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Associations Between Physical Activity and Sedentary Time on Components of Metabolic Syndrome Among Adults with HIV

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Abstract

Recent data show that people living with HIV/AIDS (PLWHA) are at a greater risk of cardiovascular disease (CVD), which could possibly be explained by an increased prevalence of metabolic syndrome (MetSyn) due to the known toxicities associated with antiretroviral therapy (ART). The purpose of this study is to examine the relationships among physical activity (PA) and components of MetSyn in a sample of PLWHA taking ART. A total of 31 males and 32 females living with HIV and currently taking ART were enrolled in a home-based PA intervention aimed to reduce risk factors for CVD. Clinical assessments included measures of resting blood pressure (BP), waist circumference, height, weight, PA levels via accelerometer, and a fasted blood draw. Components of MetSyn were divided into three clusters (1=0–1; 2 = 2; 3 = 3 or more). A one-way ANOVA was used to determine differences between clusters. Multiple linear regressions were used to identify significant associations between moderate intensity PA (MPA) and sedentary time among components of MetSyn. MPA was significantly lower across MetSyn clusters ($p < 0.001$), whereas sedentary time was significantly higher ($p = 0.01$). A multiple linear regression showed MPA to be a significant predictor of waist circumference after controlling for age, race, gender and sedentary time. Routine PA can be beneficial in helping PLWHA reduce waist circumference ultimately leading to metabolic improvements. This in turn would help PLWHA self-manage known components of MetSyn, thus reducing their risk of CVD and mortality.

Keywords

Metabolic syndrome X; aerobic exercise; fitness; lipodystrophy; cardiovascular disease; body composition

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Introduction

Now that people living with HIV/AIDS (PLWHA) have lived well into their adult life we are beginning to see the long term consequences of HIV disease and antiretroviral therapy (ART). Data have begun to show increased prevalence rates of metabolic disturbances after initiating treatment (Samaras et al., 2007; Wand et al., 2007). These disturbances, such as lipodystrophy and increased blood lipids, place these individuals at high risk for metabolic syndrome (MetSyn) and other chronic diseases. As a result the primary cause of death among PLWHA are now chronic conditions often seen in elderly populations such as cardiovascular disease (CVD), kidney disease and renal failure, among others (Mayor, Gomez, Rios-Oliveras, & Hunter-Mellado, 2005). Although ART has become a necessity for many people to maintain low viral loads, it also has become a daily burden living with the toxic side effects.

The majority of known side effects associated with ART directly alter metabolic processes, thus increasing the risk of MetSyn. Symptoms of the side effects associated with ART include lipodystrophy (abnormal fat displacement), hypertension, hyperlipidemia (i.e. high triglycerides, cholesterol), decreased HDL-C, and impaired fasting glucose among many others (Montessori, Press, Harris, Akagi, & Montaner, 2004; Crane, Van Rompaey, & Kitahata, 2006). Central fat accumulation is the most common outcome of lipodystrophy resulting in an increased waist circumference, which is also a strong indicator of a person's risk of developing chronic conditions like hypertension, stroke, or CVD (Janssen, Katzmarzyk, & Ross, 2004; Zhu et al., 2005).

Moderate to high levels of physical activity are known to improve the quality of life in healthy and clinical populations. The importance of physical activity is strongly supported within the literature with studies showing beneficial effects on most of the components associated with MetSyn and positive associations with risk factors for CVD (Andersen et al., 2006; Blair et al., 1996; Warburton, Nicol, & Bredin, 2006). Numerous prospective cohort studies have repeatedly shown that higher levels of physical activity are associated with reduced incidence of CVD, diabetes, certain cancers, all-cause mortality, and many other chronic conditions (Bassuk & Manson, 2005; Blair et al., 1996; Church et al., 2002; Jaggers et al., 2009; Warburton et al., 2006). Emerging data are showing similar benefits among HIV patients (Bopp et al., 2004; Dudgeon et al., 2012; Hand et al., 2008; Hand, Lyrly, Jaggers, & Dudgeon, 2009). However, no one has focused specifically on the components of MetSyn when studying the effects of physical activity among PLWHA. Therefore the purpose of this investigation is to examine the relationships between time spent in MPA and sedentary behavior on components of MetSyn in a sample of HIV+ adults currently taking ART.

Methods

A complete description of the methodology for this home-based physical activity intervention can be found elsewhere (Jaggers et al., 2013). In brief, this was a randomized controlled trial with a standard care control group. The treatment condition consisted of telephone-based coaching sessions with the primary goal to increase daily amounts of

moderate-intensity PA. Written informed consent was obtained from all participants prior to any form of data collection. Thorough descriptions of the recruiting and screening processes, as well as the methods are available (Jaggers et al., 2013).

Outcome measures and methods

For this investigation the primary outcome of interest is MPA, as measured by the SenseWear® armband. Secondary outcomes include components of MetSyn, such as blood pressure, waist circumference, fasted glucose, triglycerides, and HDL levels. Blood draws occurred in the early morning following a 12 hour fast. Blood serum was separated via centrifuge and stored in a -80 freezer until ready for analysis.

Physical Activity Assessment

Physical activity was assessed with the SenseWear® armband, a commercially available lightweight physical activity monitor that is worn on the upper left arm halfway between the acromion and olecranon processes. The intra-class correlation has been reported at 0.8 and reports on the validity, reliability and overall accuracy can be found elsewhere (St-Onge, Mignault, Allison, & Rabasa-Lhoret, 2007; Welk, McClain, Eisenmann, & Wickel, 2007). Participants were given the armband for a 7–10 day period and asked to wear the armband at all times. Armband data was considered valid if the participant had a wear time of at least 10 hours a day for a minimum of 3 days. The maximum wear time for some participants consisted of a full 7 days. The daily average of time spent in MPA was used for data analysis.

MetSyn Criteria

Components of MetSyn were identified according to ATPIII criteria and is defined as having three or more of the following disorders: Hypertension (i.e. blood pressure $\geq 130/85$) or currently taking hypertension medication; Triglycerides ≥ 150 mg/dL or currently taking lipid lowering medication; Waist circumference > 102 cm for men or > 88 cm for women; HDL cholesterol < 40 mg/dL for men or < 50 mg/dL for women; Fasting glucose ≥ 110 mg/dL (Grundy, Brewer, Jr., Cleeman, Smith, Jr., & Lenfant, 2004). Participants who exhibited any of these components were categorized into one of three groups: 0–1 components of MetSyn; 2 components of MetSyn; 3 or more components of MetSyn.

Statistical Analysis

A one-way ANOVA was used to determine any significant differences between groups. To examine the relationships between MPA and components of MetSyn we ran two separate linear regression analyses with MPA as the dependent variable in one, and sedentary time as the dependent variable in the other. Each model controlled for age, race, gender, and medications. Second regression models were ran that also controlled for the independent variable of the other model (i.e. sedentary time was controlled for in the MPA model). All dependent and independent variables were tested for normality in which it was discovered that the blood lipid measures did not follow a normal distribution. Therefore they were log-transformed prior to running the linear regression.

Results

Table 1 shows the distribution of components for MetSyn and physical activity measures separated by PA tertiles. Levels of PA were determined by splitting the data into three equal groups, which are as followed: Tertile 1: < 42 mins/day of MPA; Tertile 2: 42–90 mins/day of MPA; Tertile III: > 90 mins/day of MPA. Statistically significant differences were observed between groups showing lower values of waist circumference, weight, BMI, and incidence of MetSyn as levels of MPA increased. There was also a significantly higher VO₂peak across tertiles indicating higher cardiorespiratory fitness (CRF) levels with increased MPA.

Table 2 shows the results of all regression models. Even when controlling for sedentary time (Model 3) MPA significantly predicted waist circumference while adjusting for the other MetSyn components. No other significant relationships were observed, indicating sedentary time was not a significant predictor for any component of MetSyn. It also did not affect the observed relationship between MPA and waist circumference.

Figure 1 shows differences in MPA, light intensity PA, sedentary time, and CRF across MetSyn clusters. We found significant differences in MPA and sedentary time across all groups. However there was no statistically significant difference in the amount of light intensity PA observed. There was also a trending decrease of CRF levels across MetSyn clusters, which barely reached significance ($p = 0.05$).

Discussion

The purpose of this investigation was to examine the relationships between MPA and sedentary time among components of MetSyn in a sample of PLWHA currently taking ART. After adjusting for potential confounding variables we observed statistically significant independent associations of MPA, waist circumference, and the number of MetSyn components present. The primary finding of the investigation was the significant association between waist circumference and MPA, even when sedentary time was included in the model. Further there was an inverse relationship between the number of MetSyn components and MPA. There also was a significant difference in the amount of time engaged in sedentary behavior when comparing people with 0–1 MetSyn components to those with 3 or more. Similarly we observed a significant trend among CRF and MetSyn, indicating that those with MetSyn had lower fitness levels.

This study is not without limitations. Even though there was large power detecting the effect size of the relationship between MPA and waist circumference, the small sample size limited the power to detect significant differences in most blood lipids and fasting glucose. These small changes in blood profiles may more accurately be detected with a larger sample. We also acknowledge that since this is a cross-sectional study we cannot suggest causality between the dependent and independent variables.

Our findings are in agreement with the consensus of physical activity investigations in clinical and healthy populations. The significance and novelty behind our findings is that it is the first of its kind to look at extensive physical activity behaviors in a sample of PLWHA

currently taking ART. It is well known that ART has toxic side effects often resulting in lipodystrophy, increased abdominal fat, as well as increased blood lipids. What has yet to be addressed is whether or not these toxic effects will inhibit the known benefits of increased physical activity and fitness. In conclusion, our findings show that greater amounts of MPA are significantly associated with a smaller waist circumference for PLWHA currently taking ART. A significant relationship was also observed among sedentary time and waist circumference, however did not retain significance in the linear regression model. Routine MPA can be beneficial in helping PLWHA reduce waist circumference while ultimately leading to metabolic improvements. This in turn would help PLWHA self-manage known components of MetSyn, thus reducing their risk of CVD and mortality.

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Figure 1.
Differences in physical activity and CRF across metabolic syndrome clusters (A) Moderate

Table 1

Components of metabolic syndrome and physical activity measures for all participants and separated by physical activity group.

	All	Tertile I	Tertile II	Tertile III	P value
Number	63	20	23	20	
Age	48 ± 11	49 ± 10	50 ± 12	45 ± 10	0.294
Height	66.91 ± 3.56	65.89 ± 3.51	66.85 ± 3.28	68.01 ± 3.77	0.254
Weight (lbs)	193.11 ± 51.97	225.43 ± 56.16	195.20 ± 45.96	160.11 ± 31.79	< 0.001
BMI (kg/m ²)	30.40 ± 7.46	36.38 ± 6.55	30.53 ± 6.28	24.28 ± 3.92	< 0.001
Waist circumference (cm)	99.55 ± 18.04	112.54 ± 15.9	100.38 ± 14.73	85.68 ± 12.85	< 0.001
Systolic BP	128 ± 14	126 ± 13	131 ± 12	126 ± 18	0.490
Diastolic BP	83 ± 9	82 ± 9	83 ± 9	82 ± 11	0.885
Triglycerides	147.02 ± 122.14	162.89 ± 183.01	150.24 ± 66.25	127.00 ± 82.79	0.688
HDL	47.88 ± 22.74	47.94 ± 19.89	46.65 ± 21.85	49.06 ± 27.34	0.955
Glucose	110.64 ± 42.05	114.50 ± 40.13	122.53 ± 58.10	94.64 ± 10.48	0.137
MPA (Avg Min/day)	88.54 ± 85.66	26.00 ± 10.50	56.48 ± 13.63	187.95 ± 88.61	< 0.001
Sedentary Time (Avg Mins/day)	863.57 ± 209.80	880.85 ± 211.48	927.96 ± 206.51	772.25 ± 188.19	0.013
VO2 peak (ml/kg/min)	20.13 ± 8.56	15.33 ± 3.64	17.51 ± 5.19	26.84 ± 10.23	< 0.001
Number of MetSyn components %, (n)					0.034
0-1	36.5 (23)	25 (5)	30.4 (7)	55 (11)	
2	27 (17)	15 (3)	34.8 (8)	30 (6)	
3 or more	36.5 (23)	60 (12)	34.8 (8)	15 (3)	
Lipid lowering medication %, (n)					0.182
Yes	34.9 (22)	45 (9)	39.1 (9)	20 (4)	
No	65.1 (41)	55 (11)	60.9 (14)	80 (16)	
Blood pressure medication %, (n)					0.220
Yes	47.6 (30)	65 (13)	39.1 (9)	40 (8)	
No	52.4 (33)	35 (7)	60.9 (14)	60 (12)	
Diabetic (Type II) %, (n)					0.072
Yes	14.3 (9)	20 (4)	21.7 (5)	0	
No	85.7 (54)	80 (16)	78.3 (18)	100 (20)	

Tertile 1: < 42 mins/day of MPA; Tertile II: 42–90 mins/day of MPA; Tertile III: > 90 mins/day of PA MPA: Moderate intensity physical activity; BMI: Body mass index

Table 2

Linear regression of associations between PA and components of metabolic syndrome

Model 1. Dependent variable: MPA					Model 2. Dependent variable: Sedentary time				
Variable	β	SE B	F	p	β	SE B	F	p	
Intercept	5.36	2.84			5.52	1.19			
SBP	0.01	0.01	1.18	0.29	-0.001	0.004	0.003	0.96	
DBP	-0.02	0.02	0.83	0.37	-0.001	0.007	0.02	0.72	
Waist	-0.03	0.01	12.68	0.001	0.005	0.003	3.29	0.07	
Triglycerides	0.25	0.31	0.65	0.43	0.07	0.13	0.31	0.58	
HDL	0.58	0.38	2.31	0.14	-0.06	0.16	0.14	0.71	
Glucose	-0.27	0.39	0.48	0.49	0.19	0.17	1.27	0.27	
<i>Note: R² = 0.63; p < 0.001; N = 65</i>					<i>Note: R² = 0.28; p = 0.15; N = 65</i>				
*Both models controlled for sex, age, and race.									
Model 3					Model 4				
Variable	β	SE B	F	p	β	SE B	F	p	
Intercept	5.16	2.87			6.11	1.22			
SBP	0.01	0.01	1.18	0.29	-0.001	0.004	0.02	0.88	
DBP	-0.02	0.02	0.86	0.36	-0.002	0.007	0.12	0.73	
Waist	-0.02	0.01	11.22	0.002	0.002	0.004	0.31	0.58	
Triglycerides	0.28	0.32	0.78	0.38	0.10	0.13	0.61	0.44	
HDL	0.56	0.38	2.12	0.15	0.004	0.16	0.00	0.98	
Glucose	-0.18	0.41	0.18	0.67	0.19	0.17	1.22	0.27	
<i>Note: R² = 0.64; p = 0.001; N = 65</i>					<i>Note: R² = 0.34; p = 0.10; N = 65</i>				
*Same as model 1 but also controlling for sedentary time					*Same as model 2 but also controlling for MPA				

MPA: Moderate intensity physical activity; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL: High density lipoprotein