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Exploring the impact of hyperlipidemia on cardio-motor function and exercise adaptability in Hispanic-Latinos living with HIV

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ABSTRACT

HIV may precipitate a myriad of health-related complications, potentially culminating in disabilities that detrimentally affect the quality of life. Certain conditions, such as hyperlipidemia (LP), which are exacerbated by HIV, can pose additional difficulties for this particular demographic. The aim of this study is to investigate the influence of LP on the cardio-motor profile of Hispanic Latinos living with HIV. The methodology of this study consisted of a submaximal cardiovascular assessment (Ross Test) to collect relevant cardio-motor data for this research. These data were sourced from the records of individuals registered at La Perla de Gran Precio Community Centre for HIV in San Juan, Puerto Rico. The motor profile captured included treadmill speed and incline. Cardiovascular parameters recorded were blood pressure and heart rate at the cessation of the Ross Test. A total of 291 participants were classified into 229 in the non-LP group and 62 in the LP group. The findings of this study showed similar average CD4 counts. An ANOVA analysis revealed significant differences ($P < 0.05$) in the LP group, including decreased cardio time and treadmill incline compared to their counterparts. Hispanic Latinos living with HIV and LP exhibit notable deficits in motor gait. Gait parameters are particularly compromised in individuals affected by both conditions. The practical implication is to alert healthcare providers to integrate the specific cardio-motor assessments discussed in this study to address the factors influencing gait, which in turn may impact the quality of life of those with HIV.

Contribution/Originality: The primary contribution of this study is the identification of cardio-motor maladaptations during a submaximal cardiovascular test in individuals living with HIV and hyperlipidemia. This research has uncovered distinctive patterns on challenging surfaces that indicate disturbances in gait patterns or the initial stages of such disturbances.

1. INTRODUCTION

The World Health Organization (2022) reports that approximately 39 million people worldwide live with the human immunodeficiency virus (HIV). HIV is an autoimmune disease that severely compromises the immune system, causing fatigue, malaise, and increased susceptibility to other diseases. A standard treatment for HIV is antiretroviral therapy (ART), which reduces the volume of HIV in the blood and restores moderate immune function. However, ART does not entirely remove HIV from an individual's system (Williams, Lima, & Gouws, 2011). While ART can help HIV-positive individuals lead relatively normal lives, the immune system remains compromised, allowing other complications.

Despite the administration of ART, many individuals living with HIV face various comorbidities, including high blood pressure, arthritis, neuropathy, diabetes, hyperlipidemia, depression, anemia, and chronic pain that often affects

the quality of life in this population (Hyder & Rosario, 2021; Roomaney, van Wyk, & Pillay-van Wyk, 2022). The more significant issue is that as this population gets older, other complications come to the surface, such as gait, balance, neuromuscular activation, cardiovascular problems, and adaptability to exercise (Kehler, Milic, Guaraldi, Fulop, & Falutz, 2022). These comorbidities contribute to higher scores on frailty scales, increasing the risk of injurious falls and all-cause mortality (Zhou et al., 2023).

One major concern in this population is HIV and hyperlipidemia; research shows that ART has significantly improved the lives of People Living with HIV (PLHIV), it is often associated with an increased risk of dyslipidemia, a condition characterized by abnormal levels of lipids in the blood. Dyslipidemia can lead to various health complications, including cardiovascular disease (Kigongo et al., 2024). The full understanding of the mechanisms by which antiretroviral therapy (ART) contributes to dyslipidemia is still lacking. Despite the potential benefits of antiretroviral medication, recent evidence has shown that certain components of these drugs may have the unintended consequence of inducing lipid metabolic disorders. Lipodystrophy, a condition commonly observed in PLHIV, involves changes in the distribution of body fat as well as metabolic disturbances, such as dyslipidemia and hyperglycemia. Furthermore, HIV, being a chronic inflammatory condition, has the potential to cause insulin resistance and worsen lipid imbalances, as demonstrated by studies conducted by Bowman et al., 2020 and Kigongo et al., 2024).

Research indicates that hyperlipidemia affects motor functions, including gait and balance. HIV and hyperlipidemia can impair motor skills and balance, increasing the risk of falls among middle-aged PLHIV (Berner, Morris, Baumeister, & Louw, 2017). Various factors, including gender, age-related changes, and lifestyle aspects, can affect motor functions in PLHIV (Rosario, 2022; Rosario & Orozco, 2022). Despite some studies on hyperlipidemia, there has been limited focus on its impact on cardiovascular and motor components in PLHIV. Addressing this gap and building on previous research by Rosario, Jamison, and Gines (2020) this study aims to investigate hyperlipidemia's effects on gait, balance, and cardiovascular adaptability to exercise in PLHIV. The hypothesis posits that HIV-positive individuals with hyperlipidemia will show altered cardiovascular and gait adaptability to exercise, potentially affecting their daily activity participation and quality of life.

2. METHODS

Individuals were registered at the La Perla de Gran Precio (LPGP) Community Center in San Juan, Puerto Rico, between 2000 and 2020. The participant's enrollment was dependent on obtaining clearance from their primary care physician, who was responsible for supervising the treatment and progression of their HIV condition. The main focus of the LPGP Community Center is to improve the well-being and quality of life for Hispanic Latino PLHIV through exercise therapy.

Prior to participating in any activities at the community center, individuals underwent an assessment by a licensed physical therapist. Afterwards, a certified personal trainer administered a series of exercise tests, including the Ross submaximal treadmill test. The Ross test protocol utilized for the HIV population bore resemblance to those previously published by Rosario (2022). This cardiovascular test is a core component of the exercise regimen designed for LPGP participants.

This study's retrospective analysis of data gathered from participant records spanning two decades is an essential feature. The study was granted approval by LPGP and adhered to stringent privacy and confidentiality protocols set forth by the organization. In accordance with LPGP's regulations, all participants are required to present up-to-date laboratory test results and undergo a series of physical fitness assessments. The cardiovascular and motor components were examined using the Ross submaximal treadmill test. Data concerning participants' immune status (as indicated by CD4 count) and lipid profiles were collected through interviews and recent laboratory results.

Motor and Cardiovascular Components: Participants' vital signs were measured before the cardiovascular test. The Ross treadmill test began with participants walking at a speed of 2.0 mph with zero inclination. Over the first six minutes, both speed and inclination increased incrementally. By the second minute, the speed increased to 2.5 mph; by the third minute, it was at 3.0 mph; and by the fourth minute, it reached 3.4 mph, still at zero inclination. Beyond this point, the speed remained constant at 3.4 mph, while the inclination increased by 3% every three minutes, reaching a maximum of 15% at minute 21. The test concluded when participants reached their maximum heart rate or reported muscle or cardiovascular fatigue. The cardiovascular data collected for this study were the measurements taken at the end of the Ross test. These included heart rate and blood pressure, while motor data included treadmill speed and inclination.

2.1. Data Collection and Database Development

1. The initial step involved collecting data from all participants enrolled in LPGP from 2000 to 2020 who had completed the center's enrollment prerequisites. Approximately 1,300 files were reviewed for accuracy and completeness. LPGP participants undergo comprehensive longitudinal assessments, which document comorbidities, medications, lipid panels, years since HIV diagnosis, demographics (age, gender), HIV status (CD4 count), vital signs, and physical activity status. This study used the most recent information available in the participant records. Most LPGP participants are Hispanic/Latino residing in the United States. Therefore, the data gathered here aim to provide a representative cardiomotor profile for this ethnic group.

2. Following data collection, a codebook was developed to facilitate data mapping and comparisons. The codebook provided data codes and variable definitions, guiding data organization into a comprehensive database for further analysis, comparison, and interpretation.

3. Data were then categorized based on hyperlipidemia (LP) status. Participants with an LP diagnosis was placed in the LP group. In contrast, those without the LP diagnosis were placed in the non-LP group. These groupings were used for subsequent comparisons and analysis.

2.2. Data Analysis

The present report focuses on an in-depth comparison of cardiovascular and motor profiles to assess an individual's physical abilities. Key motor components considered in this study included treadmill speed and inclination, as they are critical metrics for evaluating physical performance. Furthermore, the study assessed cardiovascular and respiratory health during the Ross test, noting the duration of the test and measuring vital signs, with particular attention to heart rate and blood pressure immediately after the test's completion.

To compare the hyperlipidemia group (LP) and non-Hyperlipedia (non-LP) groups, the study used statistical software SPSS version 28 to analyze variance (ANOVA), a method used to identify significant differences between groups. A p-value of 0.05 or lower was statistically significant, indicating that the observed outcomes are unlikely to be due to chance.

3. RESULTS

Table 1 provides an overview of the demographic characteristics of the participants in the current study. The analysis was conducted on data derived from 291 participant records, which were further categorized into 62 LP (mean CD4 count = 719.3 ± 358.3) and 229 non-LP (mean CD4 count = 610.4 ± 348.3) groups based on CD4 levels. The LP group had a significantly longer duration since their HIV diagnosis and higher CD4 counts, as indicated in Table 1.

Table 1. Demographic data of all participants. Results of ANOVA performed comparing Non-LP and LP groups significance level set at p≤0.05.

Characteristics	Non-LP	LP	P value
	n=229	n=62	n/a
Age (Years)	M= 52.4+/-10. 1 years	M=56.9 +/7.4years	P= 0.01
Gender	Male=1	Male=1	
	Female =0	Female=0	
	M= 0.24+/-0.43	M=0.35+/-0.48	P= 0.59
Year of Dx (Years)	M= 19.1+/-8.8	M=17.9+/-7.6	P= 0.41
Cd4	M=610.4+/-348.9	M= 719.3+/-358.3	P= 0.05
LP=Hyperlipidemia			

3.1. Cardiovascular and Motor Components

Table 2 illustrates the comparison of cardiovascular factors between the two groups. The LP group displayed a shorter duration of the cardiovascular test, with a statistically significant reduction in test time (P<0.05). Regarding the motor components, treadmill inclination (also shown in Table 2) was significantly lower in the LP group compared to the non-LP group, indicating a noticeable difference in physical performance.

Table 2. Cardiovascular component at the end of the Ross Submaximal test. results of ANOVA performed comparing non-PN and PN groups significance level set at p≤0.05.

Characteristics	Non-LP	SD	F value	P value
	n=2229	n=62		
Heart rate (bpm)	M=139.8 +/- 17.7	M=131.3 +/- 19.2	0.001	P= 0.34
Systolic BP (mmHg)	M=123.5+/- 16.7	M=126.8 +/- 17.3	1.6	P= 0.22
Diastolic BP (mmHg)	M=74.3 +/ 10.6	M=77.3 +/- 11.4	0.65	P= 0.08
Cardio test time	M=10.7 +/- 4.8	M=8.7 +/- 3.9	4.9	P=0.01
Motor component at the end of the Ross Submaximal test				
Velocity	M=3.31 +/- 0.28	M=3.31+/- 0.26	0.81	P= 0.96
Inclination	M=5.9+/-4.2	M=4.1+/- 3.6	3.05	P= 0.01
LP=Hyperlipidemia				

4. DISCUSSION

This investigation seeks to elucidate the impact of hyperlipidemia on gait and cardiovascular adaptability to exercise among PLHIV. The guiding hypothesis suggests that HIV-positive individuals with hyperlipidemia may

exhibit significant changes in their cardiovascular response to exertion and alterations in walking adaptability, potentially influencing their participation in daily activities and diminishing their quality of life. The findings revealed a notable decrease in cardio time and treadmill inclination during the Ross test, indicating that hyperlipidemia impedes exercise adaptability in PLHIV. Consequently, these outcomes affirm the study's initial assumption.

Research indicates elevated lipid levels detrimentally affect the cardiovascular system. Hyperlipidemia substantially increases the risk of cardiovascular incidents, such as heart attacks and strokes, by promoting the accumulation of plaques in arteries, a condition known as atherosclerosis. The above problem restricts blood flow and can lead to severe cardiovascular complications, including myocardial infarction and cerebrovascular accidents. PLHIV, particularly those on specific ART regimens, face an increased risk of developing cardiovascular diseases due to hyperlipidemia (Denu, Revoori, Buadu, Oladele, & Berko, 2024). These vascular restrictions likely account for the observed reduction in cardio time during the Ross test for the LP group.

Rosario identified the increased risk related to the virus and ART of cardiovascular diseases in HIV-positive individuals (2022), which are due to both the HIV infection and the effects of ART, as well as other factors like smoking (Buendia, Sears, & Mgbere, 2022). The interaction of HIV and ART leads to systemic inflammation and immune dysregulation, affecting the lipid profile and elevating cardiovascular disease risk. The increase in cardiovascular risk can lead to broader health challenges, potentially affecting mobility, such as gait disturbances and sedentary behaviors, especially in the aging HIV-positive population (Martin & Elizabeth, 2022). Dyslipidemia affects this demographic's cardiovascular risk, physical function, and quality of life (Chastain, Henderson, & Stover, 2018). Some studies revealed that hyperlipidemia significantly predicts treadmill time and inclination, suggesting that an increase in lipidemia negatively affects the cardiomotor system, particularly on challenging walking surfaces. The study also demonstrated that the duration of HIV diagnosis, along with factors such as age, body mass index (BMI), and pre-existing comorbidities, exacerbates the risk of cardiovascular events among PLHIV (Denu et al., 2024). In the current study, those in the hyperlipidemia group had a significantly longer duration of living with HIV, and therefore in the ART protocol underscoring the association between prolonged HIV infection and a higher risk of developing hyperlipidemia and subsequent cardiovascular issues (Husain & Ahmed, 2015).

Additionally, hyperlipidemia can have severe consequences, such as peripheral artery disease, which reduces blood flow to the lower extremities and consequently leads to gait and balance issues (Achila et al., 2022; Maggi et al., 2017). Moreover, medications like statins, which lower lipid levels, may have side effects including muscle weakness and neuropathy, potentially affecting gait. This correlation explains the findings of this study (Attardo, Musumeci, Velardo, & Toscano, 2022; Khan & Kleiman, 2022). Participants in this study exhibit a variation in time on a treadmill, and the inclination which was impacted in those with hyperlipidemia. A limitation of this inquiry is that it did not account for lipid medication use or the diagnosis of peripheral artery disease. Future research should investigate the type of lipid medication and compare the gait variables mentioned in this study, as this may be a crucial factor in understanding the adaptability to exercise in individuals living with HIV.

5. CONCLUSION

This study identifies individuals living with HIV and hyperlipidemia, demonstrating alterations in their cardio-motor adaptability to exercise. A notable finding, which also represents a limitation, is that lipid-lowering medications may contribute to these differences in addition to the known impacts of antiretroviral therapy (ART). This highlights the importance of regular monitoring of lipid levels, cardiac function, and gait deficiencies, as well as the specific types of medications used to regulate lipid levels. The study's limitations include reliance on data extracted from a database, restricted to participants who completed the Ross test, resulting in the unavailability of current lipid medication data. Future research should investigate the relationship between lipid levels, balance, lower limb neuromuscular activation, and cognitive function.

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Institutional Review Board Statement: The Ethical Committee of the Texas Woman's University, Dallas, USA has granted approval for this study on 28 March 2022 (Ref. No. FY-2022-210).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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