



A CROSS-SECTIONAL STUDY ON FACTORS INFLUENCING LONG TERM SURVIVAL AMONG HIV PATIENTS TAKING ART IN A GOVERNMENT TERTIARY CARE HOSPITAL.

Dr. Venkata Sai Krishna Reddy

Postgraduate, Department of General Medicine, Siddhartha Medical College, Vijayawada.

Dr. K. Tushitha

Duty Medical Officer, Dr. NTR University of Health Sciences.

Dr. B. Arunkumar*

Assistant Professor, Department of Community Medicine, Guntur Medical College, Guntur. *Corresponding Author

Dr. B. Bhavadharani

Postgraduate, Department of Community Medicine, Guntur Medical College, Guntur.

ABSTRACT

Background: HIV infection, as a persistent chronic condition, leads to both morbidity and mortality and antiretroviral therapy (ART) contributes to enhanced survival and overall well being of people living with HIV. Lack of adherence to antiretroviral therapy has a direct relationship with CD4 counts. Hence, the present study aimed to study the clinical characteristics and outcomes of individuals living with HIV for duration of at least 10 years, during the antiretroviral therapy (ART) era. **Methodology:** A descriptive cross-sectional study was carried out at the Government tertiary care hospital in the year 2022. 50 persons living with HIV for the past 10 years were included. Data were collected regarding the demographic characteristics, clinical and treatment history. Data analysis was done by SPSS version 17. **Results:** The proportion of female patients (56%) was higher than male patients (44%). At the end of the mean 13.97 years of living with HIV (PLHIV), 98% of patients who maintained a high compliance rate of 95% with antiretroviral therapy (ART) were found to be asymptomatic. These results demonstrate the importance of adhering to ART and its positive impact on the long-term health outcomes of PLHIV, particularly in females. However, it also underscores the significance of consistent medication adherence to achieve optimal results and prevent disease progression. **Conclusion:** TB coinfection and lower CD4 counts have significant impact on the outcome of PLHIV. A high compliance rate and absence of symptoms demonstrate the importance of adherence to ART and its positive impact on the long-term health outcomes of PLHIV.

KEYWORDS : Human Immunodeficiency Virus (HIV), Anti-retroviral therapy (ART), People Living with HIV (PLHIV), adherence, CD4 counts, TB Co-infection

INTRODUCTION:

HIV infection, as a persistent chronic condition, leads to both morbidity and mortality and Antiretroviral therapy (ART) contributes to enhanced survival and overall well being of people living with HIV. Its achievements can be attributed to its high effectiveness, minimal occurrence of side effects and simplicity in use¹. The changing pattern of mortality underscores the need for adjustments in clinical monitoring protocols for HIV-infected patients along with epidemiological surveillance².

While there has been a notable reduction in AIDS-defining illnesses and related fatalities, other causes of mortality, such as long-term complications stemming from diabetes and heart disease, have become more apparent as patients live longer^{3,4}. Another factor that has been recognized is the lack of adherence to antiretroviral therapy (ART), which has a direct relationship with CD4 counts and the prospects for future survival among people living with HIV (PLHIV)⁵. HIV-TB coinfection is also increasing which can be improved by appropriate and timely intervention of ART after initiation of anti-TB treatment⁶. There is a minor yet persistent gap between PLHIV and individuals without HIV infection⁷.

However, the range of health challenges encountered by individuals aging with HIV is still significantly shaped by factors related to HIV itself, its treatment, as well as the behaviours, conditions, and demographics associated with HIV infection. It is imperative that the present focus should treat HIV as a multifaceted chronic condition, where morbidity and mortality arise from a multitude of interconnected factors⁸.

OBJECTIVES:

- To study the clinical characteristics and outcomes of individuals living with HIV for duration of at least 10 years, during the antiretroviral therapy (ART) era.

- To analyze various factors that contribute to long-term survival in individuals living with HIV for 10 years or more.

MATERIALS & METHODS:

Study Design and Population:

A descriptive cross-sectional study was carried out at the Department of General Medicine, Government General Hospital, Vijayawada in the year 2022. The study involved 50 persons living with HIV who had been living with the condition for at least 10 years or more. These individuals were receiving medical care at the Out Patient and Casualty wards. The data collected for the study encompassed information about the participants' age, gender, HIV diagnosis, treatment status, baseline laboratory parameters, duration of treatment, and their current health status.

Study Procedure:

A total of 50 patients were included in the study using convenient sampling method. Dependent variables such as age at the time of diagnosis and duration of PLHIV were determined and the patients satisfying the inclusion criteria were included in the study. Patients with non availability of complete data, date of registration and initiation of ART and other inconsistent data were excluded.

Statistical analysis:

Demographic and clinical characteristics were presented using descriptive statistics, and these variables were also assessed to identify potential risk factors. Independent sample t-test was used to calculate difference in the mean values. For statistical analysis, a p-value less than 0.05 was considered statistically significant, and the software SPSS version 17 was utilized for conducting the analyses.

RESULTS:

The study encompassed 50 patients who had received their diagnosis either on or prior to April 2012. Table No.1 presents the demographic and clinical characteristics of the study

population. The proportion of female patients (56%) was higher than male patients (44%). The majority of the patients were found to be in between 31 – 50 years (80%) with the highest in the 41-50 year age group (56%) and the mean age at diagnosis was 29.6 ± 7.82 years. The mean years of duration was found to be 13.74 ± 2.98 years. Most of the patients acquired infection from their married partner (56%) followed by sexual contact outside marriage (24%). 16% of the patients do not know their source of infection and only 4% had a history of vertical transmission. The predominant type of HIV was type 1 (96%) in the present study.

Table no.1 Gender distribution

Gender	No. (%)
Female	28 (56%)
Male	22 (44%)

Table no.2 : Age wise distribution

Age Group	No. (%)
< 30 years	3 (6%)
31 – 40 years	12 (24%)
41- 50 years	28 (56%)
> 50 years	7 (14%)
Mean age at Diagnosis	29.6 ± 7.82
Mean years of Infection	13.74 ± 2.98

Table no 3 : source of infection in proportion Table no. 4 : HIV 1 AND HIV2 Positivity

Virus Type	No. (%)
HIV 1	48 (96%)
HIV 2	1 (2%)
Both HIV 1 & 2	1 (2%)

Although there was a significant difference ($p < 0.05$; Table No.5), in the mean age at diagnosis with females having a younger mean age at diagnosis (27.07 ± 8.46) compared to males, the mean duration of HIV is almost similar in both females and males (13.79 ± 2.71 vs 13.68 ± 3.35) with no significant difference ($p > 0.05$).

Table no.5: Gender wise characteristics (Mean \pm S.D)

Source of Infection	No. (%)
Married Partner	28 (56%)
From the parent	2 (4%)
Extramarital contact	12 (24%)
Unknown	8 (16%)

Table no.6: Gender wise CD4 Counts at the initiation of therapy and current levels (Mean \pm S.D)

Gender	At the time of initiation of treatment	Current study time	P value
Female	320.25 ± 215.96	503.82 ± 304.33	0.012*
Male	188.36 ± 145.93	445.82 ± 175.89	0.000*

At the time of diagnosis, the majority of female patients (80%) showed no symptoms, whereas males (65%) presented with symptoms suggesting a more likely and advanced stage of the disease. This can be attributed to the fact that the mean CD4 count in men is comparatively much lower than women (188.36 vs 320.25) as shown in table no.6. A significant increase in the mean CD4 counts at time of diagnosis to the current levels both in men and women is also observed ($p < 0.05$) as a response to the treatment.

Two female patients acquired the infection from their parents. The first patient was diagnosed with pulmonary TB at the age of 12 years. Unfortunately, she passed away at 21 years old due to meningitis, with her latest CD4 count recorded at 57. The second patient, diagnosed at 6 years old with repeated illnesses, is currently asymptomatic at 23 years old, and her latest CD4 count is 942.

TB Co-infection:

At the time of diagnosis, 7.6% of symptomatic males and 25%

of symptomatic females were found to be co-infected with TB. This indicates that symptomatic females have a higher predisposition to Tuberculosis compared to males. Another possible explanation could be that males may have overlooked screening for TB, leading to cases going unnoticed. It is worth noting that bidirectional screening for HIV-TB was recommended by WHO only since 2011. The patients included in this study were diagnosed before April 2012.

Duration of treatment regimen:

In the present study, the Zidovudine based regimen exhibited the longest mean usage duration of 5.34 years, while the Tenofovir based regimen had a slightly lower mean usage of 2.5 years, followed by the Dolutegravir based regimen with the shortest mean usage of 2 years.

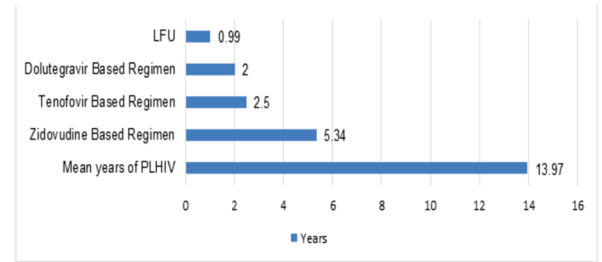


Figure no.1: Mean duration of different treatment regimens

LFU – Loss to follow up

Prevalence of Co-morbidities:

In Table No.7, it was observed that all the patients included in the study were diagnosed with Anemia, representing a prevalence of 100%. Among the comorbidities identified, Diabetes mellitus had the highest prevalence, affecting 20% of the patients. Hypertension followed as the second most prevalent comorbidity, observed in 11.1% of the patients, while Hypothyroidism, CAD (Coronary Artery Disease), and CVA (Cerebrovascular Accident) were found to have prevalence rates of 4.4%, 2.2%, and 2.2%, respectively.

Table no.7: Prevalence of Co-morbidities

Co-morbidities	No.*	%
Hypertension	5	11.1
T2DM	9	20.0
Hypothyroid	2	4.4
CAD	1	2.2
CVA	1	2.2
Anemia	45	100

Table no.8: Hemoglobin level at the time of diagnosis and at present

Hb level	Mean Hb	P value
At the time of diagnosis	7.42 ± 2.16	0.000*
Current level	9.49 ± 2.81	

5 patients had undergone blood transfusion for anemia

Despite the fact that all observed patients in the study were diagnosed with Anemia, there has been a significant rise [$(p < 0.01)$; Table No.8] in the mean Hemoglobin level, increasing from 7.42 g/dl at the beginning of the study to 9.49 g/dl at the present time.

Lipid Profile Derangement:

Table No.9 presents the variation of Lipid Profile in the study population. The table displays the mean values of different lipid parameters. 61.5% of patients had deranged Triglyceride levels, 62.5% of patients had deranged LDL-C levels, 30% of patients had deranged HDL-C levels, and 38.46% of patients had deranged Total Cholesterol levels. Furthermore, the table indicates that a significant proportion (76.9%) of the patients had at least one lipid parameter

outside the normal range, indicating an increased prevalence of lipid profile abnormalities in the study population.

Table no.9: Variation of Lipid Profile

Mean Lipid Profile Values (mg/dL)		% of patients with derangement
Triglyceride	275	61.5%
VLDL-C	59.05	-
LDL-C	267.125	62.5%
HDL-C	40.05	30%
Total Cholesterol	211.69	38.46%
One or the other is deranged		76.9%

Table no.10: Clinical profile at a glance(N=50)

Medical condition requiring IP treatment in the past	No.	%
Severe anemia needing blood transfusion	5	10%
Diarrheal illness	2	4%
Cervical cancer	1	2%
Meningitis	1	2.2
Medical condition requiring Long term treatment in the past	No.	%
Skin manifestation	3	6%
Isoniazid preventive therapy	50	100%

Overall, this study highlights the various health challenges (table no.10) faced by the study participants, including the management of diarrheal illness, anemia, cervical cancer, and opportunistic infections like TB, while also emphasizing the importance of IPT in HIV care.

Opportunistic infections:

Among the study participants, 12 individuals (24%) experienced opportunistic infections at some point. Out of these cases, 11 individuals had Pulmonary Tuberculosis, while one had Cervical Lymph node tuberculosis. All cases underwent Drug Sensitivity Testing (DST) and were successfully cured, currently showing no symptoms and being asymptomatic. This highlights the prevalence of Tuberculosis as the most common opportunistic infection observed in the study and emphasizes the effectiveness of the treatment provided in resolving these cases.

Current status:

At the end of the mean 13.97 years of living with HIV (PLHIV), 98% of patients who maintained a high compliance rate of 95% with antiretroviral therapy (ART) were found to be asymptomatic. Out of the total participants, only 2% (n=1) succumbed to the disease after being on ART for 16 years. One patient, who acquired HIV through vertical transmission, unfortunately passed away at the age of 21 due to irregular medication adherence.

Among the female participants (n=27), an impressive 96.42% remained asymptomatic after a mean of 19 years since the diagnosis of HIV. These results demonstrate the importance of adhering to ART and its positive impact on the long-term health outcomes of PLHIV, particularly in females. However, it also underscores the significance of consistent medication adherence to achieve optimal results and prevent disease progression.

DISCUSSION:

This retrospective cohort study analyzed data collected from 50 patients who had received their diagnosis either on or prior to April 2012. The most commonly affected age group was 41-50 years (56%) which was also similar to the observations made in a study done by Shaik RA et al.⁹ where most of the patients were in the age group between 31 to 49 years. In their study the authors also reported a higher mortality among people with HIV with more than 45 years (42.8%) compared to less than 30 years (24.1%). Similarly in studies done by

Bakanda C et al.¹⁰ and Fatti G et al.¹¹ age specific death rates were higher among patients aged >50 or 55 years. Mutevedzi PC et al.¹² revealed in their study that the primary cause of death among older individuals is related to non-HIV factors.

Among the study population 56% were females which is similar to Wang H et al study¹³. Infection through heterosexual contact was the predominant mode of transmission (80%) followed by mother to child transmission (4%). Studies done by Kumawat S et al.¹⁴, Joge US et al.¹⁵, Jha AK et al.¹⁶ also reported similar higher transmission rates through heterosexual contact. Male patients are at most risk of death in this study which is congruent with the observations made by Hawkes S et al¹⁷ and these survival and other health disparities were also consistent across men around the world at all ages as revealed in a systematic review¹⁸.

TB Co-infection was diagnosed among 7.6% of symptomatic males and 25% of symptomatic females. According to a report from 2015, individuals with HIV/AIDS were determined to have a 26-fold higher risk of developing active TB compared to the general population¹⁷.

A significant increase in the mean CD4 counts at time of diagnosis to the current levels both in men and women is also observed (p<0.05) as a response to the treatment in the present study. Many studies also reported higher survival rates among patients with CD4 count >200 cells/mm³^{19,20}. Most female patients (80%) exhibited no symptoms, while males (65%) displayed symptoms indicative of a potentially more advanced stage of the disease in the present study. Zhang G et al.²¹ in their study on predictive survival analysis in HIV infected patients also observed a similar trend where females patient with HIV/AIDS had longer survival time (100.4 months) compared to male patients (91.5 months). This was attributed to higher ART adherence in female patients and also timely intervention and treatment of opportunistic infections.

The Zidovudine-based regimen demonstrated the lengthiest average duration of use, totaling 5.34 years, with the Tenofovir-based regimen showing a slightly shorter mean usage period of 2.5 years, followed by the Dolutegravir-based regimen in the present study. A large collaborative cohort study²² conducted on 88,504 patients to examine survival benefit of patients starting combination ART between 1996 and 2013 revealed that even in the later stages of the ART era, survival rates within the initial three years of ART treatment continued to show improvement which reflects the transition to less toxic ART drugs. Bijker R et al.²³ in their study on survival of HIV patients on long term ART exposure found that in a total of 3996 patients with 10 years history of ART use the mortality rate was 0.72 per 100 person years (2%) and the factors identified for increased mortality were older age, injecting drug use, treatment interruptions, HBV co-infection, diabetes and renal failure.

Diabetes mellitus had the highest prevalence, affecting 20% of the patients in the present study followed by Hypertension observed in 11.1% of the patients. Other comorbidities identified were Hypothyroidism, CAD (Coronary Artery Disease), and CVA (Cerebrovascular Accident). In studies done by Hernández-Ramírez RU et al.²⁴, Islam FM et al.²⁵ a high prevalence of non communicable diseases such as cardiovascular diseases, diabetes, kidney disease and cancer were noted in the PLHIV compared to general population. Nduka CU et al.²⁶ in their study also reported a high prevalence of diabetes and kidney disease in patients with longer exposure to ART.

Anemia is observed in all the patients in the present study and even 5 patients had to undergo blood transfusion. A significant association between Zidovudine (ZDV) based

regimens and anemia has been reported by several studies.^{27,28} In concordance with these findings majority of the patients were on long term ZDV based regimen in the present study.

Lipid Profile Derangement is seen in 76.9% of the patients in the present study indicating a high prevalence of dyslipidemia. Leonardo Calza et al.²⁹ in their review mentioned that abnormalities of lipid metabolism have been increasingly being recognized among HIV infected after the advent of HAART. Savès, M et al.³⁰ in their study established that dyslipidemia is significantly associated with NNRTIs, but PI based regimens also appear to have lipid Profile Derangement. Achila OO et al.³¹ in their study identified that the most dominant was LDL-C derangement which was similar to the present study (62.5%). However it was found in the same study that patients on ZDV based regimens were least affected by lipid abnormalities, with highest proportion of patients diagnosed with lipid abnormalities in abacavir based regimens.

CONCLUSION

The most commonly affected age group was 41-50 years and a higher mortality among people with HIV with more than 45 years was observed among different studies. A significantly higher number of women were living with the virus compared to men and the mean age of the female patients was also lower compared to men. The study has demonstrated that CD4 count has a significant association with long term quality of life among the patients. TB Co-infection was found to be an important risk factor for persistence of symptoms and other complications. Diabetes was the most common co-morbidity among the patients who are on long term ART. High prevalence of anemia underscores the importance of hematologic toxicities manifested among the patients using ZDV based regimens. A large proportion of patients were diagnosed with lipid profile abnormalities of which LDL-C derangement was the most dominant, which may exacerbate pre-existing CVD and also acts as a strong surrogate marker of future CVD. A high compliance rate and absence of symptoms demonstrate the importance of adherence to ART and its positive impact on the long-term health outcomes of PLHIV. So, programmes of non-communicable diseases should be integrated with HIV and TB patients to detect the risk in beforehand and it may help in reducing the morbidity and mortality arising out of these diseases.

Ethical Considerations: Ethical clearance was obtained from the Institutional ethical committee before starting the study.

Funding: Nil

Conflicts Of Interest: Nil

REFERENCES:

- Hogg R. Life expectancy of individuals on combination antiretroviral therapy in high-income countries: a collaborative analysis of 14 cohort studies. *Lancet*. (2008) 372:293-9. doi: 10.1016/S0140-6736(08)61113-7.
- Bonnet F, Morlat P, Chêne G, Mercié P, Neau D, Chossat I, Decoin M, Djossou F, Beylot J, Dabis F; Groupe d'Epidémiologie Clinique du SIDA en Aquitaine (GECSA). Causes of death among HIV-infected patients in the era of highly active antiretroviral therapy, Bordeaux, France, 1998-1999. *HIV Med*. 2002 Jul;3(3):195-9. doi: 10.1046/j.1468-1293.2002.00117.x. PMID: 12139658.
- Henry K, Melroe H, Huebsch J, Hermundson J, Levine C, Swensen L, Daley J. Severe premature coronary artery disease with protease inhibitors. *Lancet*. 1998 May 2;351(9112):1328. doi: 10.1016/S0140-6736(05)79053-X. PMID: 9643798.
- Carr A, Samaras K, Thorisdottir A, Kaufmann GR, Chisholm DJ, Cooper DA. Diagnosis, prediction, and natural course of HIV-1 protease-inhibitor-associated lipodystrophy, hyperlipidaemia, and diabetes mellitus: a cohort study. *Lancet*. 1999 Jun 19;353(9170):2093-9. doi: 10.1016/S0140-6736(98)08468-2. PMID: 10382692.
- Javalkar P, Prakash R, Isac S, Washington R, Halli SS (2016) An Estimation of Mortality Risks among People Living with HIV in Karnataka State, India: Learnings from an Intensive HIV/AIDS Care and Support Programme. *PLOS ONE* 11(6): e0156611. <https://doi.org/10.1371/journal.pone.0156611>.
- Naidoo K, Rampersad S, Karim SA. Improving survival with tuberculosis & HIV treatment integration: A mini-review. *Indian J Med Res* 2019;150:131-8.
- ART Cohort Collaboration 2008 Life expectancy of individuals on combination antiretroviral therapy in high-income countries: a collaborative

- analysis of 14 cohort studies. *Lancet* 372: 293.
- Justice AC (2010) HIV and aging: time for a new paradigm. *Curr HIV/AIDS Rep* 7: 69-76.
- Shaik RA, Holyachi SK, Ahmad MS, Miraj M, Alzahrani M, Ahmad RK, Almeahdi BA, Aljulifi MZ, Alzahrani MA, Alharbi MB and Ahmed MM (2023) Clinic-demographic and survival profile of people living with HIV on antiretroviral treatment. *Front. Public Health* 11:1084210. doi: 10.3389/fpubh.2023.1084210.
- Bakanda C, Birungi J, Mwesigwa R, Ford N, Cooper CL, Au-Yeung C, et al. Association of aging and survival in a large HIV-infected cohort on antiretroviral therapy. *AIDS*. (2011) 25:701-5. doi: 10.1097/QAD.0b013e3283437ed7.
- Fatti G, Mothibi E, Meintjes G, Grimwood A. Antiretroviral treatment outcomes amongst older adults in a large multicentre cohort in South Africa. *PLoS ONE*. (2014) 9:e100273. doi: 10.1371/journal.pone.0100273.
- Mutevedzi PC, Lessells RJ, Rodger AJ, Newell ML. Association of age with mortality and virological and immunological response to antiretroviral therapy in rural South African adults. *PLoS ONE*. (2011) 6:e21795. doi: 10.1371/journal.pone.002.
- Wang H, Wolock TM, Carter A, Nguyen G, Kyu HH, Gakidou E, et al. Estimates of global, regional, and national incidence, prevalence, and mortality of HIV, 1980-2015: the global burden of disease study 2015. *Lancet HIV*. (2016) 3:e361-87. doi: 10.1016/S2352-3018(16)30087-X.
- Kumawat S, Kochar A, Sirohi P GJ. Socio-demographic and clinical profile of HIV/AIDS patients in HAART era at a tertiary care hospital in North-West Rajasthan, India. *Int J Community Med Public Health*. (2016) 3:2088-93. doi: 10.18203/2394-6040.ijcmph20162551.
- Joge US, Deo DS, Lakde RN, Choudhari SG, Malkar VR UH. Sociodemographic and clinical profile of HIV/AIDS patients visiting to ART Centre at a rural tertiary care hospital in Maharashtra state of India. *Int J Biol Med Res*. (2012) 3:1568-72.
- Jha AK, Chadha S, Uppal B, Bhalla P, Jugal K, Dewan R. Socio-demographic and immunological profile of HIV patients attending ART clinic in a tertiary care hospital in North India. *J HIV Clin Sci Res*. (2014) 1:4. doi: 10.17352/2455-3786.
- Hawkes S, Buse K. Gender and global health: evidence, policy, and inconvenient truths. *Lancet*. (2013) 381:1783-7. doi: 10.1016/S0140-6736(13)60253-6.
- GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. (2018) 392:1736-88. doi: 10.1016/S0140-6736(18)32203-7.
- Nansera D, Bajunirwe F, Elyanu P, Asimwe C, Amanyire G, Graziano FM. Mortality and loss to follow-up among tuberculosis and HIV co-infected patients in rural southwestern Uganda. *Int J Tuberc Lung Dis*. (2012) 16:1371-6. doi: 10.5588/ijtld.11.0589.
- Gezie LD. Predictors of CD4 count over time among HIV patients initiated ART in Felege Hiwet Referral Hospital, northwest Ethiopia: multilevel analysis. *BMC Res Notes*. (2016) 9:377. doi: 10.1186/s13104-016-2182-4.
- Zhang G, Gong Y, Wang Q, Deng L, Zhang S, Liao Q, et al. Outcomes and factors associated with survival of patients with HIV/AIDS initiating antiretroviral treatment in Liangshan Prefecture, southwest of China: a retrospective cohort study from 2005 to 2013. *Medicine*. (2016) 95:e3969. doi: 10.1093/med/95.12.3969.
- Antiretroviral Therapy Cohort Collaboration. Survival of HIV-positive patients starting antiretroviral therapy between 1996 and 2013: a collaborative analysis of cohort studies. *Lancet HIV*. (2017) 4:e349-56. doi: 10.1016/S2352-3018(17)30066-8.
- Bijker R, Kiertiburanakul S, Kumarasamy N, Pujari S, Sun LP, Ng OT, Lee MP, Choi JY, Nguyen KV, Chan YJ, Merati TP, Cuong DD, Ross J, Jiamsakul A, IeDEA Asia-Pacific. Survival after long-term ART exposure: findings from an Asian patient population retained in care beyond 5 years on ART. *Antivir Ther*. 2020;25(3):131-142. doi: 10.3851/IMP3358. PMID: 32369040; PMCID: PMC7641962.
- Hernández-Ramírez RU, Shiels MS, Dubrow R, et al. Cancer risk in HIV-infected people in the USA from 1996 to 2012: a population-based, registry-linkage study. *Lancet HIV* 2017; 4: e495- e504. doi: 10.1016/S2352-3018(17)30125-X. [PubMed: 28803888].
- Islam FM, Wu J, Jansson J, et al. Relative risk of renal disease among people living with HIV: a systematic review and meta-analysis. *BMC Public Health* 2012; 12: 234. doi: 10.1186/1471-2458-12-234. [PubMed: 22439731].
- Nduka CU, Stranges S, Kimani PK, et al. 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; 33: e2902. doi: 10.1002/dmrr.2902.
- Tamir Z, Alemu J, Tsegaye A. Anemia among HIV infected individuals taking art with and without zidovudine at Addis Ababa, Ethiopia. *Ethiop J Health Sci*. 2018;28(1):73-82. doi:10.4314/ejhs.v28i1.9.
- Takuya S, Maske M, Brennan AT, Sanne I, MacPhail AP, Fox MP. Anemia among HIV-infected patients initiating antiretroviral therapy in South Africa: improvement in hemoglobin regardless of degree of immunosuppression and the initiating ART regimen. *J Trop Med*. 2013;2013:1-6. doi:10.1155/2013/162950.
- Leonardo Calza, Roberto Manfredi, Francesco Chiodo, Dyslipidemia associated with antiretroviral therapy in HIV-infected patients, *Journal of Antimicrobial Chemotherapy*, Volume 53, Issue 1, January 2004, Pages 10-14, <https://doi.org/10.1093/jac/dkh013>.
- Savès, M., Raffi, F., Capeau, J. et al. (2002). Factors related to lipodystrophy and metabolic alterations in patients with human immunodeficiency virus infection receiving highly active antiretroviral therapy. *Clinical Infectious Diseases* 34, 1396-405.
- Achila OO, Ahrhaley F, Kesete Y, Tesfaldet F, Alazar F, Fisschaye L, Gebremeskel L, Mehari R, Andemichael D. Dyslipidemia and associated risk factors among HIV/AIDS patients on HAART in Asmara, Eritrea. *PLoS One*. 2022 Jul 1;17(7):e0270838. doi: 10.1371/journal.pone.0270838. PMID: 35776747; PMCID: PMC9249179.