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COMPLICATIONS OF HIV AND ANTIRETROVIRAL THERAPY (GA MCCOMSEY, SECTION EDITOR)

Contemporary Lifestyle Modification Interventions to Improve Metabolic Comorbidities in HIV

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Abstract

Purpose of Review Metabolic comorbidities including diabetes, obesity, dyslipidemia, and hypertension, all of which are traditional cardiovascular disease risk factors that are highly prevalent in people with HIV (PWH). Bone disease including osteopenia, osteoporosis, and fragility fractures is also prevalent in PWH. These comorbidities may be prevented and treated in part with lifestyle modification, including changes to dietary and physical habits. The purpose of this review is to highlight recent literature that characterizes current lifestyle habits in PWH as well as the effectiveness of lifestyle strategies to improve metabolic comorbidities prevalent in PWH.

Recent Findings Recent studies have expanded our knowledge regarding the current lifestyle habits of PWH as well as the potential for lifestyle modification to prevent or improve comorbidities prevalent in PWH. Clinical trials focusing on lifestyle modification have shown some benefit of such interventions on traditional risk factors for comorbidities; however, significant heterogeneity exists between studies and results are not consistent.

Summary Further clinical trials are needed including developing lifestyle strategies that are feasible, effective, and sustainable to prevent and decrease prevalence of comorbidities in this population.

Keywords HIV · Lifestyle modification · Diet · Physical activity · Metabolic comorbidities · Bone disease

Introduction

With improved management and advances in the treatment of HIV infection, largely related to improvements in antiretroviral therapy (ART), people with HIV (PWH) are living longer. The life expectancy of PWH on ART has increased [1] [2] and the prevalence of HIV globally, among people older than 50, has been increasing steadily since the introduction of ART [3, 4]. Nonetheless, as PWH live longer, multiple comorbidities that may prevent life expectancy from reaching that of the general population are becoming more prevalent, and strategies tailored for PWH are needed to delay onset and treat these comorbidities.

It is estimated that the proportion of PWH, with at least one metabolic comorbidity, including hypertension, dyslipidemia, and diabetes, will increase from 29% to 85% between 2010 and 2030 [4]. Observational studies assessing weight status in PWH revealed that the proportion of PWH who were obese at ART initiation increased from 9% in 1998 to 18% in 2010 [5]. Another large observational study in ART naïve participants with HIV noted that the proportion who were overweight/obese increased from 25% to 40% after 144 weeks of ART. In a recent meta-analysis, to estimate the relative risk of incident acute myocardial infarction (AMI) and simultaneously understand the effect of traditional and HV-related cardiovascular risk factors, Rao et al. found that PWH had a 2-fold higher AMI risk, as previously reported [6, 7], and that dyslipidemia, hypertension, and smoking were independently associated with AMI in PWH [8], while bone disease including osteopenia, osteoporosis and fragility fractures are also prevalent in this population [9–11]. In the general population, lifestyle modification interventions have been associated with improvements in metabolic comorbidities such as altered glucose metabolism, hypertension and dyslipidemia, bone disease, decreased incidence of cardiometabolic disease and

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incidence of CVD, fragility fracture, as well as all-cause mortality and life expectancy [12–16]. Modification of dietary and physical activity habits are considered first line approaches for the prevention and management of cardiovascular disease (CVD) and bone disease and their associated risk factors in the general population [17, 18]. The primary care guidelines for the management of PWH endorse recommendations based on the general population as first line prevention and management for these comorbidities [19]. However, developing relevant lifestyle modification strategies tailored for PWH is essential and may prove to be more successful to prevent and treat metabolic comorbidities in this population. Treating HIV infection with effective ART, integrating prevention and management strategies to prevent metabolic comorbidities early during HIV infection, is essential to maintain and improve upon advances made thus far in the life expectancy of PWH.

Current Lifestyle Habits and Relationship with Metabolic Comorbidities in PWH

Dietary Intake

A healthy diet is associated with lower risk of metabolic comorbidities prevalent in PWH, and there is evidence that in the general population, a diet that meets current dietary recommendations, as measured by diet quality scores, may prevent or delay the onset of metabolic comorbidities [20, 21]. Studies evaluating diet quality in PWH have recently been reported. Utilizing the healthy eating index (HEI) [22] to measure conformance to dietary guidelines, studies have shown that HEI scores are usually reported around 50 (out of 100) [23–25]. This is lower than HEI scores in the general population [26] and indicates that PWH are not conforming with current dietary guidelines.

Although HIV has historically been related to decreased appetite and low energy intake [27], recent data show that energy intake in PWH is equivalent to or exceeds that of individuals without HIV [28, 29]. Comparing dietary intake utilizing 4-day food records or 24-h recall between PWH and without HIV, Joy et al. [28] demonstrated increased intake of total fat, saturated fat, and dietary cholesterol in PWH. Among those with HIV, saturated fat intake was positively related to serum triglycerides. Administering a validated food frequency questionnaire to 395 PWH in the Swiss HIV cohort study, Marzel et al. [30] found that the combined consumption of meat, refined grains, carbonated beverages, and coffee was positively associated with measures of dyslipidemia.

Evaluating dietary habits associated with bone disease, Galli et al. found among a majority cohort of males that less than half (40%) had optimal daily calcium intake of > 1000 mg daily [31], participants with less than optimal daily calcium intake were more likely to have femoral osteoporosis measured by dual-energy X-ray absorptiometry (DXA). Serum vitamin D levels have also been observed to be low in this population [32, 33].

Physical Activity

In PWH, physical inactivity has been related to cardiometabolic comorbidities including increased waist-to-hip ratio (WHR), hypertension, and diabetes [34, 35]. Current guidelines for adults recommend at least 150 min of moderate-intensity physical activity each week [36, 37]. In a systematic review of physical activity in adults with HIV, an estimated 50% of PWH worldwide met the recommendations of 150 min of moderate-intensity physical activity per week [38].

Benefits of physical activity have been demonstrated in studies examining the effect of physical activity on cardiovascular health in PWH. A nested study within the SATURN-HIV study [39] evaluated measures of physical activity by questionnaire in 147 participants enrolled in the study. Measures of cardiometabolic health, inflammation, and surrogate markers of CVD were performed. Participants who reported engaging in at least 2.5 h per week of moderate-intensity exercise, therefore meeting current physical activity guidelines, had lower levels of inflammatory markers as well as evidence of subclinical CVD [35]. In a secondary analysis of baseline data to explore the relationship of physical activity on bone health, also from the SATURN-HIV study [40], among participants meeting physical activity guidelines, moderate-to-vigorous activity was a significant predictor of hip BMD even controlling for potential confounders. Another recent study directly measuring physical activity utilizing accelerometers for 7 consecutive days in a group of men living with HIV found that compared with controls, men with HIV achieved an average of 55 min per day of engagement in moderate-to-vigorous physical activity compared with 31 min per day by the controls. Among the men with HIV, there was a significant inverse relationship between total time spent doing moderate-intensity activity with both triglyceride level and measures of insulin resistance; there was also a significant association between the presence of metabolic syndrome and physical inactivity [41]. Thereby demonstrating that meeting current physical activity guidelines does benefit on cardiovascular health among PWH.

Several recent studies have explored barriers and facilitators to achieve physical activity and dietary recommendations. In a recent systematic review, to better understand barriers and facilitators to participate in physical activity by PWH, Vancampfort et al. [42] found that low physical activity was related to several factors including older age and lower education level as well as HIV-specific factors including lower CD4, exposure to ART, and presence of lipodystrophy. Additional barriers expressed by PWH to physical activity and diet reported in the literature include low socioeconomic

status, perceptions of decreased weight as health risk, housing instability as well as lack of social support. Facilitators include the quality of the patient-provider relationship, social support from friends and family, and self-motivation [43–46]. Lifestyle modification interventions that address participant-identified barriers and facilitators offer a more patient-centered approach (in contrast to a one size fits all approach) ultimately impacting engagement, increasing adherence and response to the intervention being tested, and ultimately result in better outcomes.

Diet and Physical Activity Status by Sex in PWH

Sex-specific differences in lifestyle habits exist between women and men with HIV. In a recent study evaluating diet quality in a cross-sectional evaluation of adults with HIV, women had significantly lower total HEI score as compared with men. In this evaluation, women had lower consumption of vegetables coupled with higher consumption of refined grains compared with their male counterparts [23]. Physical activity also differs between women with HIV compared with their male counterparts. Among women with HIV in the southern part of the USA, 84% reported no vigorous physical activity and 48% reported no moderate-intensity activity in the previous 7 days while the minutes per week of physical activity was also reported to be 32.5 min per week which is substantially lower than the 150 min per week recommended by the guidelines [44]. Describing differences in exercise patterns between men and women with HIV, Webel et al. [47] found that during middle adulthood, there was a significant difference in quantity of exercise between women and men (2.4 h per week vs. 4.5 h per week, women vs. men) and the most common form of exercise was walking. These differences are important to consider when evaluating response or benefit of lifestyle modification.

Metabolic Comorbidity Care for PWH: Status of Prevention and Treatment

Understanding the provision of care for metabolic comorbidities as well as the status of preventative counseling and treatment is important to evaluate the quality of care PWH receive and inform future practice to improve prevention and care in this regard. Exploring the quality of cardiovascular preventative care from a US national representative sample of individuals with and without HIV, between 2006 and 2013, Ladapo et al. [48] found that only 14.9% of PWH with any risk factors for cardiovascular disease received diet and/or exercise counseling while only 18.8% of smokers received smoking cessation advice/pharmacotherapy; rates of counseling decreased during the study period and although preventative counseling was not statistically different between individuals with and without HIV, these findings demonstrate very low rates of preventative counseling in general and an increased need for increased lifestyle counseling to prevent CVD [48]. In a study utilizing electronic medical record (EMR) review to evaluate the prevalence of cardiometabolic comorbidities in an urban cohort of PWH, the investigators found that while the prevalence of cardiometabolic comorbidities was high, evidence of treatment for comorbidities was lacking in the EMR, 40% lacked evidence of treatment for diabetes, 66% lacked evidence of treatment for dyslipidemia, and 38% lacked evidence of treatment for hypertension [49].

Few recent studies have evaluated the quality of care received by PWH regarding the prevention and treatment of bone disease. A recent study conducted among PWH attending a clinic in Australia found that only 61% who met guidelines for BMD screening had had recent BMD assessment. This study did not evaluate preventative counseling on lifestyle practices for the prevention and treatment of bone disease. However, among those PWH who also had a diagnosis of osteoporosis, 78% were treated with vitamin D and calcium [50]. Alvarez et al. [51] explored providers' perspectives on screening practices for bone disease and found that key barriers were lack of HIV-specific guidelines and lack of access to DXA machines for screening. Practices regarding patient education on the prevention of bone disease were not reported.

The Effects of Lifestyle Modification on Metabolic Parameters in HIV

The literature reviewed suggests that a large proportion of PWH do not meet the current diet and physical activity recommendations and there continues to be a great need to develop effective lifestyle modification strategies to help PWH meet diet and physical activity recommendations as one tool to prevent or mitigate metabolic comorbidities in this population. Despite clear recommendations for the general population regarding the prevention and management of metabolic abnormalities, there are no specific strategies developed in HIV. Several studies have attempted to fill this gap in the literature with varied results thus far. The following is a summary of a variety of lifestyle modification interventions conducted in adults with HIV, within the past 5 years (2014 to present), to evaluate the effects of lifestyle modification interventions on metabolic parameters in PWH. The goal of any lifestyle modification is to produce sustainable, beneficial changes in physical activity, diet, and ultimately improve cardiovascular disease and bone disease risk factors to delay onset or manage metabolic comorbidities prevalent in this population. Below is a narrative review of contemporary lifestyle modification approaches summarized with these goals in mind.

Recent Interventions Evaluating the Effects of Lifestyle Modification Metabolic Parameters

Recent studies evaluating the effects of a physical activity intervention on cardiometabolic parameters in PWH have utilized a variety of interventions including type of activity (aerobic, resistance/strength training, or both) (Table 1). Short study duration, ranging from weeks (8–12 weeks) [52–54, 56] to 12 months [55], and sample sizes have been relatively small (15–90 participants). Improvements in cardiometabolic indices including lipid profile, blood pressure, glucose/insulin, and body composition have been inconsistent across studies due to differences between interventions. Cutrono et al. [54] found an effect of a combined aerobic (walking) and resistance training to decrease prevalence of metabolic syndrome from baseline although the difference was not significant and there was no control group for comparison. The effects of a walking program on cardiometabolic parameters were superior to a walking program with circuit training. Sixty minutes of brisk walking, 3 times a week for 12 weeks, was effective to decrease total cholesterol and LDL cholesterol as well as body composition measures including weight, BMI, and waist-to-hip ratio, while adding 30 min of circuit training was only effective to decrease LDL cholesterol [53]. These findings agree with other studies [57] that increasing exercise intensity does not appear to provide added benefit to improve CVD risk factors. None of the studies reported adverse effects for any of the physical activity interventions and for studies that included a control group; moderate exercise whether it is aerobic activity or resistance training demonstrated benefits over no exercise at all. The strengths of recent physical activity interventions including the majority evaluated the effects of an easily replicable activity (walking or treadmill), strong representation of women in most studies, although not all, and the interventions were carried out in high-resourced and low-resourced settings.

Recent interventions have been conducted to evaluate the effects of dietary modification on cardiometabolic indices among PWH (Table 2). An intervention compared the effects of dietary advice to reduce saturated fat versus Mediterranean diet over 6 months [59]. Men and women with HIV, on ART and elevated LDL, were randomized to standard recommendations (low saturated fat diet) or Mediterranean diet. Participants randomized to the Mediterranean diet group had significant reduction in LDL cholesterol, total to HDL cholesterol ratio, and systolic blood pressure compared with those in the low saturated fat diet group. No effects on body composition parameters were reported. In a more intensive approach, Reeds et al. [58] tested a weight loss program in obese women with HIV (compared with obese women without HIV) to test if HIV infection itself impairs beneficial metabolic effects of weight loss. The intervention consisted of a prepared diet resulting in a 1000 kcal/day energy deficit; participants received weekly dietary counseling and meal replacements to replace two meals per day. Among the participants who met the weight loss goal, women with HIV experienced a 7.7% weight loss which resulted in improved cardiometabolic indices including a decrease in visceral adipose tissue, multiorgan insulin sensitivity measured by hyperinsulinemic-euglycemic clamp, systolic, and diastolic blood pressure. However, neither basal plasma insulin nor lipid profile improved. Both studies were conducted in high-resourced settings, representation of women was strong; however, the proportion of participants completing each study was low. Sixty-five percent of women with HIV completed the intensive weight loss program while 93% of participants completed the 6-month intervention to assess the effects of dietary advice; however, despite high completion rates in this study, mean adherence to Mediterranean diet advice was low at 59%.

Several recent studies have evaluated the effects of interventions utilizing concurrent modifications in diet and physical activity to improve cardiometabolic abnormalities (Table 3). Two of these recent studies highlighted below utilized approaches that attempted to address barriers to lifestyle modification as reported by PWH. These recent studies incorporated individual goal setting [61] and addressed social environments [24] as part of the intervention. In a mixed methods exploratory study, to evaluate feasibility and effectiveness of intensive physical activity and dietary intervention to reduce type 2 diabetes risk in PWH with impaired glucose tolerance, Duncan et al. [61] utilized an individualized advice approach to achieve 10 standardized lifestyle goals (i.e., achieve 7% weight loss, decrease saturated fat to < 10% total daily energy intake, sodium restriction of < 2.5 g daily, and 10,000 steps/day) over 6 months. This individualized lifestyle modification approach significantly improved several cardiometabolic indices, including fasting serum glucose, insulin, HDL cholesterol, triglyceride, weight, waist circumference, systolic, and diastolic blood pressure, as was the 10-year CVD risk. Most participants in this study were male (75%) and 22% of the participants achieved 6 or more of the lifestyle goals; reduction of sodium and added sugar intake, as well as attaining 10,000 steps per day were the most common goals achieved. However, as this was a pilot study, there was no comparator group. Another recent study implemented a behavior change program to facilitate intervention goals for diet and physical activity. Webel et al. enrolled PWH at high risk for CVD as calculated by the Framingham risk score and randomized participants to a 6-month behavior change to improve diet and physical activity behaviors compared with enhanced usual care. Compared with enhanced usual care, behavior change participants consumed fewer carbohydrates and lost a significant amount of body weight after 6 months. The change in body weight was found to be directly related to a

Table 1 Recent interventions evaluating the effects of physical activity on cardiometabolic parameters

Author, year, country	Population	Intervention vs. control	*N* (% women), pre, post	Sessions	Minutes/ session	Duration	Supervision (Y/N)	Effect on cardiometabolic parameters	Of interest
Zanetti et al. (2016) Brazil [52]	Sedentary, HIV+ adults on ART	Nonlinear resistance training	Pre: 15 (46%), post: NR	3/week	NR	12 weeks	Y	↓TC, ↓LDL, ↓TG, ↑HDL-c, ↓hsCRP	Included familiarization period
		Usual care	Pre: 15 (40%), post: NR	NA			NA		
Bonato et al. (2017) Italy [53]	Sedentary, HIV+ adults on ART, with ≥ 1 risk factor for CVD	60-min brisk walking	Pre: 29 (26%), post: 21	3/week	60	12 weeks	Y	↓TC, ↓LDL, ↓Wt., ↓BMI, ↓WHR, ↓hsCRP, ↓IL-6, ↓d-dimer	61% adherence for walk, 69% adherence walk + strength
		Brisk walking with 30-min circuit training	Pre: 20 (0%), post: 14	3/week	60		Y	↓LDL, ↓hsCRP	
Cutrono et al. (2016) USA [54]	HIV+ adults on ART	Combined aerobic and resistance training	Pre:90 (53.9%), post: NR	4/week	40–60	12 weeks	Y	↓DBP, ↓WC	Nonsignificant decline in ppts with MetS (32% to 19%), 24% met exercise recommendations
Roos et al. (2014) South Africa [55]	HIV+ adults on ART, with ≥ 1 risk factor for CVD	Brisk walking, steps titrated to reach 3000 steps/day from baseline	Pre: 42 (83.3%), post (6 months): 35; post (12 months): 29	3/week	NA	12 months (0 contact between 6 and 12 months)	N	BL-12 mo:↓WHR, ↓glucose, ↑HDL	
		1 phone call monthly	Pre: 42 (73.8), post (6 months): 32; post (12 months): 22	NA	NA		NA		
Ezema et al. (2014) Nigeria [56]	Sedentary HIV+ adults	Treadmill, moderate-intensity (titrated)	Pre: 17 (NR), post: 15	3/week	45 × 2 weeks, 60 × 6 weeks	8 weeks	NR	↓SBP, ↓DBP	
		Counseling	Pre: 16 (NR), post: 15		0		NR		

ART, antiretroviral therapy; BMI, body mass index; *CVD*, cardiovascular disease; *DBP*, diastolic blood pressure; *HDL*, high density cholesterol; *LDL*, low density cholesterol; *NR*, not recorded; *SBP*, systolic blood pressure; *WC*, waist circumference; *WHR*, waist-to-hip ratio; *Wt*, weight

Table 2 Recent interventions evaluating the effects of a dietary modification on cardiometabolic parameters

Author, year, country	Population	Intervention	*N* (% women), pre, post	Sessions	Minutes/ session	Duration	Supervision (Y/N)	Effect on cardiometabolic parameters	Of interest
Reeds et al. (2017) USA [58]	HIV+ obese women on ART	HIV+, 6–8% Wt loss, meal replacement	Pre: 20 (100%), post: 13	1/week	NR	Until target weight loss achieved	N	↓Wt., ↓BMI, ↓VAT, ↓SBP, ↓DBP, ↓leptin	68% achieved 6–8% Wt. loss
	HIV− obese women		Pre: 8 (100%), post: 6	1/week	NR		N	↓Wt., ↓BMI, ↓VAT, ↓SBP, ↓DBP	
Stradling et al. (2018) UK [59]	HIV+ adults on ART, LDL >116 mg/dL	Saturated fat reduction to < 10% daily energy	Pre: 31 (55%), post: 29	3/week	60	12 months (6-month results reported)	NR	NR	
		MedDiet with additional cholesterol lowering foods	Pre: 29 (48%), post: 27	3/week	60		NR	↓LDL, ↓Total to HDL ratio, ↓SBP,	↑MedDiet score ↑ olive oil, fish, legumes, nuts, stanols

ART, antiretroviral therapy; *BMI*, body mass index; *DBP*, diastolic blood pressure; *HDL*, high density cholesterol; *LDL*, low density cholesterol; *NR*, not recorded; *SBP*, systolic blood pressure; *VAT*, visceral adipose tissue; *Wt*, weight

reduction in carbohydrates and sugar-sweetened beverages [24]. While each of these studies demonstrates varied findings, due to their differences in design and participant population, there were positive effects of each intervention likely due to the approach taken to address barriers to lifestyle modification.

Few recent studies have evaluated the effects of a physical activity intervention, dietary intervention, or both on bone disease in PWH. One recent study by Santos et al. [64] evaluated a 12-week supervised strength training program among 20 sedentary PWH with low BMD. There were significant increases in BMD of the lumbar spine, femoral neck and 1/3 distal radius after the intervention, demonstrating that supervised intensive exercise may be beneficial in this population to improve bone disease. High-dose vitamin D and calcium supplementation attenuated bone loss associated with ART initiation [65], among postmenopausal women with HIV, Yin et al. [66] observed that supplementation with either 1000 IU (low) or 3000 IU (moderate) vitamin D mitigates bone loss at some but not all bone sites evaluated and there was no difference between low- and moderate-dose vitamin D. Larger, longer studies are needed to understand if these effects are sustainable in PWH, and primary prevention studies are needed to evaluate if providing physical activity and recommendations for calcium and vitamin D is beneficial to prevent bone disease and subsequently fragility fractures in this population.

Conclusions

Lifestyle modification has shown to be highly effective to improve metabolic morbidities in the general population. In the setting of HIV, the benefits of lifestyle modification neither contribute to the heavy pill burden experienced by PWH nor confer additional risk for adverse effects. The interventions reviewed were limited by relatively small sample sizes, with varied interventions and were short in duration. Despite these limitations, the literature reviewed demonstrates that PWH can modify CVD risk and bone disease risk indices by lifestyle modification, and strategies that address individual barriers and social environment may be effective for preventing and treating cardiometabolic comorbidities. Chronic co-morbid conditions including hypertension, diabetes, CVD, and bone disease are now a reality in many living with HIV [6, 67], and lifestyle modification interventions that do not also address social determinants of health as part of the intervention will likely not be effective or sustainable in this population. Furthermore, many lifestyle interventions are multimodal, cover a broad range of dietary modification and physical activity components simultaneously, and can

Table 3 Recent interventions evaluating the effects of combined dietary modification and physical activity on cardiometabolic parameters

Author, year, country	Population	Intervention	Control group (Y/N)	*N* (% women), pre, post	Sessions	Minutes/session	Duration	Supervision (Y/N)	Effect on cardiometabolic parameters	Of interest
Bloch et al. (2014) Australia [60]	HIV+ ≥ 50 years on ART, FRS ≥ 10%	Team approach: treatment for lipids, HTN, ART, counseling re diet, PA, smoking cessation	Y	Pre: NR (NR%), post: 33	NR	NR	12 months	NR	↓TC, ↓% body fat, ↓FRS, ↓D:A:D score	Smoking occurred in 25% cases vs. 0% controls
Duncan et al. (2019) UK [61]	HIV+ adults with IFG	Individualized approach to achieve 10 lifestyle goals	N	Pre: 33 (25%), post: 28	1/month	30	6 months	N	↓glucose, ↓insulin, ↓Wt, ↓SBP, ↓DBP, ↓triglycerides, ↑HDL-C, ↓10-year CVD risk	Utilized goal setting, self-monitoring. Sig. improvement in satisfaction with life, overall QOL
Saumoy et al. (2016) Spain [62]	HIV+ adults on ART, FRS ≥ 10%	Reduction in saturated fats, refined sugar; increase in PUFA, MUFA, fiber, smoking cessation; moderate aerobic exercise	Y	Pre: 27 (100%), post: 23	Diet: almost a month during year 1, then every 4 months year 2–3, PA: 3/week	NR	36 months	N	↓TC, ↓% w LDL > 130 mg/dL, ↓FRS at months 12 and 24	23% quit smoking vs. 0% in control group
Webel et al. (2018) USA [24]	HIV+ adults on ART, FRS > 20% (women), > 30% (men)	Behavior change + healthy lifestyle behavior education to improve diet quality and increase PA	Y	Pre: 54 (35%), post: NR	6 weekly face-to-face group sessions	30 min behavior change, 30 min diet and PA	6 months	N	↓Wt, ↓BMI	No effect of intervention on diet quality, PA or steps/day
Wing et al. (2019) USA [63]	HIV+ adults, BMI ≥ 27 kg/m^2	Diet education (low cal diet) 30-min walking daily	Y	Pre: 20 (40%), post:18	12	NR	12 weeks		↓Wt	Ppts reported increased strategies related to PA, coping self-monitoring

ART, antiretroviral therapy; *DBP*, diastolic blood pressure; *BMI*, body mass index; *FRS*, Framingham risk score; *IFG*, impaired fasting glucose; *NR*, not recorded; *PA*, physical activity; *QOL*, quality of life; *SBP*, systolic blood pressure; *SOC*, standard of care; *TC*, total cholesterol; *Wt*, weight

be overwhelming and disempowering for some PWH if positive results are not quickly achieved. Future lifestyle interventions should attempt to understand current lifestyle habits, potential barriers to change, and perceived risk of change; lifestyle advice should be tailored to the individual's educational and socioeconomic status as well as cultural background and environment. This agrees with the current ACC/AHA guidelines for the primary prevention of CVD [68] that recommend a team-based care approach for the prevention of CVD; the recommendations also advise clinicians to evaluate the social determinants of health that may affect an individual's decision to inform decisions. This approach may well be suited for PWH and future lifestyle modification interventions seeking to achieve effective, feasible, and sustainable results to improve cardiometabolic abnormalities should consider testing this type of intervention in this population.

Compliance with Ethical Standards

Conflict of Interest Ms. Fitch reports personal fees from Gilead Sciences, Inc., from Merck, outside the submitted work.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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