J Diabetes Clin Res. 2024;6(1):48-55.

Journal of Diabetes and Clinical Research Research Article

Incidence of Diabetic Mellitus among HIV Patients Receiving Antiretroviral Therapy in Ethiopia: Ten Years Retrospective Follow-up Study

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Received date: October 26, 2024, **Accepted date:** November 13, 2024

Citation: Gebreyohannes LT, Wake AD. Incidence of Diabetic Mellitus among HIV Patients Receiving Antiretroviral Therapy in Ethiopia: Ten Years Retrospective Follow-up Study. J Diabetes Clin Res. 2024;6(1):48-55.

Abstract

Introduction: Diabetes mellitus (DM) is an important chronic comorbid condition that occurs in people living with the human immunodeficiency virus (HIV). It is associated with increased morbidity and mortality. Many cases of comorbidities with diabetes mellitus have been reported, particularly in areas of the world where the prevalence of HIV is high. The rate of diabetes hospitalizations among HIV-infected individuals increased from 3.9 to 8.4 per 100 hospitalizations. Although the cost of HIV care has increased, the burden of DM among people living with HIV has economic consequences.

Objectives: This study aimed to assess the incidence of DM among HIV patients receiving ART in the Asella Referral and Teaching Hospital, Oromia Regional State, Ethiopia.

Methods: Ten years retrospective follow-up study was conducted among 268 HIV patients receiving ART at Asella Referral and Teaching Hospital. HIV patients receiving ART between January 01/2013 and Dec 31/2022 were enrolled in this study. A systematic sampling technique was used to select patients' medical charts. Data were extracted from the patients' medical chart records from March 21 to March 23, 2023, using a data extraction format. Data were entered into Epi Data version 4.6.0.0, and exported to STATA version 14.2 for statistical analysis.

Results: A total of 268 medical charts of HIV patients receiving ART were included in the final analysis, which provided a response rate of 98.52%. The mean age of participants was 38.17 years. Among 268 HIV patients followed for 10 years, 142 (52.99%) were female, 33(49.63%) were aged between 30-40 years. Approximately 154 (57.46%) of them were urban residents. The incidence density rate (IDR) of DM in the cohort of HIV patients receiving ART during 1291.33 person-year observation was 6.20 per 1000 [95% CI: 3.10, 12.39] person-years. The cumulative incidence proportion of DM among HIV patients receiving ART was 2.99% [95% CI: 1.49, 5.88] within the 10 years follow-up period.

Conclusion: The incidence of DM among HIV patients receiving ART was relatively high. It is important to emphasize HIV patients receiving ART for early screening of DM among these patients.

Keywords: Incidence, Diabetes mellitus, ART, HIV/AIDS, Ethiopia

Introduction

DM is a heterogeneous disturbance of metabolism, the main finding of which is chronic hyperglycemia. DM is caused by impaired insulin secretion, action or both [1]. The diagnosis and management of DM in HIV patients are vital issues. This is because more patients with HIV have chronic comorbidities. Although there is conflicting evidence regarding HIV as an independent risk factor for diabetes, HIV infection and its treatment are linked to the disease [2]. The prevalence of DM in HIV-infected patients varies depending on the makeup of the cohort analyzed, how the diagnosis of DM is made, and how DM risk variables are taken into consideration in the study [3–5]. One of the HIV adult patients receiving medical

care had DM. DM in HIV-infected individuals may develop at an earlier age and without obesity [6]. The incidence of DM in HIV-infected individuals is due to the type of Highly Active Antiretroviral Therapy (HAART), study population, HAART exposure duration, and definition of DM used [3,7-9]. The prevalence of DM among HIV patients HAART users in different parts of countries is 4.51% in Thailand [10], 4.5 % in Malawi [11], 2.1 to 25.5% in Africa [12].

Sex, physical inactivity, smoking, alcohol use, family history of DM, CD4 count, viral load, body mass index, age, hepatitis C co-infection, inadequate diet, history of hypertension, and duration of HIV infection have been identified as contributing factors to the development of DM in HIV-infected people [13-15]. The risk of DM among HIV-infected patients increases with long-term exposure to HAART [16]. The hazard of DM among HIV patients was approximately four times higher than that among HIV-uninfected individuals, and HAART is considered the single determinant of DM in HIV-infected people [17]. DM is now recognized as an important chronic comorbid condition occurring in people living with HIV and is associated with increased morbidity and mortality, which accounting 14.5% and approximately 4.2 million people aged 20-79 years died due to DM [19]. As ART may have increased the life expectancy of people living with HIV, diabetes may play a larger role in chronic care and management. Among people living with HIV, diabetes is common and associated with age and long-term HIV or ART exposure [17,19]. The success of ART in controlling HIV replication and restoring immunity has been strengthened by the knowledge that the incidence of metabolic diseases, including DM, is increasing in people living with HIV [20].

Studies conducted in Zimbabwe have been reported 12% of incidence rate of DM after nine years follow up [14,15]. Many cases of comorbidities with DM have been reported, particularly in areas of the world where the prevalence of HIV is high [21]. Between 1994 and 2004, the rate of hospitalization for diabetes among HIV patients increased from 3.9 to 8.4. The probability of hospitalization for diabetes increased among patients between 2002-2004 [22]. The risk of death in HIV-infected individuals was similar in those with and without DM diagnosis but tended to increase thereafter in patients with DM [10].

In Sub-Saharan Africa, where the burden of diabetes and HIV is high, there is limited data on the prevalence of diabetes among people living with HIV and the impact of diabetes on clinical outcomes. Available data suggest people living with HIV with diabetes may be at increased risk of active tuberculosis and death compared to people living with HIV without diabetes [23-25]. The economic burden of HIV infection and DM indicates the need to design interventions to delay the development of type 2 DM in HIV-positive populations. Nearly US$19 billion was spent on HIV-related burden in low- and middle-income countries in 2015 [26]. Comorbidities, including DM, in people living with HIV are of increasing clinical concern in combination with ART [27].

HIV-infected patients on ART are at a greater risk of developing diabetes and thus suffer from extra morbidity and mortality than those without the disease [17]. However, there are limitations to studies that have addressed the incidence rate of DM among HIV patients receiving ART in Ethiopia. This would lead to poor insight among concerned bodies concerning this critical and high burden issue. Therefore, this study aimed to assess the incidence of DM among HIV patients receiving ART at the Asella Referral and Teaching Hospital in Ethiopia. The findings of this study would provide essential baseline information to the government, healthcare professionals, stakeholders, diabetic associations, HIV associations, local and national policymakers, and implementers.

Methods

Study area and period

The study was conducted at the Asella Referral and Teaching Hospital, which is located in Asella Town. Asella is a town located in the Arsi Zone of the Oromia Regional State, which is approximately 175 km from Addis Ababa and 75 km from Adama. This hospital has about 4.5 million populations. The hospital was established in 1964 and rebuilt in 1992 by the Italian government with a capacity of 250 beds. The company began providing ART services in 1993. Currently, 4,689 HIV patients are enrolled in the ART clinics. Of these, 3,851 were adults (obtained from the ART database of the hospital). The study was conducted from March 21/2023 to March 23/2023.

Study design

Ten years of retrospective follow-up study was conducted.

Source population

All patients ever started ART at the Asella Referral and Teaching Hospital, which had been followed up.

Study population

All HIV patients started ART at the Asella Referral and Teaching Hospital and were followed up between January 01/2013 and December 31/2022.

Eligibility criteria

Inclusion criteria: All adult individuals aged ≥ 18 years who were enrolled in the Asella Referral and Teaching Hospital ART Clinic between January 01/2013 and December 31/2022.

Exclusion criteria:

- Pregnant women
- Patients who had DM at the beginning of the study

- Patients whose dates of ART initiation and last contact were not registered in their medical charts.

Sample size determination

A single-population proportion formula was used to calculate the sample size of this study. The following statistical assumptions were made for the sample size calculation.

P = proportion of failure= 22.1% [28].

Z α/2 = corresponding Z score of 95%CI=1.96

d= margin of error= 5%

$$n=\frac{Z\left(\frac{@}{2}\right)2*p(1-p)}{(d)2}=\frac{(1.96)2*0.221(1-0.221)}{(0.05)2}=264$$

The population of HIV patients receiving ART within a cohort of ten years was 2,250, which was less than 10,000. Therefore, a correction formula was used to adjust the sample size nf= $\frac{n}{1+\frac{n}{N}}=\frac{264}{1+\frac{264}{2250}}=236$.

Considering the high possibility of incomplete documentation, 15% was used for incomplete medical records. The final sample size was 272.

Sampling technique and procedure

The eligibility of patients with HIV receiving ART was assessed using medical records. All HIV patients receiving ART from January 01/2013 to December 31/2022 were considered for this study. A systematic sampling technique was used to select patients with HIV who received ART medical charts. The regular interval, K^{th} was calculated to be 8. The figure of the first patient's medical chart to be included in the sample was chosen randomly by picking one of the first eight pieces of paper, numbered one to eight. Then, five were selected randomly, and the selection of the sample was performed at regular intervals.

Variables

Dependent variables: Incidence rate of DM.

Independent variables:

Sociodemographic variables: Age, gender, and residency.

Clinical and laboratory variables: BMI, CD4 count, viral load, WHO clinical stage, hemoglobin level, ART regimen, and family history of DM.

Operational definition

DM: It refers to a medical diagnosis of the patients stated as "diabetes mellitus" by the physician on the patient's medical record chart.

Entry date: First date for each observation within the study period on the date of ART initiation.

End date: The last date of each observation within the study period that the subject visited.

Survival status: Refers to either diabetes or censored that was ascertained on the patient's medical chart record on the last day of contact.

Event: The occurrence of DM in HIV patients receiving ART, as ascertained by physicians.

Censored: HIV patients receiving ART who did not develop DM were lost to follow-up, withdrawn, transferred, or died without developing DM until the end of the study.

A lost to follow up: HIV patients receiving ART who missed visits for more than 2 months after the last scheduled visit.

Withdrawn: HIV patients receiving ART who missed visits for more than three months after the last scheduled visit.

Survival time: Time from ART initiation to DM development. This was calculated by subtracting the entry date from the end date.

Data collection tool, procedures, and quality control

The data extraction format was developed in English by reviewing relevant literature [28-31]. The data extraction format was used to extract the required information from HIV patients receiving ART medical charts. The data-extraction format consists of three parts. Part 1: Sociodemographic factors, Part II: Baseline clinical and laboratory characteristics, and Part III: Survival status-related information.

A pre-test was conducted on 27 medical charts of patients' receiving ART to check the consistency of the data extraction format. Half-day training was provided for the data collectors in the data extraction and procedures. The extracted data were checked daily for completeness each day.

Data processing and analysis

Data were entered using Epi Data, version 4.6.0.0. Statistical analyses were performed using STATA version 14.2 statistical software. Patient outcomes were dichotomized into events and censored. Continuous variables were categorized to determine their frequencies and percentages. Descriptive statistics were calculated for the sociodemographic, clinical, and laboratory variables. The ten years cumulative incidence proportion of DM among HIV patients receiving ART was calculated and presented as 95%CI. Survival analysis was performed to determine the IDR of DM among HIV patients receiving ART, which was reported per 1000-person time. The findings of this study are presented in tables and narration.

Results

Sociodemographic characteristics of HIV patients

Among 272 enrolled into this study, 268 medical charts of HIV patients receiving ART were included in the final analysis, which provided a response rate of 98.52%. The mean age of

participants was 38.17 years. Among 268 HIV patients followed for 10 years, 142 (52.99%) were female, 33 (49.63%) were aged between 30-40 years. Approximately 154 (57.46%) of them were urban residents **(Table 1)**.

Baseline clinical and laboratory characteristics of HIV patients

The majority 96 (35.82%) and 93 (34.70%) HIV patients receiving ART were categorized in WHO clinical stage three and stage one, respectively. More than half of 139 (52.85%) HIV patients receiving ART had a baseline CD4 count less than 350 cells/mm^3. The majority 117 (90%) of HIV patients receiving ART had a baseline viral load less than 500 cells/mm^3. Most 148 (55.43%) of HIV patients receiving ART had a BMI 18.5-24.9, which is normal weight. Approximately 105 (39.18%) HIV patients receiving ART were presented with comorbidities. The predominant regimen prescribed was a combination of the DTG-based ART regimen, 223 (83.21%) **(Table 2)**.

Table 1. Baseline Sociodemographic Characteristics of HIV patients Receiving ART from January 01/2013 to December 31/2022 in Asella Referral and Teaching hospital, Oromia Regional State, Ethiopia, 2023 [n=268].

Variable	Category	Frequency	Percent
Age in years	18-29	59	22.01
	30-44	133	49.63
	45-64	72	26.87
	≥ 65	4	1.49
Gender	Male	126	47.01
	Female	142	52.99
Residency	Urban	154	57.46
	Rural	114	42.54

Table 2. Baseline Clinical and Laboratory Characteristics of HIV patients Receiving ART from January 01/2013 to December 31/2022 in Asella Referral and Teaching Hospital, Oromia Regional State, Ethiopia, 2023 [n=268].

Variable	Category	Frequency	Percent
BMI	<18.5	104	38.95
	18.5-24.9	148	55.43
	25-29.9	11	4.12
	≥ 30	4	1.50
CD4 count	≤ 350	139	52.85
	>350	124	47.15
Viral load	<500	117	90
	≥ 500	13	10
WHO clinical stage	Stage I	93	34.70
	Stage II	57	21.27
	Stage III	96	35.82
	Stage IV	22	8.21
Hemoglobin	<10	18	7.17
	≥10	233	92.83
ART regimen	DTG- based ART	223	83.21
	NNRTI-based ART	40	14.93
	AZT-based ART	1	0.37
	Other	4	1.49

Presence of comorbidity	Yes		105	39.18
	No		163	60.82
If yes, which one of the following?	TB	Yes	78	74.29
		No	27	25.71
	Heart disease	Yes	7	6.67
		No	98	93.33
	Renal disease	Yes	11	10.48
		No	94	89.52
	Hepatitis B infection	Yes	16	15.24
		No	89	84.76
	Other		8	2.99
Family history of DM	Yes		2	0.75
	No		266	99.25
Non-ART medication	Yes		107	39.93
	No		161	60.07

Note: ART regimen: DTG-based ART regimen: TDF+3TC+DTG; NNRTI-based ART regimen: TDF+3TC+EFV; AZT-based ART regimen: AZT+3TC+EFV; Other ART regimens: ABC + 3TC + EFV, TDF+ 3TC + ATV/r.

Abbreviations: ART: Antiretroviral Therapy; AZT: Zidovudine; EFV: Efavirenz; BMI: Body Mass Index; DTG: Dolutegravir; HIV: Human Immune Virus; NNRTIs: NonNucleoside Reverse Transcriptase Inhibitors; TDF: Tenofovir; 3TC: Lamivudine; ATV/r: Atazanavir/ritonavir.

Survival status of HIV patients

IDR of DM: A total of 268 HIV patients receiving ART were followed for a minimum and maximum follow-up period of 0.12 to 9.96 years, respectively. The IDR of DM in the cohort of HIV patients receiving ART during 1291.33 person-year observation was 6.20 per 1000 [95% CI: 3.10, 12.39] person-years.

Cumulative incidence proportion of DM

The cumulative incidence proportion of DM among HIV patients receiving ART was 2.99% [95%CI: 1.49, 5.88] within the 10 years follow-up period **(Figure 1)**.

Type of censored

A total of 260 (97.01%) of HIV patient's received ART were considered censored. Out Of these, 196 (75.40%) did not develop the DM within 10 years follow up period, 31 (11.90%) were transferred out, 21 (8.10%) had died without developing DM, 9 (3.50%) were withdrawn, and three (1.20%) were lost to follow up **(Figure 2)**.

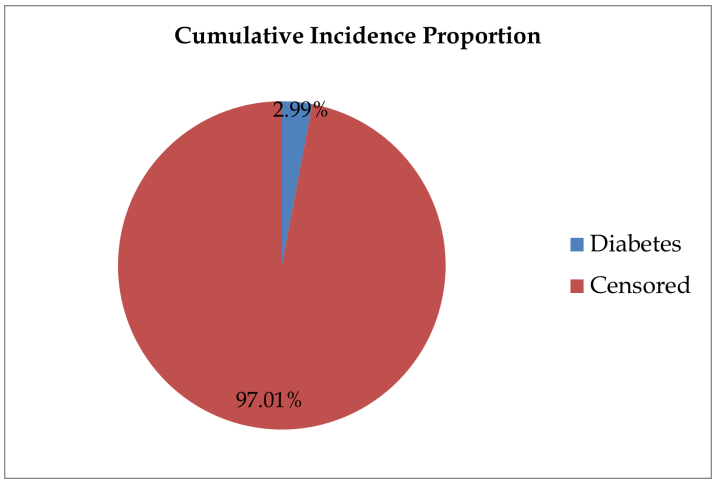

Figure 1. Cumulative incidence proportion of DM among HIV patients receiving ART from January 01/2013 to December 31/2022 in Asella Referral and Teaching Hospital, Oromia Regional State, Ethiopia, 2023 [n=268].

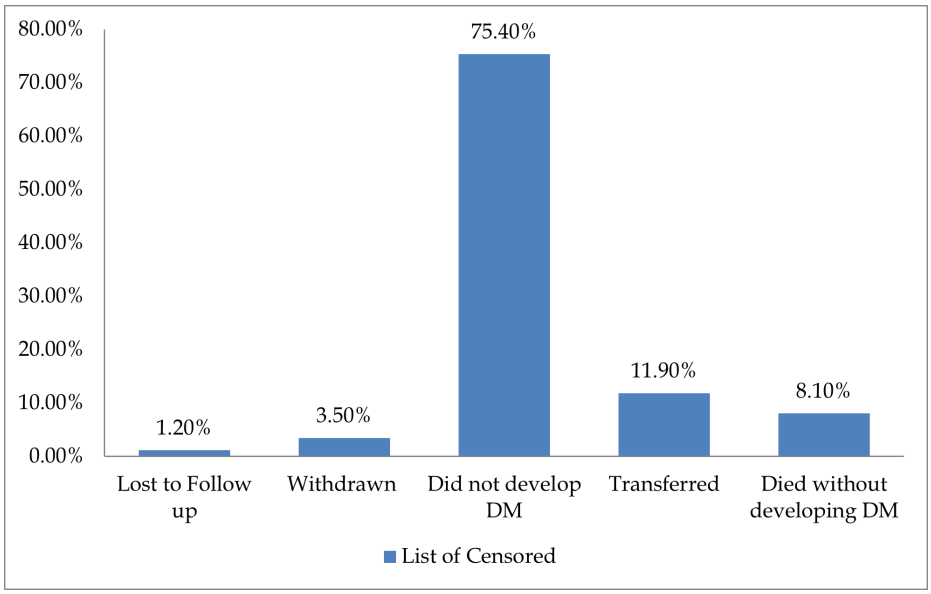

Figure 2. List of censored types of HIV patients receiving ART from January 01/2013 to December 31/2022 in Asella Referral and Teaching Hospital, Oromia Regional State, Ethiopia, 2023 [n=268].

Discussion

This study was the first to examine the study setting and national level. This ten years retrospective follow-up study aimed to determine the IDR for DM among HIV patients receiving ART. The IDR of DM in the cohort of HIV patients receiving ART during 1291.33 person-year observation was 6.20 per 1000 [95% CI: 3.10, 12.39] person-years.

The findings of this study were consistent with those of a study conducted in 212 clinics in Europe, the U.S., Argentina, and Australia, with an incidence rate of DM as 5.72 per 1,000 person-year of follow-up [32]. The findings of this study are consistent with a study conducted in South Carolina, which reported an incidence rate of DM of 11.35 [29]. The findings of this study are consistent with a study conducted in Italy, which reported an incidence rate of DM of 10.13 [30]. The findings of this study are consistent with a study conducted in Britain, which reported an incidence rate of DM of 7.4 [31].

The findings of this study were lower than those of a multicenter AIDS cohort study by Pittsburgh, PA; Baltimore, MD; Chicago, IL; and Los, which reported an incidence rate of 47.4% for DM [3]. The finding of this study was also lower than the study conducted in six United States cities (Bronx, Brooklyn, Chicago, Los Angeles, San Francisco, and Washington DC, which is a multicenter prospective cohort study reported incidence rate of DM as 34.0 [7]. The findings of this study were also lower than those of a study conducted in France, which reported an incidence rate of 14.1 [8]. The findings of this study were also lower than those of a study conducted in Britain, which reported an incidence rate of 16.1 [28]. These discrepancies might be due to the differences in the characteristics of the study population, follow-up periods, study period, limited access to healthcare services, poor quality health care and screening practices, longer exposure to ART agents, use of older drugs, exposure to high levels of first-generation drugs, and availability of new drug regimens (Dolutegravir-containing regimen). However, the findings of this study were higher than those of a study conducted in Denmark, which reported an incidence rate of 3.7 [4].

The cumulative incidence proportion of DM among HIV patients receiving ART was 2.99% [95%CI: 1.49, 5.88] within the 10 years follow-up period. The finding of this study was also lower than the study conducted in six United States cities (Bronx, Brooklyn, Chicago, Los Angeles, San Francisco, and Washington DC; is the Women's Interagency HIV study, which is multicenter prospective cohort study reported cumulative incidence proportion of DM as 7.61% [7]. The findings of this study were also lower than those of a study conducted in France, which reported a cumulative incidence proportion of DM of 10.6% [8]. The finding of this study was also lower than that of a study conducted in Britain which reported a cumulative incidence proportion of DM of 22.1% [28]. The findings of this study were lower than those of a study conducted in South Carolina, which reported cumulative incidence proportion of DM as 7.9% [29].

However, the findings of this study were consistent with those studies conducted in Britain, which reported cumulative incidence proportion of 4.6% [31]. The findings of this study are consistent with the studies conducted in the 212 clinics in Europe, the U.S., Argentina, and Australia, which reported a cumulative incidence proportion of 2.85% [32]. The findings of this study were consistent with the study conducted in

Denmark, which reported a cumulative incidence proportion of 2.97% [4]. The strength of this study was that it was ten years retrospective follow-up study. This is the first retrospective cohort study conducted in a country. This was performed by reviewing the patients' medical charts. Therefore, it was difficult to extract all the necessary information because of inconsistent documentation.

Conclusion

This study showed that the IDR for DM among HIV patients receiving ART was relatively higher. This finding is particularly important in attracting the attention of concerned bodies towards this high-burden leading issue. Healthcare professionals who provide care for HIV patients receiving ART should emphasize early screening of DM among these patients. Considering the burden of DM among HIV patients receiving ART, all concerned bodies, the government, diabetic association, HIV association, local and national health policy implementers and makers, and researchers need to focus on this critical issue.

Ethics Approval and Informed Consent

Ethical clearance was obtained from the Ethical Review and Research Committee of the Nursing Department, College of Health Sciences, Arsi University, after a thorough assessment of the study for its scientific contribution and ethical issues. A letter of permission was received and sent to Asella Referral and Teaching Hospital. Permission was obtained from the concerned body before the commencement of this study. Since the data were collected from the patients' medical charts using a data extraction format, written or verbal informed consent was not applicable. This study was approved by the ethical review and research committee of the Nursing Department, College of Health Sciences, Arsi University, as it was ethically acceptable.

Author Contributions

The authors have contributed to the conception of the study, data analysis, drafting or revision of the article, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

Data Sharing Statement

The data used to support the findings of this study have been included in this article.

Consent for Publication

Not applicable.

Acknowledgments

We would like to acknowledge Asella Referral, the Teaching Hospital, and the data collectors.

Funding

None.

Competing Interests

The author declares that there are no conflicts of interest.

References

1. Petersmann A, Müller-Wieland D, Müller UA, Landgraf R, Nauck M, Freckmann G, et al. Definition, Classification and Diagnosis of Diabetes Mellitus. Exp Clin Endocrinol Diabetes. 2019 Dec;127(S 01):S1-S7.
2. Monroe AK, Glesby MJ, Brown TT. Diagnosing and managing diabetes in HIV-infected patients: current concepts. Clin Infect Dis. 2015 Feb 1;60(3):453-62.
3. Brown TT, Cole SR, Li X, Kingsley LA, Palella FJ, Riddler SA, et al. Antiretroviral therapy and the prevalence and incidence of diabetes mellitus in the multicenter AIDS cohort study. Arch Intern Med. 2005 May 23;165(10):1179-84.
4. Rasmussen LD, Mathiesen ER, Kronborg G, Pedersen C, Gerstoft J, Obel N. Risk of diabetes mellitus in persons with and without HIV: a Danish nationwide population-based cohort study. PLoS One. 2012;7(9):e44575.
5. Polsky S, Floris-Moore M, Schoenbaum EE, Klein RS, Arnsten JH, Howard AA. Incident hyperglycaemia among older adults with or at-risk for HIV infection. Antivir Ther. 2011;16(2):181-8.
6. Hernandez-Romieu AC, Garg S, Rosenberg ES, Thompson-Paul AM, Skarbinski J. Is diabetes prevalence higher among HIV-infected individuals compared with the general population? Evidence from MMP and NHANES 2009-2010. BMJ Open Diabetes Res Care. 2017 Jan 5;5(1):e000304.
7. Tien PC, Schneider MF, Cole SR, Levine AM, Cohen M, DeHovitz J, Young M, Justman JE. Antiretroviral therapy exposure and incidence of diabetes mellitus in the Women's Interagency HIV Study. AIDS. 2007 Aug 20;21(13):1739-45.
8. Capeau J, Bouteloup V, Katlama C, Bastard JP, Guiyedi V, Salmon-Ceron D, et al. Ten-year diabetes incidence in 1046 HIV-infected patients started on a combination antiretroviral treatment. AIDS. 2012 Jan 28;26(3):303-14.
9. Ledergerber B, Furrer H, Rickenbach M, Lehmann R, Elzi L, Hirschel B, et al. Factors associated with the incidence of type 2 diabetes mellitus in HIV-infected participants in the Swiss HIV Cohort Study. Clin Infect Dis. 2007 Jul 1;45(1):111-9.
10. Paengsai N, Jourdain G, Chaiwarith R, Tantraworasin A, Bowonwatanuwong C, Bhakeecheep S, et al. Incidence and clinical outcomes of diabetes mellitus in HIV-infected adults in Thailand: a retrospective cohort study. BMC Public Health. 2018 Aug 30;18(1):1079.
11. Divala OH, Amberbir A, Ismail Z, Beyene T, Garone D, Pfaff C, et al. The burden of hypertension, diabetes mellitus, and cardiovascular risk factors among adult Malawians in HIV care: consequences for integrated services. BMC Public Health. 2016 Dec 12;16(1):1243.

12. Husain NE, Noor SK, Elmadhoun WM, Almobarak AO, Awadalla H, Woodward CL, et al. Diabetes, metabolic syndrome and dyslipidemia in people living with HIV in Africa: re-emerging challenges not to be forgotten. HIV AIDS (Auckl). 2017 Nov 8;9:193-202.

13. Kalra S, Kalra B, Agrawal N, Unnikrishnan A. Understanding diabetes in patients with HIV/AIDS. Diabetol Metab Syndr. 2011 Jan 14;3(1):2.

14. Karamchand S, Leisegang R, Schomaker M, Maartens G, Walters L, Hislop M, et al. Risk Factors for Incident Diabetes in a Cohort Taking First-Line Nonnucleoside Reverse Transcriptase Inhibitor-Based Antiretroviral Therapy. Medicine (Baltimore). 2016 Mar;95(9):e2844.

15. Cheza A, Tlou B, Zhou DT. Incidence of non-communicable diseases (NCDs) in HIV patients on ART in a developing country: Case of Zimbabwe's Chitungwiza Central Hospital-A retrospective cohort study (2010-2019). PLoS One. 2021 May 27;16(5):e0252180.

16. Samaras K. The burden of diabetes and hyperlipidemia in treated HIV infection and approaches for cardiometabolic care. Curr HIV/AIDS Rep. 2012 Sep;9(3):206-17.

17. Nduka CU, Stranges S, Kimani PK, Sarki AM, Uthman OA. Is there sufficient evidence for a causal association between antiretroviral therapy and diabetes in HIV-infected patients? A meta-analysis. Diabetes Metab Res Rev. 2017 Sep;33(6).

18. Monroe AK, Glesby MJ, Brown TT. Diagnosing and managing diabetes in HIV-infected patients: current concepts. Clin Infect Dis. 2015 Feb 1;60(3):453-62.

19. Prioreschi A, Munthali RJ, Soepnel L, Goldstein JA, Micklesfield LK, Aronoff DM, et al. Incidence and prevalence of type 2 diabetes mellitus with HIV infection in Africa: a systematic review and meta-analysis. BMJ Open. 2017 Mar 29;7(3):e013953.

20. 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 Aug 19;10(8):e0134410.

21. Abebe SM, Getachew A, Fasika S, Bayisa M, Girma Demisse A, Mesfin N. Diabetes mellitus among HIV-infected individuals in follow-up care at University of Gondar Hospital, Northwest Ethiopia. BMJ Open. 2016 Aug 18;6(8):e011175.

22. Kourtis AP, Bansil P, Kahn HS, Posner SF, Jamieson DJ. Diabetes trends in hospitalized HIV-infected persons in the United States, 1994-2004. Curr HIV Res. 2009 Sep;7(5):481-6.

23. Boillat-Blanco N, Ramaiya KL, Mganga M, Minja LT, Bovet P, Schindler C, et al. Transient Hyperglycemia in Patients With Tuberculosis in Tanzania: Implications for Diabetes Screening Algorithms. J Infect Dis. 2016 Apr 1;213(7):1163-72.

24. Faurholt-Jepsen D, Range N, Praygod G, Jeremiah K, Faurholt-Jepsen M, Aabye MG, et al. Diabetes is a risk factor for pulmonary tuberculosis: a case-control study from Mwanza, Tanzania. PLoS One. 2011;6(8):e24215.

25. Oni T, Berkowitz N, Kubjane M, Goliath R, Levitt NS, Wilkinson RJ. Trilateral overlap of tuberculosis, diabetes and HIV-1 in a high-burden African setting: implications for TB control. European Respiratory Journal. 2017 Jul 1;50(1).

26. Masuku SK, Tsoka-Gwegweni JM, Sartorius B. The economic burden of HIV and type 2 diabetes comorbidity: Implications for care in countries with high burden of HIV. Journal of Diabetology. 2019 Sep 1;10(3):89-96.

27. 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. Journal of the International AIDS Society. 2019 Jan;22(1):e25236.

28. Samad F, Harris M, Puskas CM, Ye M, Chia J, Chacko S, et al. Incidence of diabetes mellitus and factors associated with its development in HIV-positive patients over the age of 50. BMJ Open Diabetes Res Care. 2017 Nov 26;5(1):e000457.

29. Tripathi A, Liese AD, Jerrell JM, Zhang J, Rizvi AA, Albrecht H, et al. Incidence of diabetes mellitus in a population-based cohort of HIV-infected and non-HIV-infected persons: the impact of clinical and therapeutic factors over time. Diabet Med. 2014 Oct;31(10):1185-93.

30. Leone S, Prosperi M, Costarelli S, Nasta P, Maggiolo F, Di Giambenedetto S, et al. Incidence and predictors of cardiovascular disease, chronic kidney disease, and diabetes in HIV/HCV-coinfected patients who achieved sustained virological response. Eur J Clin Microbiol Infect Dis. 2016 Sep;35(9):1511-20.

31. Bratu A, McLinden T, Kooij K, Ye M, Li J, Trigg J, et al. Incidence of diabetes mellitus among people living with and without HIV in British Columbia, Canada between 2001 and 2013: a longitudinal population-based cohort study. BMJ Open. 2021 May 11;11(5):e048744.

32. De Wit S, Sabin CA, Weber R, Worm SW, Reiss P, Cazanave C, et al. Incidence and risk factors for new-onset diabetes in HIV-infected patients: the Data Collection on Adverse Events of Anti-HIV Drugs (D:A:D) study. Diabetes Care. 2008 Jun;31(6):1224-9.