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This article is derived from the master's dissertation entitled "Dietary Pattern Predictive and Protective of Cardiovascular Risk According to the Score Method in Adolescents Living with HIV," authored by Monyque Hellen Teixeira de Jesus Espinosa under the supervision of Maria Izabel Siqueira de Andrade, Poliana Coelho Cabral, and Luiz Rodrigo Augustemak de Lima. The dissertation was submitted to the Programa de Pós-Graduação em Nutrição at the Universidade Federal de Alagoas, Maceió, Brazil, in 2023.

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Predictive and protective dietary pattern of cardiovascular risk according to the scoring method in adolescents living with HIV

Padrão alimentar preditivo e protetor do risco cardiovascular segundo o método dos escores em adolescentes vivendo com HIV

Abstract

Introduction: The adverse effects of long-term antiretroviral therapy in association with poor dietary habits can contribute to the development of metabolic and cardiovascular abnormalities in HIV. *Objective*: To evaluate dietary patterns that predict or protect against cardiovascular risk in adolescents living with HIV. *Methods*: This case series included 34 adolescents diagnosed with HIV, male and female, aged 10 to 18 years. The cardiovascular risk factors assessed included overweight and obesity status, elevated waist circumference, elevated systolic and diastolic blood pressure, unfavorable lipid profiles, and glucose levels. Dietary intake was assessed using a Food Frequency Questionnaire, and analyzed using a scoring system that attributed points to food items based on consumption frequency. The association between dietary patterns and cardiovascular outcomes was evaluated using the Mann-Whitney U test. *Results*: There was a high frequency of normal weight (74%), blood glucose (80%), total cholesterol (82%), LDL-c (78%), blood pressure (91%), body fat percentage (76%), and waist circumference values (100%). Substantial proportions of adolescents were found to have elevated triglyceride levels (50.0%) and reduced HDL-c concentrations (77.7%). Despite a higher intake of protective food items, the overall consumption of fruits and vegetables was low. High intake of added sugars, fried foods, processed meats, soft drinks, and cookies was observed. An inverse association was found between predictive dietary patterns and systolic blood pressure values ($p = 0.04$). *Conclusion*: A high intake of foods considered protective against cardiovascular risk was observed, despite the low consumption of fruits and vegetables and a high intake of foods associated with increased cardiovascular risk. A high frequency of dyslipidemia was identified, alongside an association between predictive dietary patterns and low systolic blood pressure.

Keywords: HIV. Food intake. Nutrients. Cardiovascular diseases. Adolescent.

Resumo

Introdução: Os efeitos adversos da terapia antirretroviral de longo prazo, associados a maus hábitos alimentares, podem contribuir para o desenvolvimento de anormalidades metabólicas e cardiovasculares no HIV. ***Objetivo***: Avaliar padrões alimentares que predizem ou protegem contra o risco cardiovascular em adolescentes vivendo com HIV. ***Métodos***: Esta série de casos incluiu 34 adolescentes diagnosticados com HIV, de ambos os sexos, com idades entre 10 e 18 anos. Os fatores de risco cardiovascular avaliados incluíram sobrepeso e obesidade, circunferência da cintura elevada, pressão arterial sistólica e diastólica elevadas, perfis lipídicos e níveis glicêmicos desfavoráveis. A ingestão alimentar foi avaliada por meio de um Questionário de Frequência Alimentar e analisada por meio de um sistema dos escores que atribui pontos aos alimentos com base na frequência de consumo. A associação entre padrões alimentares e desfechos cardiovasculares foi avaliada pelo teste U de Mann-Whitney. ***Resultados***: Houve alta frequência de peso normal (74%), glicemia (80%), colesterol total (82%), LDL-c (78%), pressão arterial (91%), percentual de gordura corporal (76%) e valores de circunferência da cintura (100%). Proporções substanciais de adolescentes apresentaram níveis elevados de triglicerídeos (50%) e concentrações reduzidas de HDL-c (77,7%). Apesar damaior ingestão de itens alimentares protetores, o consumo geral de frutas e vegetais foi baixo. Foi observada alta ingestão de açúcares adicionados, frituras, carnes processadas, refrigerantes e biscoitos. Foi encontrada associação inversa entre padrões alimentares preditivos e valores de pressão arterial sistólica (p = 0,04). ***Conclusão***: Foi observada alta ingestão de alimentos considerados protetores contra risco cardiovascular, apesar do baixo consumo de frutas e vegetais e alta ingestão de alimentos associados ao aumento do risco cardiovascular. Foi identificada alta frequência de dislipidemia, juntamente com associação entre padrões alimentares preditivos e baixa pressão arterial sistólica.

Palavras-chave: HIV. Consumo alimentar. Nutrientes. Risco cardiovascular. Adolescente.

INTRODUCTION

Over the past few decades, the widespread use of combined antiretroviral therapy (ART) has significantly increased the survival of individuals infected with the human immunodeficiency virus (HIV), leading to a substantial reduction in HIV-related mortality.[1,2] The primary objectives of ART are to inhibit viral replication to undetectable levels, strengthen immune function, and reduce the incidence of opportunistic infections. Additionally, ART helps to suppress the activation of pro-inflammatory cytokines, lowers the risk of antiretroviral drug resistance, and minimizes treatment-related toxicity.[3-5] The implementation of ART has been essential in supporting normal growth and developmental processes in children and adolescents living with HIV.[4]

On the other hand, ART is associated with adverse effects which, when combined with HIV-related metabolic alterations, such as chronic immune activation, low-grade inflammation, and cellular senescence can lead to long-term complications that may persist throughout life.[2,6] Moreover, both HIV infection and the long-term use of ART are associated with adverse metabolic outcomes, including changes in body fat distribution (lipodystrophy), dyslipidemia, and disturbances in carbohydrate metabolism.[3,6-9] Although clinical symptoms of atherosclerosis typically do not manifest during childhood, the atherogenic process can begin in the early years of life, potentially increasing the risk of cardiovascular disease and premature atherosclerotic events in adolescents living with HIV.[3,6-9]

Currently, most adolescents are growing up in an obesogenic and labor-saving environment, which promotes unhealthy lifestyle habits such as poor dietary patterns and physical inactivity, contributing to weight gain and the development of chronic noncommunicable diseases,[10] a trend that is increasingly evident at earlier ages in the general population.[11] Thus, individuals living with HIV who are undergoing ART and have poor dietary habits are at increased risk for developing cardiovascular disease.[12]

An inadequate dietary composition, characterized by high intake of saturated and trans fats, sodium, and refined carbohydrates, along with low dietary fiber, may contribute to alterations in the lipid profile of adolescents living with HIV, especially when combined with HIV-related complications and the adverse effects of ART, thereby exacerbating cardiovascular risk factors.[13,14] Data from children and adolescents living with HIV emphasize that lifestyle changes, such as adopting a healthy diet and engaging in regular physical activity, are essential for optimizing nutritional status, promoting overall health, and preventing chronic disease complications.[15]

Although several studies have examined food consumption and cardiovascular risk in children and adolescents living with HIV, few have statistically linked dietary intake to specific cardiovascular risk factors within this population. Given the limited research in this area, investigating the relationship between food consumption and cardiovascular risk in this group is of critical importance.[14]

The scoring method used to assess food consumption reflects dietary quality by assigning a continuous numerical scale based on the frequency of consumption of specific food groups (according to the pattern being investigated). Higher scores correspond to greater consumption of a particular food group, allowing for statistical analysis of the association between dietary patterns and cardiovascular risk or protection.[12,16,17]

From this perspective, adolescents living with HIV who are undergoing ART and consume foods associated with increased cardiovascular risk may be particularly vulnerable to developing cardiovascular complications. Accordingly, the present study aimed to evaluate dietary patterns–both predictive and protective–associated with cardiovascular risk in adolescents living with HIV receiving care at a referral hospital in the state of Alagoas, Brazil.

METHODS

Study population and design

This case series was conducted between March 2022 and January 2023 with adolescents diagnosed with HIV who were undergoing clinical follow-up at the Hospital Escola Dr. Helvio José de Farias Auto – Specialized Assistance Service (HEHA-SAE), located in Maceió, Alagoas, Brazil. HEHA-SAE is a reference center for the care of pediatric patients living with HIV/AIDS in the state and provides outpatient treatment through a multidisciplinary team, including medical, pharmaceutical, psychosocial, nutritional support, among others.

The study population was selected based on the following inclusion criteria: 1) HIV infection diagnosis; 2) age between 10 and 18 years; 3) clinical follow-up at HEHA-SAE; 4) availability of clinical and laboratory records. Exclusion criteria included: 1) inability to stand or move; 2) speech or hearing impairments; 3) reliance on enteral or parenteral nutritional therapy; and 4) pregnancy.

A total of 72 adolescents, aged 10 to 18 years, are currently undergoing clinical follow-up at HEHA-SAE. Of these, 65 were invited to participate in the study. The remaining 7 adolescents did not attend HEHA-SAE during the data collection period. Of those invited, 25 declined participation, while 40 agreed to take part. However, six participants were excluded for the following reasons: HIV diagnosis not confirmed (n=4), inability to stand or move (n=1), and pregnancy (n=1). As a result, 34 adolescents living with HIV were included in the study.

Characterization variables

Clinical variables

Data on the type and duration of antiretroviral therapy (ART) were collected, with results categorized as no ART, ART without protease inhibitors (PI), and ART with PI. Information on CD4+ T lymphocyte count and viral load was also gathered. Viral load was classified as undetectable (< 40 copies/mL) or detectable (≥ 40 copies/mL). These data were collected using a semi-structured questionnaire developed for this study, with additional HIV-related information extracted from the participants' medical records.

Sociodemographic variables

Data were collected on sex (female or male), age (10-18 years), date of birth (2003-2011), and skin color (white, brown, black, yellow, and indigenous).

Maternal education was categorized as follows: ≤8 years of schooling (no schooling, incomplete elementary school 1 [1st to 4th grade], completed elementary school 1 [1st to 4th grade], incomplete elementary school 2 [5th to 8th grade], and completed elementary school 2 [5th to 8th grade]) and >8 years of schooling (incomplete secondary education [1 to 3 years], completed secondary education [1 to 3 years], incomplete higher education, and completed higher education).

Household income was classified into social classes (A-E) based on the financial provider's earnings, using the number of minimum wages as a reference. The classification was based on the Brazilian Institute of Geography and Statistics (IBGE) guidelines, with the minimum wage set at R$ 1,212.00 (approximately $247 USD). The income classifications were as follows: Class A: > 20 minimum wages; Class B: 10-20 minimum wages; Class C: 4-10 minimum wages; Class D: 2-4 minimum wages; and Class E: ≤ 2 minimum wages.[18]

Assessment of food intake scores

Dietary patterns were assessed using a Food Frequency Questionnaire (FFQ) specifically developed and validated for Brazilian adolescents. The instrument reliably categorizes individuals based on their previous nutrient intake, except for retinol and iron.[19]

A simplified version of the FFQ, consisting of 64 food items, was used. To adapt the questionnaire to the local context, a list of regional foods was included, incorporating typical foods from the Northeast region, such as corn-based dishes (e.g., couscous), tubers (e.g., yam and cassava), and their by-products (e.g., tapioca) [https://alimentacaosaudavel.org.br/].

The questionnaire is semi-quantitative, with response options reflecting frequency over time: never, less than once a month, once to three times a month, once a week, two to four times a week, once a day, and more than once a day.

The scoring method proposed by Fornés et al.[20] was used to assess dietary patterns. In this method, the frequency of consumption was treated as a quantitative variable by converting categories into annual consumption frequency and assigning a weight (S) to each frequency category. The maximum weight (S7) was defined as 1 for daily consumption, while the minimum weight was S7 = 0. The weights for the other frequency categories were calculated using the following formula: $Sn = (1/365) \times [(a + b)/2]$, where "a" and "b" represent the frequency of food consumption.

Consumption frequency scores were calculated for two dietary groups: the predictive diet, which included fried foods, full-fat dairy products (e.g., cheese and cream cheese), sausages, vegetable fats (e.g., margarine), and ultra-processed foods; and the protective diet, which concentrated on fruits, natural juices, vegetables, cereals, and their derivatives. This classification was performed by researchers with degrees in Nutrition.

To obtain the frequency score for each group, the weights of each item were summed.[20] The dietary pattern model was then evaluated based on the exploratory variables. Higher scores indicated greater consumption of a specific food group, allowing for the assessment of the association between exposure to dietary patterns and cardiovascular risk and/or protection.[12,16,17]

Cardiovascular risk variables

Anthropometry and body composition

Anthropometric measurements included body mass, height, body mass index (BMI), waist circumference, and skin fold thicknesses at sub scapular, abdominal, calf, and triceps sites to evaluate body composition, with a focus on body fat distribution and quantity. All assessments were conducted following the standardized protocols established by the International Society for the Advancement of Kinanthropometry (ISAK).[21]

Body fat percentage was estimated using the predictive equation proposed by Lima et al.,[22] which is specifically designed for children and adolescents living with HIV.

Body mass index (BMI) was interpreted using the BMI-for-age index, based on age- and sex-specific cutoff points established by the World Health Organization (WHO) growth reference curves.[23] BMI-for-age z-scores were classified as follows: marked thinness and thinness (< –2 standard deviations [SD]), normal weight (≥ –2 SD and < +1 SD), and overweight (≥ +1 SD).[24] Z-scores were calculated using the AnthroPlus® software developed by the World Health Organization.

For waist circumference, the 90th percentile was used as the cutoff point for children aged 10 years or older, following the criteria established by Freedman et al.,[25] desirable (< 90th percentile) and undesirable (≥ 90th percentile).

Body fat percentage was evaluated based on the cutoff points established by Lohman,[26] which classify values for males as follows: below ideal (<10%), ideal (≥10% and ≤20%), and above ideal (>20%); and for females as: below ideal (<15%), ideal (≥15% and <25%), and above ideal (>25%).

Blood pressure

Blood pressure classification was considered normal when systolic and/or diastolic blood pressure was below the 97th percentile, and high when it was at or above the 97th percentile, specific to gender and age.[27]

In adolescents, high blood pressure was diagnosed when values were equal to or greater than 120/80 mmHg, even if they were below the 97th percentile.[27]

Laboratory analysis

Data obtained from routine clinical follow-up medical records of patients living with HIV were used to assess the following variables: total cholesterol (acceptable: <170 mg/dL; high: ≥170 mg/dL), triglycerides (acceptable: <90 mg/dL; high: ≥90 mg/dL), HDL cholesterol (desirable: >45 mg/dL; undesirable: ≤45 mg/dL), LDL cholesterol (acceptable: <110 mg/dL; high: ≥110 mg/dL), and glucose (desirable: <100 mg/dL; undesirable: ≥100 mg/dL).

The interpretation of metabolic health biomarkers was based on the Brazilian Guidelines for Dyslipidemia and Atherosclerosis Prevention[28] and Guideline of the Brazilian Society of Diabetes.[29]

Statistical analysis

Descriptive statistics were employed, including measures of central tendency and dispersion, as well as the use of absolute and relative frequencies. Food pattern scores were analyzed by summing the weighted averages of food scores within each food group.

These scores were expressed on an ordinal scale, presented as means and standard deviations, to characterize the food pattern scores of the established food groups. Comparisons between the consumption scores and the studied variables were performed using the Mann-Whitney or Kruskal-Wallis tests, as appropriate.

The two groups of food consumption scores (protective diet and cardiovascular risk predictor diet) were then compared with cardiovascular risk factors. Additionally, simple linear regression analyses were conducted to assess the associations between predictive and protective dietary intakes and anthropometric and biochemical variables.

All analyses were performed using STATA® 13.0 (Stata Corporation®, College Station, TX, USA). A 95% confidence interval was applied, and statistical significance was set at $p \leq 0.05$.

Ethical aspects

This study adhered to the ethical principles of respect for individuals' autonomy, as outlined in Resolution No. 466, dated December 12, 2012, from the National Health Council. All participants' legal guardians provided written informed consent for their participation, and the students themselves signed a term of free and informed assent.

The study was approved by the Research Ethics Committee of the Federal University of Alagoas, under CAAE number 40332920.0.0000.5013 and opinion number 4.506.466.

RESULTS

Participants baseline characteristics

The study included 34 adolescents diagnosed with HIV from the state of Alagoas, Brazil, of which 52.9% were female. The mean age was 14.4 ± 2.1 years for both sexes. Most participants were classified as brown/black (67.6%), with at least 91.1% having an income of up to two minimum wages and belonging to social class E.

Furthermore, 61.2% of mothers had an education level of ≤8 years. Regarding HIV treatment, 70.5% of participants had an undetectable viral load, and 54.5% were using antiretroviral therapy (ART) with protease inhibitors. The average number of T CD4 cells was 882.9 ± 473.7 cells/µL. Table 1 provides detailed information on the socio-demographic and clinical characteristics of the participants.

Table 1. Characterization of the sample of adolescents living with HIV, Maceió-AL, 2022.

Variables	Total (n=34)	Female (n=18)	Male (n=16)
Age (years)	14.4 ± 2.1	14.6 ± 2.1	14.2 ± 2.2
Skin color			
Brown/black	23 (67.6)	12 (66.6)	11 (68.7)
Others	11 (32.2)	6 (33.2)	5 (31.2)
Income (economic status)			
Class D/E	33 (96.9)	18 (100.0)	15 (93.7)
Class A/B/C	1 (2.9)	0 (0.0)	1 (6.2)
Mother's education[a]			
≤ 8 years	19 (61.2)	10 (62.5)	9 (60.0)
> 8 years	12 (38.7)	6 (37.5)	6 (40.0)
T CD4 (cells/mm3)	883 (474)	823 (401)	950 (550)
Viral load			
Undetectable	24 (70.5)	12 (66.6)	12 (75.0)
Detectable	10 (29.4)	6 (33.3)	4 (25.0)
ART[b]			
No ART	2 (6.0)	1 (5.5)	1 (6.6)
ART without PI	13 (39.3)	8 (44.4)	5 (33.3)
ART with PI	18 (54.5)	9 (50.0)	9 (60.0)
ART time (years)	8.5 ±3.4	7.6 ± 3.6	9.4 ± 3.0

The results were expressed as mean and standard deviation: mean ± sd; or n and percentage: n (%), according to the analyses performed.[a]n=31; [b]n= 33.
ART, antiretroviral therapy.
PI, protease inhibitors.

Characterization of cardiovascular risk factors

It was found that 73.5% of the adolescents were eutrophic according to BMI. All individuals had acceptable values for waist circumference. Normal levels were observed in 73.9% for glucose, 80.7% for total cholesterol, 79.1% for LDL-c, and 90.6% for blood pressure.

The population exhibited acceptable triglyceride levels in 50% of cases, while a significant proportion (77.7%) had HDL-c levels below the recommended thresholds. Additionally, 76.4% of individuals had a body fat percentage below the reference values. Table 2 presents the cardiovascular risk factors.

Table 2. Cardiovascular risk factors in adolescents with HIV, Maceió-AL, 2022.

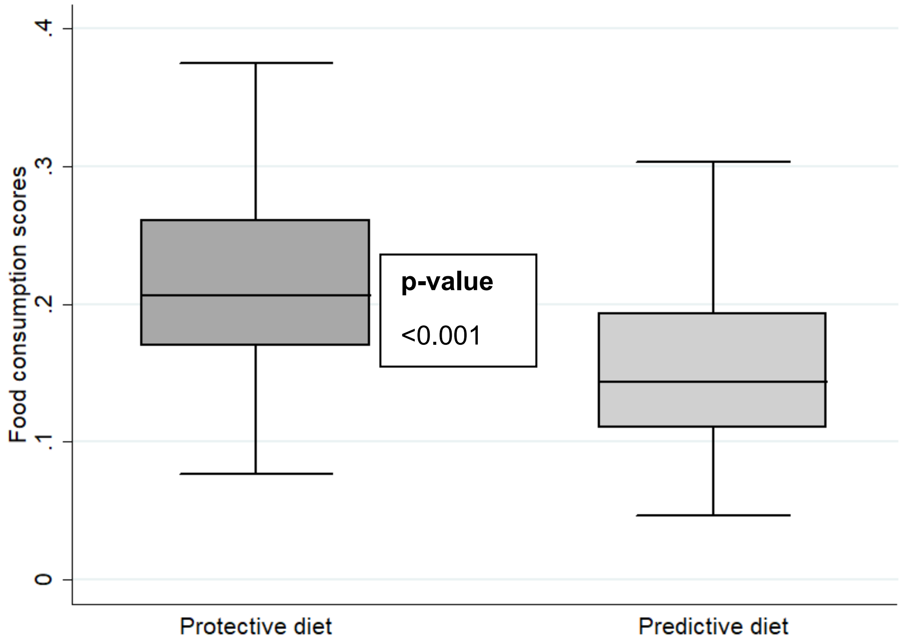
Variables	Total (n=34)	Female (n=18)	Male (n=16)
BMI (kg/m²)			
Thinness	4 (11.7)	1 (5.5)	3 (18.7)
Eutrophy	25 (73.5)	16 (88.8)	9 (56.2)
Overweight	5 (14.7)	1 (5.5)	4 (25.0)
Glucose (mg/dL) [a]			
Acceptable	20 (80.0)	10 (76.9)	10 (83.3)
Undesirable	5 (20.0)	3 (23.0)	2 (16.6)
Total cholesterol (mg/dL) [b]			
Acceptable	23 (82.1)	12 (80.0)	11 (84.6)
High	5 (17.8)	3 (20.0)	2 (15.3)
LDL-c (mg/dL) [c]			
Acceptable	21 (77.7)	11 (73.3)	10 (83.3)
High	6 (22.2)	4 (26.6)	2 (16.6)
HDL-c (mg/dL) [d]			
Desirable	6 (22.2)	4 (26.6)	2 (16.6)
Undesirable	21 (77.7)	11 (73.3)	10 (83.3)
Triglycerides (mg/dL) [e]			
Acceptable	14 (50.0)	8 (53.3)	6 (46.1)
High	14 (50.0)	7 (46.6)	7 (53.8)
Bloodpressure (mmHg)			
Normal	31 (91.1)	18 (100.0)	13 (81.2)
High	3 (8.8)	0 (0.0)	3 (18.7)
Body fat (%)			
Below	26 (76.4)	14 (77.7)	12 (75.0)
Ideal	5 (14.7)	3 (16.6)	2 (12.5)
High	3 (8.8)	1 (5.5)	2 (12.5)
Waistcircumference (cm)			
Desirable	34 (100.0)	18 (100.0)	16 (100.0)
Undesirable	0 (0.0)	0 (0.0)	0 (0.0)

The results were expressed as n and percentage: n (%), according to the analyses performed.[a]n=25; [b]n=28; [c]n=27; [d]n=27; [e]n=28.

Characterization of food pattern of adolescents living with HIV

It was observed that the sample had a significantly higher median consumption score for protective foods ($p < 0.001$) (Figure 1). A low daily consumption of fruits and vegetables was noted, along with a higher intake of rice, beans, bread, corn couscous, and olive oil (protective foods).

Figure 1. Consumption scores of the protective diet that predicts cardiovascular risk in adolescents living with HIV, Maceió-AL, 2022.



In contrast, there was a high consumption of added sugars, sweets, fried foods (including chicken, fish, eggs, sausage, and processed meats), soft drinks, and biscuits (predictor foods). Figures 2A and 2B illustrate the frequency percentages of consumption of protective foods and predictors of cardiovascular risk.

Figure. 2 A. Percentage of frequency of consumption of protective foods (A) of cardiovascular risk in adolescents living with HIV. Black color on the cardiovascular risk protective diet chart: a warning sign, as they are cardioprotective foods and "never" consumed. Thus, successively, until those consumed "daily", represented by the lighter color, Maceió-AL, 2022.

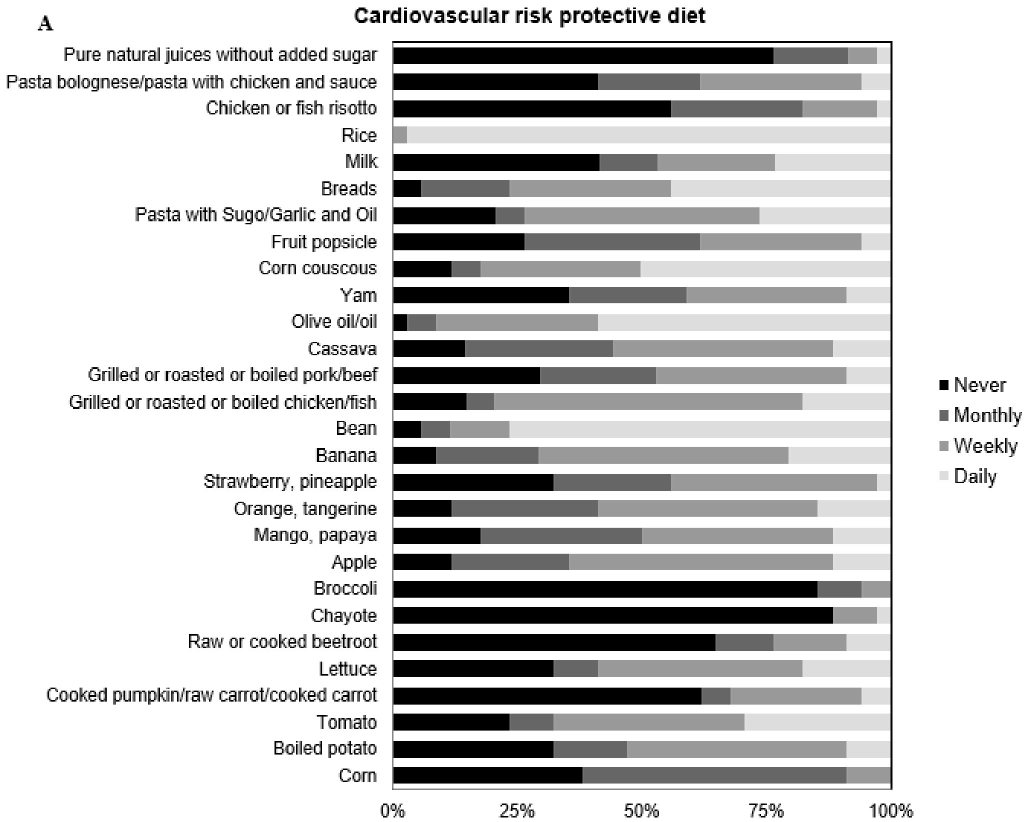
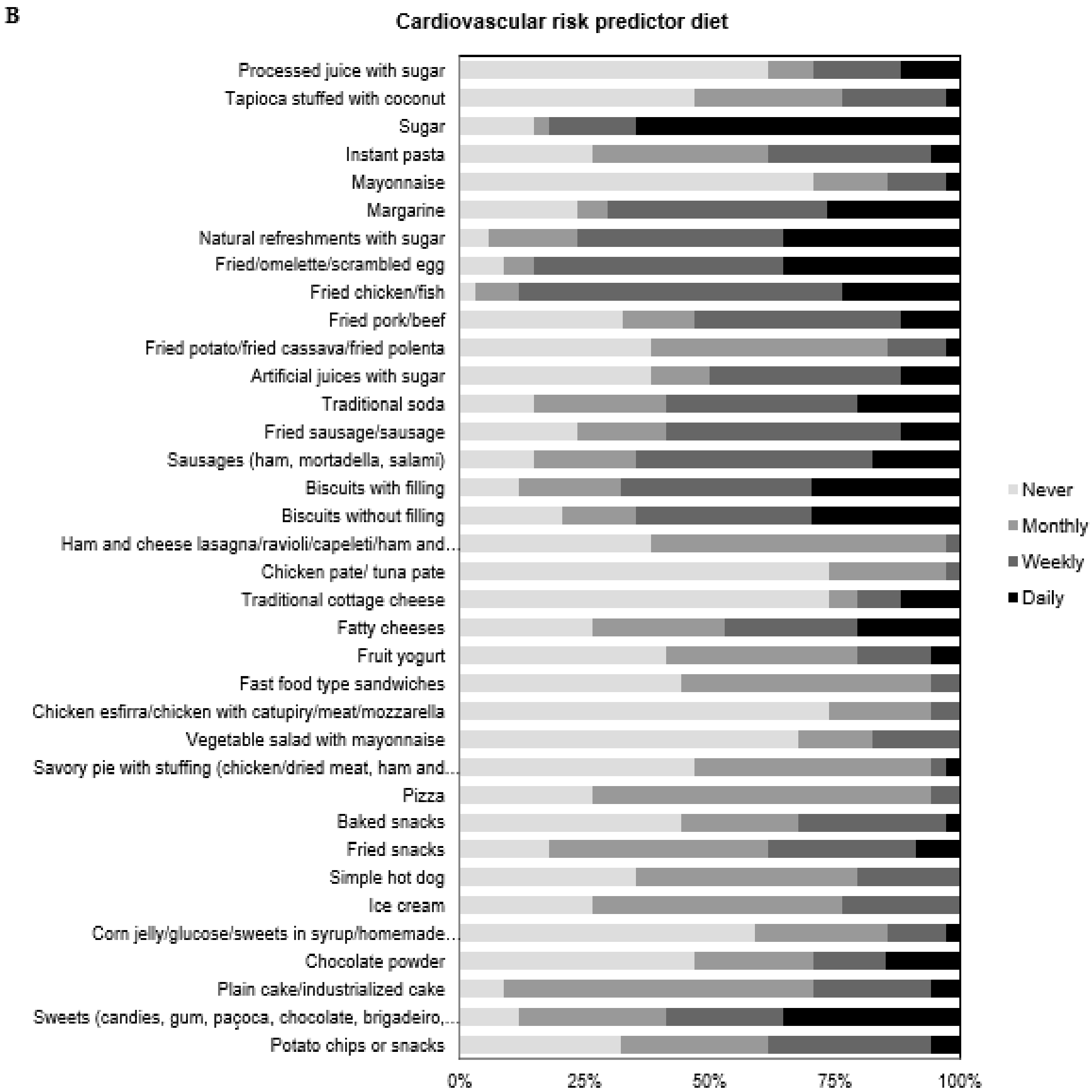


Figure. 2 B. Percentage of frequency of consumption of predictors (B) of cardiovascular risk in adolescents living with HIV. Black color in the cardiovascular risk predictor foods and are consumed "daily". Thus, successively, until the "never" consumed, represented by the lighter color, Maceió-AL, 2022.



Food pattern scores and cardiovascular risk factors

No significant differences were found in the consumption of a protective diet across categories of sex, age, BMI, waist circumference, total cholesterol, LDL-c, HDL-c, triglycerides, blood pressure, or body fat percentage. Similarly, no significant differences were observed in the consumption of a predictive diet in relation to sex, age, BMI, waist circumference, total cholesterol, LDL-c, HDL-c, triglycerides, blood pressure, or body fat percentage. Table 3 presents the comparison of food pattern scores and cardiovascular risk factors.

Table 3. Medians and interquartile intervals of food patternscores according to cardiovascular risk factors in adolescents living with HIV, Maceió-AL, 2022.

Variables	Cardiovascular risk predictor diet		Cardiovascular risk protective diet	
	Median	Interquartile Intervals	Median	Interquartile Intervals
Sex				
Female	0.1437	0.1083-0.1739	0.2191	0.1448-0.2679
Male	0.1417	0.1125-0.2171	0.2038	0.1696-0.2551
p-value[a]	0.581		0.890	
Age (years)				
10-14 years	0.1396	0.1239-0.2250	0.2227	0.1790-0.2731
15-18 years	0.1476	0.1042-0.1891	0.2011	0.1346-0.2453
p-value[a]	0.309		0.285	
BMI (kg/m²)				
Thinness	0.1377	0.1135-0.1714	0.1970	0.1426-0.2023
Eutrophy	0.1437	0.1219-0.2153	0.2339	0.1671-0.2711
Overweight	0.1097	0.0981-0.1729	0.2039	0.1575-0.2666
p-value[b]	0.499		0.471	
Glucose (mg/dL)				
Desirable	0.1476	0.1067-0.1937	0.2011	0.1402-0.2404
Undesirable	0.1726	0.1337-0.2031	0.2461	0.2000-0.2937
p-value[a]	0.435		0.110	
Total cholesterol (mg/dL)				
Acceptable	0.1514	0.1091-0.1929	0.2036	0.1471-0.2646
High	0.1437	0.1140-0.1777	0.2407	0.1582-0.2796
p-value[a]	0.881		0.453	
HDL-c (mg/dL)				
Desirable	0.1337	0.1024-0.1707	0.2236	0.1640-0.2467
Undesirable	0.1437	0.1094-0.2023	0.236	0.1357-0.2618
p-value[a]	0.579		0.705	
LDL-c (mg/dL)				
Acceptable	0.1517	0.1096-0.2023	0.1986	0.1425-0.2711
High	0.1226	0.0898-0.1437	0.2400	0.1722-0.2437
p-value[a]	0.115		0.600	
Triglycerides (mg/dL)				
Acceptable	0.1394	0.1052-0.1888	0.2032	0.1448-0.2483
High	0.1477	0.1099-0.1984	0.2171	0.1547-0.2987
p-value[a]	0.566		0.613	
Bloodpressure(mmHg)				
Normal	0.1437	0.1100-0.1940	0.2304	0.1696-0.2646
high	0.1200	0.1097-0.1200	0.1986	0.1646-0.1986
p-value[a]	0.379		0.448	
Body fat (%)				
Below	0.1447	0.1175-0.2135	0.2011	0.1448-0.2679
Ideal	0.1320	0.1040-0.1833	0.2375	0.2082-0.2684
high	0.1097	0.0926-0.1097	0.2039	0.1971-0.2039
p-value[b]	0.433		0.689	

U test of Mann Whitney[a] and Kruskal Wallis[b] in the comparison between protective diet and diet predictor of cardiovascular risk ($p < 0.05$). BMI, Body Mass Index; HDL-c, High Density Lipoprotein – cholesterol; LDL-c, Low Density Lipoprotein – cholesterol.

Association between dietary intake and cardiovascular risk factors

It was observed that the consumption of predictive foods for cardiovascular risk was associated with lower systolic blood pressure ($p = 0.047$) in a simple linear regression model (Table 4).

Table 4. Regression coefficients for the associations of protective food consumption and predictive food consumption with cardiovascular risk factors in adolescents living with HIV, Maceió-AL, 2022.

Outcomes	Protective food consumption			Predictive food consumption		
	β	p value	R^2	β	p value	R^2
Sum ofskinfolds (mm)	3.651669	0.877	0.0008	-47.93333	0.067	0.1010
Waistcircumference (cm)	-3.701214	0.850	0.0011	-37.37492	0.087	0.0888
Glucose (mg/dL)	32.61295	0.102	0.1121	-1.053742	0.964	0.0001
Total cholesterol (mg/dL)	25.73636	0.769	0.0034	-144.4486	0.159	0.0747
HDL-c (mg/dL)	-23.94521	0.392	0.0294	-53.70413	0.094	0.1080
LDL-c (mg/dL)	56.85488	0.403	0.0281	-99.30412	0.208	0.0626
Triglycerides (mg/dL)	138.8287	0.418	0.0254	157.2981	0.442	0.0229
Systolicbloodpressure (mmHg)	-12.03299	0.680	0.0054	-64.1478	0.047	0.1173

Note: Statistics are β (standardized value), p value of predictor and adjusted coefficient of determination.
HDL-c, High Density Lipoprotein – cholesterol; LDL-c, Low Density Lipoprotein – cholesterol

DISCUSSION

This study identified a high frequency of dyslipidemia among adolescents living with HIV, marked by low serum HDL-cholesterol levels and elevated triglycerides. Despite this, the sample exhibited a high intake of foods known to be protective against cardiovascular risk. Among the cardiovascular risk factors evaluated, only systolic blood pressure showed a significant inverse association with the consumption of predictive foods items.

The introduction of antiretroviral therapy (ART) for HIV-infected individuals is crucial, as it can reduce plasma viremia, increase CD4 T lymphocyte counts, and consequently decrease AIDS-related events and HIV-related mortality. However, despite the success of this therapy, it also has adverse effects, including dyslipidemia, insulin resistance, increased intra-abdominal fat, among others.[30] This may help explain the frequency of dyslipidemia observed in this study. However, it is important to note that, regardless of HIV infection, an unhealthy diet can further exacerbate cardiovascular risk factors.[31]

Tremeschin et al.[32] reported a progression in the nutritional status of children and adolescents with HIV, shifting from weight loss to obesity and insulin resistance, as excessive caloric and lipid intake aggravated cardiovascular risk factors in this population. In contrast, the present study highlights the occurrence of emaciation in adolescents with HIV. This finding may be attributed to the clinical characteristics of the disease, as adolescents with HIV often exhibit lower height and body mass compared to healthy individuals. This could be due to delayed puberty onset, which is linked to mitochondrial toxicity from HIV and ART, psychosocial factors, and reduced growth hormone secretion, among other factors.[33]

Similarly, the presence of dyslipidemia in this population is consistent with findings in scientific literature, with a likely strong influence from both HIV infection and the medications used. This condition may serve as a risk factor that precedes changes in body composition.[34]

Studies suggest that the dietary intake of children and adolescents with HIV is similar to that of healthy individuals.[32,35] Therefore, the results observed in these patients, who demonstrated a higher consumption of protective foods, align with the dietary patterns of the Brazilian population. This includes a daily intake of natural foods such as rice and beans, as well as typical foods from northeastern Brazilian culture, like corn couscous.[36,37]

Furthermore, the high protective food consumption may be attributed to the fact that the participants were receiving care at a referral hospital specializing in HIV treatment, where they were followed by a multidisciplinary outpatient team, including a nutritionist. Nutritional counseling is a critical component of care for individuals living with HIV, as it contributes to improved dietary intake and, consequently, better anthropometric and biochemical outcomes.[38]

Despite the contribution of cereals and legumes to the higher intake of foods in the protective diet, the adolescents evaluated in this study showed low consumption of other items in this group, such as fruits and vegetables. In this regard, the National School Health Survey (PeNSE) of 2012 and 2019 also reported similar trends,[39] found results similar to those of this research in relation to the significant prevalence in the consumption of sweet and/or salty cookies, as well as low intake of fruits and vegetables among healthy Brazilian adolescents. These dietary habits are known to facilitate the development of chronic non-communicable diseases, representing an additional risk behavior for the HIV-positive population.[39,40]

Tavares[41] found that the consumption of ultra-processed foods among adolescents was associated with components of metabolic syndrome. This is particularly relevant, as the present study identified high consumption of soft drinks and processed meats (sausages).

The high consumption of refined cereals and trans fatty acids (primarily found in ultra-processed foods), combined with the low intake of fiber- and mineral-rich foods (such as fruits and vegetables), reflects eating habits that may contribute to the exacerbation of cardiovascular disease risk in this population.[31] Therefore, the food consumption patterns observed in this study–characterized by high intake of sugary drinks, cookies, sausages, and other unhealthy items, along with low fiber intake due to limited consumption of fruits, vegetables, and greens–raise concerns for the target population evaluated.

Regarding dyslipidemia, the literature indicates a positive association between dietary fiber intake and serum HDL-c levels, as well as between the consumption of foods rich in total, saturated, and trans fats and elevated serum triglyceride levels in individuals with HIV.[42]

In this context, the Brazilian Society of Cardiology and the American Heart Association recommend dietary strategies aimed at improving nutritional intake and reducing cardiovascular risk–guidelines that can also be applied to individuals living with HIV. These include diets low in fat, simple carbohydrates, and sodium, and rich in fiber and minerals, which may help reduce body mass, decrease abdominal obesity, and mitigate metabolic disturbances.[31]

The dietary pattern associated with lower systolic blood pressure values observed in this study contrasts with findings in scientific literature, which indicate that high intake of saturated fats, added sugars, and salt, along with low intake of fiber, vitamins, and minerals, are nutritional characteristics directly linked to increased cardiometabolic risk.[43,44]

The inverse association observed between systolic blood pressure and the intake of predictive food items may be influenced by several limitations of this study. These include the small sample size and the observational design, which may be prone to reverse causality. Confounding factors–such as antiretroviral therapy use and the underlying effects of HIV infection–might also have affected the results. Furthermore, the use of a Food Frequency Questionnaire also has inherent limitations, such as potential inaccuracies in estimating intake and reliance on participants' memory, which may affect the accuracy of the dietary assessment.[45]

Given the limited scientific evidence on dietary patterns and cardiovascular risk in adolescents with HIV, longitudinal studies are needed to examine the combined impact of dietary, anthropometric, and biochemical changes in adolescents living with HIV across different ART regimens.

In conclusion, this study found a relatively high consumption of foods considered protective against cardiovascular risk, despite low consumption of fruits and vegetables (foods considered protective against cardiovascular risk) and high consumption of added sugars, sweets, fried foods, soft drinks and processed meats (foods considered predictors of cardiovascular risk). A significant frequency of dyslipidemia was also observed, characterized by low serum levels of HDL-c and high serum levels of triglycerides. In addition, a significant association was found between the consumption of predictive foods and lower systolic blood pressure values, warranting the need for further investigation.

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Contributors

de Jesus Espinosa MHT, Andrade MIS and Lima LRA participated in the idealization of the study design, in the collection, analysis and interpretation of the study data; de Jesus Espinosa MHT, Andrade MIS, Lima LRA and Cabral PCC participated in the writing of the study, in the final review and approval of the manuscript for submission

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