional well being	72±23	69±21	−3±15	71±24	78±19	7±17	0.06
Social functioning	70±26	75±25	5±18	68±27	73±24	5±22	0.89
Pain	63±31*	73±25	**10±22**	81±21*	75±24	**−6±27**	**0.05**
General health	59±22	63±20	4±12	62±25	68±21	6±12	0.50
Health change	63±24	65±25	2±31	61±19	75±21	14±22	0.19

Mean±SD.

* p=0.02 Baseline yoga value higher than baseline standard of care value. For MOS-SF36 domains, higher scores identify a more favorable health status.

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Table 4

Average daily macro- and micro-nutrient intake.

	Standard of Care		Yoga		p-value Between group change
Nutrient Intake	**Baseline**	**Post**	**Baseline**	**Post**	
Energy (kcal)	2469±935	2234±628	2465±739	2283±682	0.80
Protein (g)	88±34	81±29	90±26	94±34	0.44
Carbohydrate (g)	305±126	292±103	315±121	276±85	0.63
Fat (g)	97±43	82±27	93±32	89±34	0.37
Fiber (g)	19±11	18±7	19±8	16±8	0.75
Cholesterol (mg)	275±146	226±108	344±178	334±181	0.65
Saturated Fat (g)	31±16	26±10	32±12	30±12	0.43
Trans fats (g)	1.2±1.1*	2.5±3.1	2.9±3.5*	1.3±1.5	**0.03**
Sodium (g)	3.6±1.4	3.5±0.8	4.1±1.4	3.7±1.4	0.77
Calcium (mg)	806±436	651±309	943±480	1042±494	0.13
Vitamin D (IU)	147±141	116±111	141±129	110±120	0.99
Caffeine (mg)	109±98	91±63	89±95	158±279	0.52

Mean±SD

* p=0.048 Baseline yoga value higher than baseline standard of care value.