

# Prevalence of Selected Cardiovascular Risk Factors and Their Associated Factors among People Living with HIV/AIDS in India

Manikandanesan Sakthivel, Venkatachalam Jayaseelan, Palanivel Chinnakali, Abdoul Hamide<sup>1</sup>, Gayathri Surendran, Yuvaraj Krishnamoorthy

Departments of Preventive and Social Medicine and <sup>1</sup>Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India

## Abstract

**Background:** Low- and middle-income countries face the dual problem of infectious and non-infectious diseases. Persons living with HIV/AIDS (PLHIV) are also at risk of cardiovascular diseases. Hence, we did this study to determine the prevalence of cardiovascular risk factors (CVRF) among PLHIV and to find the factors associated with it. **Methods:** We carried out a cross-sectional analytical study among all adults aged  $\geq 18$  years registered at a facility-integrated anti-retroviral therapy center in Puducherry, India, from September 2016 to February 2018. After obtaining informed consent, we interviewed the participants to assess physical activity, alcohol, and tobacco use. We measured weight, height, abdominal circumference, and blood pressure, with biochemical investigations such as blood glucose and lipid profile. **Results:** Of the total 316 adults PLHIV studied, the most common cardiovascular risk factor found was dyslipidemia (82.7%), followed by inadequate physical activity (74.4%). Other behavioral risk factors studied, such as current tobacco use and current alcohol use, showed a prevalence of 12.8% and 5.4%, respectively, among male participants. The prevalence of hypertension among adult PLHIV studied was 15.8%, and diabetes was 12.3%. In the multivariate analysis, diabetes, and hypertension were significantly associated with age and literacy. Obesity was found to be associated with diabetes and abdominal obesity with dyslipidemia. **Conclusion:** Dyslipidemia was the most common cardiovascular risk factor, followed by inadequate physical inactivity among PLHIV. Regular screening with blood glucose, blood pressure, and lipid profile, and timely cross-referrals can help in the early detection of CVRF among PLHIV and hence improve their quality of life through appropriate treatment.

**Keywords:** Acquired immunodeficiency syndrome, diabetes mellitus, dyslipidemia, heart disease risk factors, HIV, hypertension, India

## INTRODUCTION

According to the National AIDS Control Organization (NACO) report 2019, India had an HIV prevalence of 0.22%, translating to 23.48 lakh persons, making India home to the third-largest AIDS population globally and the largest in Asia. Although the infection rates seemed to be steadily coming down statistically, the absolute numbers posed a considerable problem.<sup>[1,2]</sup>

Another important challenge for low- and middle-income countries (LMIC) is the growing burden of non-communicable diseases (NCDs) like diabetes, hypertension, hyperlipidemia, and obesity. The global prevalence of diabetes was 10%, and raised blood pressure in persons above 25 years of age was 40%. On the whole, NCDs contributed to 71% of deaths worldwide, killing almost 41 million people every year. Once considered lifestyle diseases of the elite, these had gained importance in LMIC as well in recent times. The burden of NCDs was higher in LMIC, with nearly three-quarters of deaths happening in them.<sup>[3,4]</sup>

The rise in NCD-related deaths was estimated to be most significant in LMIC of Africa, Mediterranean, and South East Asia, surpassing the figures from the West. Premature NCD-associated deaths were also higher in LMIC, contributing to 85% of the overall burden.<sup>[4]</sup> These factors have led to a pattern of a slow shift in importance from communicable to NCDs in recent times. Increasing importance and recognition were being given to NCDs in the form of screening programs, early diagnosis, and treatment to curtail the number of early NCD-related deaths.<sup>[3]</sup>

**Address for correspondence:** Dr. Venkatachalam Jayaseelan, Department of Preventive and Social Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research, Dhanvantri Nagar, Gorimedu, Puducherry – 605 006, India. E-mail: drvenkatpgi@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** WKHLRPMedknow\_reprints@wolterskluwer.com

**How to cite this article:** Sakthivel M, Jayaseelan V, Chinnakali P, Hamide A, Surendran G, Krishnamoorthy Y. Prevalence of selected cardiovascular risk factors and their associated factors among people living with HIV/AIDS in India. Indian J Community Med 2024;49:308-15.

**Received:** 05-07-22, **Accepted:** 22-12-23, **Published:** 07-03-24

### Access this article online

#### Quick Response Code:



**Website:**  
www.ijcm.org.in

**DOI:**  
10.4103/ijcm.ijcm\_583\_22

Among NCDs, cardiovascular diseases (CVD) were the most important cause of death, killing almost 18 million people every year.<sup>[4]</sup> Modifiable risk factors such as tobacco use, insufficient physical activity, harmful use of alcohol, and unhealthy diet combined with metabolic factors such as raised blood pressure, obesity, and raised cholesterol constituted the major cardiovascular risk factors. Recognition of these risk factors and their prevention and control could significantly affect disease outcomes.<sup>[4]</sup>

Hence, these two disease groups (HIV and CVD) pose a combined threat in today's world. Studies have shown an increased prevalence of cardiovascular risk factors among people living with HIV/AIDS who were on anti-retroviral therapy (ART). The adverse effects of ART medication might be one reason. Increased prevalence of co-existing cardiovascular risk factors in HIV patients like tobacco or alcohol use might also be an important reason.<sup>[5-8]</sup> An increased incidence of myocardial infarction has also been observed in persons with HIV.<sup>[9]</sup> Hence, ART might need to be tweaked depending on the metabolic profile of the patients. Our literature search revealed that very few studies had been conducted to determine the prevalence of cardiovascular risk factors among people living with HIV (PLHIV) in India.<sup>[6,10]</sup> Hence, we did this study to estimate the prevalence of cardiovascular risk factors among adult PLHIV attending an ART center in South India and identify factors associated with the risk factors. We presented this article as a meeting abstract at the International Science Symposium on HIV and Infectious Diseases on October 13, 2019.

## MATERIALS AND METHODS

### Study setting and study participants

We conducted this cross-sectional analytical study in Puducherry, a union territory located in the southern part of India, from September 2016 to February 2018. In Puducherry, there is an ART center, a facility-integrated ART center (FIART), and a Community Care Center. We did the current study in the FIART, which caters to services to the patients from Puducherry and the nearby districts of Tamil Nadu such as Cuddalore, Villupuram, and Thiruvannamalai. It functions between 2 pm and 4.30 pm from Monday to Friday and provides high-quality pre-ART and ART care, diagnosis and treatment of opportunistic infections, free laboratory services, psychological support through counseling, and social functions like helping patients access various health schemes and legal help. The center provides services through a medical officer, one nursing staff, two counselors, and one data entry operator, along with a team of doctors from the Department of Internal Medicine.

During enrollment/registration in the ART center, all PLHIV are routinely screened for tobacco use, alcohol use, and history of comorbidities such as diabetes and hypertension and documented in the patient treatment card (white card), maintained at the ART center by the ART counselor. Additionally, all PLHIV are screened with blood pressure, blood glucose, lipid profile, and renal parameters (blood urea and serum creatinine) before ART initiation and regularly monitored afterward. All the

adult PLHIV attending this ART center were eligible for inclusion in the study.

### Sample size and sampling technique

We estimated the sample size using OpenEpi v 3.01 based on the expected proportion of PLHIV with dyslipidemia to be 55.3% with a relative precision of 10% and 95% confidence interval.<sup>[9]</sup> The minimum sample size for the study was estimated to be 318. Since the total number of persons registered at FIART was around 300, we decided to include all of them in the study.

### Study procedure

We obtained ethical approval for the study from the Institute Ethics Committee. After obtaining informed written consent, we interviewed all the PLHIV at the ART center during their routine visit to collect information on sociodemographic characteristics (age, gender, residence, and education) using a pre-tested semi-structured questionnaire. We assessed behavioral risk factors such as tobacco use, alcohol use, and physical activity using the WHO STEPS questionnaire. We measured blood pressure using an OMRON digital automatic blood pressure monitor, using an appropriate size cuff as per JNC-7 guidelines. We extracted information on the history of diabetes, hypertension, and dyslipidemia from the patient's treatment card. We screened those PLHIV who were not evaluated for these conditions during the last 6 months or any time after registration (for those registered within the last 6 months) through the ART center as a routine care process. We also extracted clinical characteristics like ART status, ART duration, and type of ART regimen from the patient treatment card.

### Operational definitions

#### *Physical activity*

As per WHO recommendations, we considered the individuals physically active if they had undergone 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity per week.

#### *Body mass index (BMI)*

According to the Asia-Pacific guidelines for obesity classification, we considered the individuals overweight if BMI was more than 23 kg/m<sup>2</sup> and obese if BMI was more than 25 kg/m<sup>2</sup>.

#### *Abdominal obesity*

According to the National Cholesterol Education Programme (NCEP) guidelines (Adult Treatment Panel (ATP) III criteria), waist circumference  $\geq 90$  cm for men and  $\geq 80$  cm for women) is considered abdominal obesity.

#### *Hypertension*

According to the Joint National Committee-7 (JNC-7) guidelines, we diagnosed individuals with hypertension if systolic BP  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mmHg on at least two measurements. We also included any PLHIV who was a known hypertensive or on anti-hypertensive medication.

#### *Diabetes mellitus (DM)*

According to the American Diabetes Association

guidelines, we considered two abnormal blood sugar values (FBS  $\geq 126$  mg/dl/PPBS  $\geq 200$  mg/dl) or random blood sugar  $\geq 200$  mg/dl with classic symptoms of diabetes (polyphagia, polyuria, and polydipsia) diagnostic of DM. We also included any PLHIV who was a known DM patient or on anti-diabetes medication.

### Dyslipidemia

According to NCEP ATP III guidelines, dyslipidemia was diagnosed when at least one of the following criteria is not met – total cholesterol  $< 200$  mg/dl; Low-Density Lipoprotein (LDL) cholesterol  $< 100$  mg/dl; High-Density Lipoprotein (HDL) cholesterol  $> 40$  mg/dl for males and  $> 50$  mg/dl for females; triglycerides  $< 150$  mg/dl. Any PLHIV who was a known dyslipidemic or on anti-lipidemic medication was also included.

### Statistical analysis

We entered data using EpiData v3.1 data entry software (EpiData Association, Odense, Denmark) and analyzed using STATA 12 software (StataCorp, College Station, TX, USA) and Open Epi software (Sullivan, Atlanta, GA, USA). We expressed continuous variables as mean and standard deviation (SD) or median and interquartile range (IQR) based on the distribution of the data. We reported categorical variables as proportion. We expressed the prevalence of each cardiovascular risk factor as a proportion with 95% confidence interval (CI). We assessed the factors associated with cardiovascular risk factors such as DM, hypertension, and dyslipidemia using log-binomial regression and quantified the risk in terms of the prevalence ratio (PR). We considered sociodemographic factors such as age, gender, education, occupation, marital status, socioeconomic status (SES, BG Prasad scale 2017), behavioral factors such as tobacco use, alcohol use, physical activity, and anthropometric factors such as obesity and abdominal obesity as explanatory variables. We considered factors significant at a  $P$  value  $< 0.2$  in the unadjusted analysis for the multivariable model. We employed the “forward stepwise” method and considered the significant model with the highest adjusted R-square value as the final model. Whenever the convergence was not achieved with log-binomial regression, we used generalized linear model using the “glm” command to arrive at the final multivariable model. We obtained adjusted PR (aPR) from the multivariable model, and the factors with  $P$  value  $< 0.05$  were considered statistically significant.

## RESULTS

### Sociodemographic characteristics

In total, 321 adults with PLHIV attended the ART center at a tertiary care center between September 2016 and March 2018. Out of these patients, 316 gave consent to participate in the study (response rate – 98.4%). Mean (SD) age of the participants was 45 (9) years. Males and females were almost equally distributed. The majority of the participants had some level of formal education (79.4%), were employed (72.8%), and belonged to middle/lower income groups (86.1%) [Table 1].

### Prevalence of cardiovascular risk factors

Among the behavioral risk factors, half of the total 164 male participants (50.0%) and none of the female participants had ever used alcohol in their entire lifetime [Table 2]. However, only 12.8% (95%CI: 8.5%–18.8%) of the males were current alcohol users. About one-third (31.7%) of males reported to have ever used tobacco, whereas only 3.3% of females had ever used tobacco. All these female participants had used only smokeless tobacco, and none were current users. Nearly three-fourths (74.4%; 95%CI: 69.3%–78.9%) of the study participants had inadequate physical activity. Regarding the anthropometric risk factors, prevalence of obesity was 28.5% (95%CI: 23.8%–33.7%), and abdominal obesity was 65.8% (95%CI: 60.4%–70.8%).

The overall prevalence of hypertension was 15.8% (95%CI: 12.2%–20.2%). Among the participants with hypertension, 17 (34.0%) were individuals with known hypertension, while 33 (66.0%) were newly diagnosed during the study. Prevalence of DM was 12.3% (95%CI: 9.1%–16.5%). Among them, 22 (59.5%) were individuals with known DM,

**Table 1: Sociodemographic details of adult PLHIV attending a Facility-Integrated ART (FIART) center in Puducherry, 2016-2018 (n=316)**

| Sociodemographic details                                       | Frequency (%) |
|--|---------------|
| Age category (in years)  |               |
| 18–24  | 3 (1.0)       |
| 25–34  | 35 (11.1)     |
| 35–44  | 108 (34.1)    |
| 45–54  | 120 (38.0)    |
| 55–64  | 42 (13.3)     |
| $\geq 65$  | 8 (2.5)       |
| Gender   |               |
| Male   | 164 (51.9)    |
| Female   | 152 (48.1)    |
| Educational status*  |               |
| No formal schooling  | 65 (20.6)     |
| Up to primary education (1 <sup>st</sup> –5 <sup>th</sup> )    | 99 (31.3)     |
| Up to secondary education (6 <sup>th</sup> –10 <sup>th</sup> ) | 100 (31.6)    |
| Higher secondary and above (11 <sup>th</sup> and above)        | 52 (16.5)     |
| Occupational category  |               |
| Unemployed†  | 86 (27.2)     |
| Currently employed   | 230 (72.8)    |
| Marital status   |               |
| Never married  | 28 (8.9)      |
| Currently married  | 185 (58.5)    |
| Divorced/separated   | 22 (7.0)      |
| Widow/widower  | 81 (25.6)     |
| Socioeconomic status‡  |               |
| Class I ( $\geq 6254$ )  | 15 (4.7)      |
| Class II (3127–6253)   | 29 (9.2)      |
| Class III (1876–3126)  | 53 (16.8)     |
| Class IV (938–1875)  | 89 (28.2)     |
| Class V ( $\leq 835$ )   | 130 (41.1)    |

\*ISCED: International Standard Classification of Education. †Includes homemakers and retired personnel. ‡According to the modified BG Prasad Scale 2017

**Table 2: Prevalence of cardiovascular risk factors among adult PLHIV attending a FIART center in Puducherry, 2016-2018 (n=316)**

| Cardiovascular risk factors                    | Number of participants (%) | 95% CI      |
|--|----------------------------|-------------|
| Number of risk factors present                 |                            |             |
| Zero   | 18 (5.7)                   | 3.6 – 8.8   |
| One  | 54 (17.1)                  | 13.3 – 21.6 |
| Two  | 103 (32.6)                 | 27.7 – 37.9 |
| Three  | 63 (19.9)                  | 15.9 – 24.7 |
| Four   | 56 (17.7)                  | 13.9 – 22.3 |
| Five   | 19 (6.0)                   | 3.9 – 9.2   |
| Six  | 3 (1.0)                    | 0.3 – 2.8   |
| Physical activity                              |                            |             |
| Adequate                                       | 81 (25.6)                  | 21.1 – 30.7 |
| Inadequate                                     | 235 (74.4)                 | 69.3 – 78.9 |
| Alcohol use*                                   |                            |             |
| Ever consumed alcohol                          | 82 (50.0)                  | 42.4 – 57.6 |
| Alcohol use in the past one year <sup>†</sup>  | 27 (16.5)                  | 11.6 – 22.9 |
| Current use (in the past 30 days) <sup>†</sup> | 21 (12.8)                  | 8.5 – 18.8  |
| Current tobacco use*                           |                            |             |
| Current non-smokers                            | 147 (89.6)                 | 84.0 – 93.4 |
| Smoke  | 14 (8.5)                   | 5.2 – 13.8  |
| Smokeless                                      | 3 (1.9)                    | 0.6 – 5.2   |
| BMI category                                   |                            |             |
| Underweight (<18.50)                           | 50 (15.8)                  | 12.2 – 20.2 |
| Normal (18.50–22.99)                           | 125 (39.6)                 | 34.3 – 45.0 |
| Overweight (23.0–24.99)                        | 51 (16.1)                  | 12.5 – 20.6 |
| Obesity (≥25.0)                                | 90 (28.5)                  | 23.8 – 33.7 |
| Abdominal obesity                              |                            |             |
| Present  | 108 (34.2)                 | 29.2 – 39.6 |
| Absent   | 208 (65.8)                 | 60.4 – 70.8 |
| Hypertension category                          |                            |             |
| Normal   | 209 (66.2)                 | 60.7 – 71.1 |
| Pre-hypertension                               | 57 (18.0)                  | 14.2 – 22.6 |
| Hypertension                                   | 50 (15.8)                  | 12.2–20.2   |
| Diabetes mellitus category <sup>‡</sup>        |                            |             |
| Normal   | 222 (74.0)                 | 68.7 – 78.6 |
| Pre-diabetes                                   | 41 (13.7)                  | 10.2 – 18.0 |
| Diabetes                                       | 37 (12.3)                  | 9.1 – 16.5  |
| Dyslipidemia <sup>‡</sup>                      |                            |             |
| Present  | 249 (82.7)                 | 78.1–86.6   |
| Absent   | 52 (17.3)                  | 13.4 – 21.9 |
| Details of dyslipidemia <sup>‡</sup>           |                            |             |
| LDL ≥100                                       | 142 (47.3)                 | 41.6 – 52.8 |
| HDL ≤40 in males; 50 in females                | 124 (41.3)                 | 35.8 – 46.8 |
| Triglyceride ≥150                              | 121 (40.3)                 | 34.8 – 45.8 |
| Total cholesterol ≥200                         | 83 (27.6)                  | 22.8 – 32.9 |

\*Alcohol use and current smoking were reported only among males.

<sup>†</sup>Not mutually exclusive categories. <sup>‡</sup>Denominator is for those with data available (300 for diabetes as the reports of blood sugar values were missing for 16 participants who were not diagnosed with DM earlier, 301 for dyslipidemia for whom complete data were available)

while 15 (40.5%) were newly diagnosed. The prevalence of dyslipidemia was 82.7% (95%CI: 78.1–86.6%). Among them, 52 (20.9%) were individuals with known dyslipidemia, while 197 (79.1%) were newly diagnosed. On checking for the

combination of cardiovascular risk factors among PLHIV, most had at least two cardiovascular risk factors (32.6%), followed by three (19.9%), four (17.7%), and one (17.1%).

### Factors associated with DM

In unadjusted analysis, age, education, SES, obesity, and abdominal obesity were significantly associated with DM. We included these factors in the multivariable model. None of the behavioral factors (tobacco, alcohol, and physical inactivity) were significantly associated with DM in the adjusted analysis. But age had a significant association as one unit (one year) increase in age increased the risk of having DM by 4% (aPR – 1.04; 95%CI: 1.02-1.08). PLHIV with some formal education form had a 4.6 times higher risk of having DM than those without any formal education (aPR – 4.62; 95%CI: 1.13–19.0), which was statistically significant. Obese patients had a 2.2 times higher risk of having DM than non-obese patients (aPR – 2.24; 95%CI: 1.15–4.37). SES and abdominal obesity were not significantly associated with DM in adjusted analysis [Table 3].

### Factors associated with hypertension

Age, gender, SES, and obesity were significantly associated with hypertension in unadjusted analysis. Education and abdominal obesity had a *P* value of less than 0.2, and we included all these factors in the multivariable model. In adjusted analysis, age was significantly associated with hypertension (aPR: 1.07; 95%CI: 1.04–1.10). Those with formal education had a 2.4 times higher risk of having hypertension than those with no formal education (aPR – 2.37; 95%CI: 1.04–5.38), and this was statistically significant. Gender, SES, obesity, and abdominal obesity did not have a significant association with hypertension in multivariable models [Table 4].

### Factors associated with dyslipidemia

Dyslipidemia was significantly associated with SES, marital status, physical inactivity, obesity, and abdominal obesity in unadjusted analysis. We considered all these factors in the multivariable analysis. In adjusted analysis, PLHIV belonging to Class II SES had a 1.2 times higher risk of having dyslipidemia (aPR – 1.19; 95%CI: 1.05-1.36) compared to those belonging to Class V SES. Married individuals had 19% lesser risk of having dyslipidemia than unmarried, and this association was statistically significant (aPR-0.81; 95%CI: 0.70-0.94). PLHIV with abdominal obesity had a 1.1 times higher risk of having dyslipidemia (aPR-1.14; 95%CI: 1.01-1.31) than those with a normal waist circumference. Physical inactivity and obesity were not significantly associated with dyslipidemia in adjusted analysis [Table 5].

## DISCUSSION

Of the total 316 adults PLHIV studied, the most common cardiovascular risk factor found was dyslipidemia (82.7%), followed by inadequate physical activity (74.4%). Other behavioral risk factors studied, such as current tobacco use and current alcohol use, showed a prevalence of 12.8% and 5.4%, respectively, among male participants. The prevalence

**Table 3: Association of sociodemographic, behavioral, and anthropometric characteristics with DM among adult PLHIV in South India, 2016-2018 (n=300)**

| Characteristics                      | Diabetes mellitus  |                    | Unadjusted PR | P      | Adjusted PR | 95% CI      |
|--------------------------------------|--------------------|--------------------|---------------|--------|-------------|-------------|
|                                      | Yes, n (%)<br>N=37 | No, n (%)<br>N=263 |               |        |             |             |
| Age in years, mean (SD)              | 49.5 (8.2)         | 44.4 (9.3)         | 1.04          | <0.001 | 1.04        | 1.02 – 1.08 |
| Gender                               |                    |                    |               |        |             |             |
| Female                               | 19 (13.2)          | 125 (56.8)         | 1             |        | -           | -           |
| Male                                 | 18 (5.4)           | 138 (88.5)         | 0.87          | 0.663  | -           | -           |
| Education status                     |                    |                    |               |        |             |             |
| Illiterate                           | 2 (3.2)            | 61 (96.8)          | 1             |        | 1           |             |
| Literate                             | 35 (14.8)          | 202 (85.2)         | 4.65          | 0.031  | 4.62        | 1.13 – 19.0 |
| Socioeconomic status <sup>#</sup>    |                    |                    |               |        |             |             |
| Class I (≥6254)                      | 6 (40.0)           | 9 (60.0)           | 4.10          | 0.001  | 1.81        | 0.81 – 4.03 |
| Class II (3127-6253)                 | 7 (24.1)           | 22 (75.9)          | 2.47          | 0.034  | 1.50        | 0.66 – 3.40 |
| Class III (1876-3126)                | 4 (8.2)            | 45 (91.8)          | 0.83          | 0.747  | 0.71        | 0.23 – 2.14 |
| Class IV (938-1875)                  | 8 (9.5)            | 76 (90.5)          | 0.97          | 0.956  | 0.68        | 0.29 – 1.58 |
| Class V (≤835)                       | 12 (9.8)           | 111 (90.2)         | 1             |        | 1           |             |
| Marital status                       |                    |                    |               |        |             |             |
| Unmarried                            | 1 (3.57)           | 27 (96.4)          | 1             |        | -           | -           |
| Married                              | 20 (11.5)          | 154 (88.5)         | 3.21          | 0.244  | -           | -           |
| Separated/Widowed                    | 16 (16.3)          | 82 (83.7)          | 4.57          | 0.132  | -           | -           |
| Occupation                           |                    |                    |               |        |             |             |
| Unemployed                           | 11 (13.3)          | 72 (86.7)          | 1             |        | -           | -           |
| Employed                             | 26 (12.0)          | 191 (88.0)         | 0.90          | 0.764  | -           | -           |
| Current tobacco use                  |                    |                    |               |        |             |             |
| Yes                                  | 3 (17.6)           | 14 (82.4)          | 1.46          | 0.483  | -           | -           |
| No                                   | 34 (12.0)          | 249 (88.0)         | 1             |        | -           | -           |
| Current alcohol use                  |                    |                    |               |        |             |             |
| Yes                                  | 4 (20.0)           | 16 (80.0)          | 1.69          | 0.267  | -           | -           |
| No                                   | 33 (11.8)          | 247 (88.2)         | 1             |        | -           | -           |
| Physical activity                    |                    |                    |               |        |             |             |
| Adequate                             | 4 (7.4)            | 50 (92.6)          | 1             |        | -           | -           |
| Inadequate                           | 33 (13.4)          | 213 (86.6)         | 1.81          | 0.721  | -           | -           |
| Obesity (BMI ≥25 kg/m <sup>2</sup> ) |                    |                    |               |        |             |             |
| Present                              | 21 (24.1)          | 66 (75.9)          | 3.21          | <0.001 | 2.24        | 1.15 – 4.37 |
| Absent                               | 16 (7.5)           | 197 (92.5)         | 1             |        | 1           |             |
| Abdominal obesity                    |                    |                    |               |        |             |             |
| Present                              | 21 (20.0)          | 84 (80.0)          | 2.43          | 0.003  | 1.12        | 0.54 – 2.30 |
| Absent                               | 16 (8.2)           | 179 (91.8)         | 1             |        | 1           |             |

of anthropometric risk factors such as obesity and abdominal obesity showed a prevalence of 28.5% and 34.2%, respectively. The prevalence of hypertension among adult PLHIV studied was 15.8%, and DM was 12.3%.

First, we compared the behavioral risk factors between PLHIV and the general population. Current tobacco users among PLHIV were very low (12.8%) compared to the prevalence of tobacco use among the general population in India (21.4%) as per the recent Global Adult Tobacco Survey-2 (GATS-2).<sup>[11]</sup> A possible reason for the lesser burden of behavioral risk factors among PLHIV could be the de-addiction counseling provided in the FIART. Many participants who were previously tobacco/alcohol users reported to have quit the habit after being started on ART. This was evident from the difference between those

who ever used tobacco (31.7%) and alcohol (50%) and the current users of tobacco (12.8%) and alcohol (5.4%). However, studies conducted worldwide have reported that the current tobacco users are almost 2-3-fold higher among PLHIV than the general population.<sup>[12-14]</sup> The prevalence of smoking among PLHIV ranged from 24% in low and low- to middle-income countries to almost 60% in high-income countries such as the United States, indicating a vast difference based on socioeconomic, cultural, and ethnic practices.<sup>[13-15]</sup>

Similarly, alcohol use among PLHIV, as found in our study (5.4%), was less compared to the prevalence among the general population in India (29%) as per the recent National Family Health Survey-4 (NFHS-4).<sup>[14]</sup> However, studies across the world have reported a higher prevalence among

**Table 4: Association of sociodemographic, behavioral and anthropometric characteristics with hypertension among adult PLHIV in South India (n=316)**

| Characteristics                      | Hypertension       |                    | Unadjusted PR | P      | Adjusted PR | 95% CI      |
|--------------------------------------|--------------------|--------------------|---------------|--------|-------------|-------------|
|                                      | Yes, n (%)<br>n=50 | No, n (%)<br>n=266 |               |        |             |             |
| Age in years, mean (SD)              | 51.2 (8.1)         | 43.9 (9.1)         | 1.06          | <0.001 | 1.07        | 1.04 – 1.10 |
| Gender                               |                    |                    |               |        |             |             |
| Female                               | 16 (10.5)          | 136 (89.5)         | 1             |        | 1           |             |
| Male                                 | 34 (2.7)           | 130 (79.3)         | 1.96          | 0.016  | 1.36        | 0.78 – 2.37 |
| Education status                     |                    |                    |               |        |             |             |
| Illiterate                           | 5 (7.7)            | 60 (92.3)          | 1             |        | 1           |             |
| Literate                             | 45 (17.9)          | 206 (82.1)         | 2.33          | 0.060  | 2.37        | 1.04 – 5.38 |
| Socioeconomic status <sup>#</sup>    |                    |                    |               |        |             |             |
| Class I (≥6254)                      | 5 (33.3)           | 10 (66.7)          | 3.33          | 0.014  | 1.81        | 0.81 – 4.03 |
| Class II (3127-6253)                 | 4 (13.8)           | 25 (86.2)          | 1.37          | 0.547  | 1.50        | 0.66 – 3.40 |
| Class III (1876-3126)                | 8 (15.1)           | 45 (84.9)          | 1.50          | 0.326  | 0.71        | 0.23 – 2.14 |
| Class IV (938-1875)                  | 20 (22.5)          | 69 (77.5)          | 2.24          | 0.014  | 0.68        | 0.29 – 1.58 |
| Class V (≤835)                       | 13 (10.0)          | 117 (90.0)         | 1             |        | 1           |             |
| Marital status                       |                    |                    |               |        |             |             |
| Unmarried                            | 1 (3.57)           | 27 (96.4)          | 1             |        | -           | -           |
| Married                              | 33 (17.8)          | 152 (82.2)         | 4.99          | 0.206  | -           | -           |
| Separated/Widowed                    | 16 (15.5)          | 87 (84.5)          | 4.34          | 0.245  | -           | -           |
| Occupation                           |                    |                    |               |        |             |             |
| Unemployed                           | 17 (19.8)          | 69 (80.2)          | 1             |        | -           | -           |
| Employed                             | 33 (14.4)          | 197 (85.6)         | 0.72          | 0.236  | -           | -           |
| Current tobacco use                  |                    |                    |               |        |             |             |
| Yes                                  | 2 (11.7)           | 15 (88.2)          | 0.73          | 0.646  | -           | -           |
| No                                   | 48 (16.1)          | 251 (83.9)         | 1             |        | -           | -           |
| Current alcohol use                  |                    |                    |               |        |             |             |
| Yes                                  | 5 (23.8)           | 16 (76.2)          | 1.56          | 0.282  | -           | -           |
| No                                   | 45 (15.3)          | 250 (84.7)         | 1             |        | -           | -           |
| Physical activity                    |                    |                    |               |        |             |             |
| Adequate                             | 7 (12.5)           | 49 (87.5)          | 1             |        | -           | -           |
| Inadequate                           | 43 (16.5)          | 217 (83.5)         | 1.32          | 0.461  | -           | -           |
| Obesity (BMI ≥25 kg/m <sup>2</sup> ) |                    |                    |               |        |             |             |
| Present                              | 23 (25.6)          | 67 (74.4)          | 2.13          | 0.003  | 1.38        | 0.72 – 2.62 |
| Absent                               | 27 (11.9)          | 199 (88.1)         | 1             |        | 1           |             |
| Abdominal obesity                    |                    |                    |               |        |             |             |
| Present                              | 23 (21.3)          | 85 (78.7)          | 1.64          | 0.055  | 1.38        | 0.72 – 2.61 |
| Absent                               | 27 (12.9)          | 181 (87.1)         | 1             |        | 1           |             |

HIV patients, ranging from 24.5% in developing countries to 42.1% in developed countries.<sup>[16]</sup> Physical inactivity was almost similar between the general population (65.4% in urban and 50% in rural as per ICMR-INDIAB study) and PLHIV (74.4%) as found in our study.<sup>[17]</sup> This reflects that physical inactivity seems to be prevalent among all the population groups, irrespective of the disease condition.

Regarding the anthropometric risk factors, the prevalence of obesity among the general population in Puducherry was 42% (as per the recent National Nutrition Monitoring Bureau (NNMB) survey).<sup>[18]</sup> However, PLHIV in our study had a lower prevalence (28.5%) compared to the general population. This is mainly because the study participants were affected by a chronic disease condition. Globally, studies have reported

varying prevalence of obesity among adult PLHIV, ranging from 6.8% to 34%.<sup>[5-9]</sup> However, a study conducted in South India (Vellore) reported a prevalence similar (23.6%) to the current study.<sup>[10]</sup> Prevalence of abdominal obesity found in our study was also similar to the study conducted in Vellore.<sup>[10]</sup> This could be due to the similarity in the study setting and criteria used to define obesity and abdominal obesity in both studies.

Finally, we explored the difference in major NCDs such as hypertension, DM, and dyslipidemia between PLHIV and the general population. A systematic review on hypertension reported a higher prevalence (29.8%) among the general population in India compared to the PLHIV (15.8%) as per the current study finding.<sup>[19]</sup> The pooled prevalence of hypertension among people in South India was reported to be

**Table 5: Association of sociodemographic, behavioral and anthropometric characteristics with dyslipidemia among adult PLHIV in South India (n=301)**

| Characteristics                      | Dyslipidemia        |                   | Unadjusted PR | P      | Adjusted PR | 95% CI    |
|--------------------------------------|---------------------|-------------------|---------------|--------|-------------|-----------|
|                                      | Yes, n (%)<br>n=249 | No, n (%)<br>n=67 |               |        |             |           |
| Age in years, mean (SD)              | 45.1 (9.2)          | 44.7 (10.0)       | 1.00          | 0.832  | -           | -         |
| Gender                               |                     |                   |               |        |             |           |
| Female                               | 122 (84.7)          | 22 (15.3)         | 1             |        | -           |           |
| Male                                 | 126 (80.8)          | 30 (19.2)         | 0.95          | 0.365  | -           | -         |
| Education status                     |                     |                   |               |        |             |           |
| Illiterate                           | 52 (82.5)           | 11 (17.5)         | 1             |        | -           | -         |
| Literate                             | 196 (82.7)          | 41 (17.3)         | 1.00          | 0.976  | -           | -         |
| Socioeconomic status <sup>#</sup>    |                     |                   |               |        |             |           |
| Class I (≥6254)                      | 10 (66.7)           | 5 (33.3)          | 0.85          | 0.404  | 0.86        | 0.59-1.26 |
| Class II (3127-6253)                 | 28 (96.5)           | 1 (3.5)           | 1.23          | <0.001 | 1.19        | 1.05-1.36 |
| Class III (1876-3126)                | 40 (81.6)           | 9 (18.4)          | 1.04          | 0.588  | 1.00        | 0.83-1.20 |
| Class IV (938-1875)                  | 74 (88.1)           | 10 (11.9)         | 1.12          | 0.052  | 1.07        | 0.93-1.23 |
| Class V (≤835)                       | 96 (78.1)           | 27 (21.9)         | 1             |        | 1           |           |
| Marital status                       |                     |                   |               |        |             |           |
| Unmarried                            | 26 (92.9)           | 2 (7.1)           | 1             |        | 1           |           |
| Married                              | 139 (79.9)          | 35 (20.1)         | 0.86          | 0.020  | 0.81        | 0.70-0.94 |
| Separated/Widowed                    | 83 (84.7)           | 15 (15.3)         | 0.91          | 0.174  | 0.84        | 0.72-0.99 |
| Occupation                           |                     |                   |               |        |             |           |
| Unemployed                           | 72 (86.7)           | 11 (13.3)         | 1             |        | -           | -         |
| Employed                             | 176 (81.1)          | 41 (18.9)         | 0.93          | 0.213  | -           | -         |
| Current tobacco use                  |                     |                   |               |        |             |           |
| Yes                                  | 11 (64.7)           | 6 (35.3)          | 0.77          | 0.154  | -           | -         |
| No                                   | 237 (83.7)          | 46 (16.3)         | 1             |        | -           | -         |
| Current alcohol use                  |                     |                   |               |        |             |           |
| Yes                                  | 16 (80.0)           | 4 (20.0)          | 0.96          | 0.760  | -           | -         |
| No                                   | 232 (82.9)          | 48 (17.1)         | 1             |        | -           | -         |
| Physical activity                    |                     |                   |               |        |             |           |
| Adequate                             | 38 (70.4)           | 16 (29.6)         | 1             |        | 1           | 1         |
| Inadequate                           | 210 (85.3)          | 36 (14.6)         | 1.21          | 0.036  | 1.14        | 0.95-1.38 |
| Obesity (BMI ≥25 kg/m <sup>2</sup> ) |                     |                   |               |        |             |           |
| Present                              | 77 (88.5)           | 10 (11.5)         | 1.10          | 0.003  | 1.02        | 0.89-1.16 |
| Absent                               | 171 (80.3)          | 42 (19.7)         | 1             |        | 1           | 1         |
| Abdominal obesity                    |                     |                   |               |        |             |           |
| Present                              | 94 (89.5)           | 11 (10.5)         | 1.13          | 0.012  | 1.14        | 1.01-1.31 |
| Absent                               | 154 (80.0)          | 41 (20.0)         | 1             |        | 1           | 1         |

around 21-25%, which was also higher than the current study finding. But studies around the world have shown that the prevalence of hypertension among adult PLHIV ranges from 12% to 29%, and the studies conducted in Vellore (17.3%), Cambodia (15.1%), and Netherlands (16%) showed results similar to the current study findings.<sup>[10,20,21]</sup>

The burden of DM was higher among PLHIV (12.3%) than the general population (7.3%) as per the recent ICMR-INDIAB study.<sup>[17]</sup> Studies around the world showed a varying prevalence of DM among adult PLHIV, ranging from 1% to 18%.<sup>[22-28]</sup> This might be because of the sociodemographic and cultural differences between the studies. Previous studies also reported that older age and higher BMI had a significant association with diabetes and hypertension, which is in line with the current

study findings.<sup>[25-29]</sup> We could not find any study reporting literacy as a significant factor associated with hypertension.

Contrasting differences were found with respect to the burden of dyslipidemia between the general population and PLHIV, as the prevalence was significantly lower among the general population (22% as per the latest NNMB survey) and more than 80% among PLHIV.<sup>[18]</sup> Studies around the world have reported only individual lipid abnormalities among PLHIV patients rather than the prevalence of dyslipidemia, as a whole, which makes it difficult to compare across the studies.

The study has several strengths. We performed a comprehensive assessment of multiple cardiovascular risk factors among adult PLHIV. This study adds to the limited literature available

regarding the assessment of multiple cardiovascular risk factors among PLHIV. As the current study included all the adult PLHIV attending an ART center in Puducherry, it assessed the true prevalence of cardiovascular risk factors, holding the internal validity good. However, social desirability bias might have affected the ascertainment of behavior characteristics like tobacco use and alcohol use. There is a further need for large cohort studies exploring the temporal association, biological plausibility, and consistency of the causative factors with cardiovascular diseases and risk factors. Based on our study findings, we conclude that prevalence of cardiovascular risk factors was high among PLHIV and regular screening with blood glucose, blood pressure, and lipid profile can help in the early identification of cardiovascular risk factors among PLHIV and help improve the quality of life of PLHIV through appropriate treatment.

### Ethical approval

This study was approved by Institute Ethics Committee (IEC), JIPMER (JIP/IEC/2016/28/938). We obtained written informed consent from all the study participants.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. HIV Facts and Figures. National AIDS Control Organization. Ministry of Health and Family Welfare, Government of India. [Internet]. NACO. Available from: <http://naco.gov.in/hiv-facts-figures>. [Last accessed on 2020 Jun 08].
2. National AIDS Control Organisation. India HIV Estimations 2017 [Internet]. NACO. Available from: [http://naco.gov.in/sites/default/files/HIV%20Estimations%202017%20Report\\_1.pdf](http://naco.gov.in/sites/default/files/HIV%20Estimations%202017%20Report_1.pdf). [Last accessed on 2020 Jun 08].
3. World Health Organization. Global Status Report on Non-Communicable Diseases 2010. Geneva: World Health Organization; 2011.
4. Non communicable diseases. World Health Organization. Available from: <http://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases>. [Last accessed on 2020 Jun 08].
5. Idiculla J, Ravindra'n GD, D'Souza J, Singh G, Furrugh S. Diabetes mellitus, insulin resistance, and metabolic syndrome in HIV-positive patients in South India. *Int J Gen Med* 2011;4:73-8.
6. Bajaj S, Bhargava A, Tyagi S. Metabolic syndrome in human immunodeficiency virus positive patients. *Indian J Endocrinol Metab* 2013;17:117.
7. Glass T, Ungsedhapand C, Wolbers M, Weber R, Vernazza P, Rickenbach M, *et al.* Prevalence of risk factors for cardiovascular disease in HIV-infected patients over time: The Swiss HIV Cohort Study. *HIV Med* 2006;7:404-10.
8. Vilela FD, Lorenzo AR de, Tura BR, Ferraiuoli GI, Hadlich M, Barros MV de L, *et al.* Risk of coronary artery disease in individuals infected with human immunodeficiency virus. *Braz J Infect Dis* 2011;15:521-7.
9. Triant VA, Lee H, Hadigan C, Grinspoon SK. Increased acute myocardial infarction rates and cardiovascular risk factors among patients with human immunodeficiency virus disease. *J Clin Endocrinol Metab* 2007;92:2506-12.
10. Carey RA, Rupali P, Abraham OC, Kattula D. Does first line anti-retroviral therapy increase the prevalence of cardiovascular risk factors in Indian patients?: A cross sectional study. *J Postgrad Med* 2013;59:258.
11. Tata Institute of Social Sciences (TISS), Mumbai and Ministry of Health and Family Welfare, Government of India. Global Adult Tobacco Survey GATS 2 India 2016-17.
12. Mdofo R, Frazier EL, Dube SR, Mattson CL, Sutton MY, Brooks JT, *et al.* Cigarette smoking prevalence among adults with HIV compared with the general adult population in the United States: Cross-sectional surveys. *Ann Intern Med* 2015;162:335-44.
13. Mdege ND, Shah S, Ayo-Yusuf OA, Hakim J, Siddiqi K. Tobacco use among people living with HIV: Analysis of data from Demographic and Health Surveys from 28 low-income and middle-income countries. *Lancet Glob Health* 2017;5:e578-92.
14. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS; 2017.
15. Mamary EM, Bahrs D, Martinez S. Cigarette smoking and the desire to quit among individuals living with HIV. *AIDS Patient Care STDS* 2002;16:39-42.
16. Duko B, Ayalew M, Ayano G. The Prevalence of alcohol use disorders among people living with HIV/AIDS: A systematic review and meta-analysis. *Subst Abuse Treat Prev Policy* 2019;14:52. doi: 10.1186/s13011-019-0240-3.
17. Anjana RM, Deepa M, Pradeepa R, Mahanta J, Narain K, Das HK, *et al.* Prevalence of diabetes and prediabetes in 15 states of India: Results from the ICMR-INDIAB population-based cross-sectional study. *Lancet Diabetes Endocrinol* 2017;5:585-96.
18. National Nutrition Monitoring Bureau. Diet and Nutritional Status of Urban Population in India and Prevalence of Obesity, Hypertension, Diabetes and Hyperlipidemia in Urban Men and Women. NNMB Tech Rep No. 27. Hyderabad: National Institute of Nutrition, ICMR; 2017.
19. Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, *et al.* Hypertension in India: A systematic review and meta-analysis of Prevalence, awareness, and control of hypertension. *J Hypertens* 2014;32:1170-7.
20. Chhoun P, Tuot S, Harries AD, Kyaw NTT, Pal K, Mun P, *et al.* High prevalence of non-communicable diseases and associated risk factors amongst adults living with HIV in Cambodia. *PLoS One* 2017;12:e0187591.
21. van Zoest RA, van der Valk M, Wit FW, Vaartjes I, Kooij KW, Hovius JW, *et al.* Suboptimal primary and secondary cardiovascular disease prevention in HIV-positive individuals on anti-retroviral therapy. *Eur J Prev Cardiol* 2017;24:1297-307.
22. Jung O, Bickel M, Ditting T, Rickerts V, Welk T, Helm EB, *et al.* Hypertension in HIV-1-infected patients and its impact on renal and cardiovascular integrity. *Nephrol Dial Transplant* 2004;19:2250-8.
23. Mocroft A, Kirk O, Gatell J, Reiss P, Gargalianos P, Zilmer K, *et al.* Chronic renal failure among HIV-1-infected patients. *AIDS* 2007;21:1119-27.
24. Jantarapakde J, Phanuphak N, Chaturawit C, Pengnonyang S, Mathajittiphon P, Takamtha P, *et al.* Prevalence of metabolic syndrome among antiretroviral-naive and antiretroviral-experienced HIV-1 infected thai adults. *AIDS Patient Care STDs* 2014;28:331-40.
25. Maganga E, Smart LR, Kalluvya S, Kataraihya JB, Saleh AM, Obeid L, *et al.* Glucose Metabolism Disorders, HIV and Antiretroviral Therapy among Tanzanian Adults. *PLoS One* 2015;10:e0134410.
26. Nansseu JR, Bigna JJ, Kaze AD, Noubiap JJ. Incidence and risk factors for prediabetes and diabetes mellitus among HIV-infected adults on antiretroviral therapy: A systematic review and meta-analysis. *Epidemiol Camb Mass* 2018;29:431-41.
27. Rasoolinejad M, Najafi E, Hadadi A, Najafi M, Kalantari S, Moradmand-Badie B, *et al.* Prevalence and associated risk factors of hyperglycemia and diabetes mellitus among HIV positive patients in Tehran, Iran. *Infect Disord Drug Targets* 2019;19:304-9.
28. Han WM, Jiamsakul A, Kiertiburanakul S, Ng OT, Sim BL, Sun LP, *et al.* Diabetes mellitus burden among people living with HIV from the Asia-Pacific region. *J Int AIDS Soc* 2019;22:e25236.
29. Van Zoest RA, van den Born B-JH, Reiss P. Hypertension in people living with HIV. *Curr Opin HIV AIDS* 2017;12:513-22.