Trends & predictors of non-AIDS comorbidities among people living with HIV and receiving antiretroviral therapy in Lebanon

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Abstract
Combined antiretroviral therapy (cART) increased the life expectancy of people living with Human Immunodeficiency Virus (HIV) (PLHIV) and remarkably reduced the morbidity and mortality associated with HIV infection. Consequently, PLHIV are experiencing non-acquired immunodeficiency syndrome (AIDS) associated comorbid conditions including diabetes, hyperlipidemia, hypertension, and cardiovascular disease. The aim of this study is to determine the frequency of non-AIDS associated comorbid conditions among a cohort of PLHIV on cART in Lebanon.

Data were collected between November 2018 and December 2019 from 105 voluntary participants. A standardized questionnaire was used to collect demographic and behavioral data including lifestyle, smoking, physical activity, substance use and abuse in addition to co-infections and family history of non-communicable diseases. Moreover, data on occurrence and treatment of cardiovascular disease, hypertension, diabetes, lipid and metabolic disorders as well as mental health were collected. Blood samples were used to assess the levels of fasting blood sugar (FBS), glycosylated hemoglobin (HbA1C), triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol, and serum creatinine.

Hypertension (29.5%) and hyperlipidemia (29.5%) followed by diabetes (23.7%) and cardiovascular disease (9.7%) were mainly reported among study participants. Higher rate of comorbid conditions was observed among participants >40 years of age than those ≤40 years with both hypertension and hyperlipidemia most commonly reported. Older age (odds ratio [OR] 7.6; 95% CI: 1.83-31.98; \(P = .005\)) is associated with higher odds of having hyperlipidemia. Moreover, participants on cART for ≥10 years are 5 times more likely to have hyperlipidemia (OR 5; 95% CI: 1.08-22.73; \(P = .039\)). Our results also showed that study participants did not experience anxiety, depression or somatic symptoms and that there was no association between these mental disorders and older age or comorbidities.

Our results provide important information on HIV trends and associated comorbidities in Lebanon and can be used to improve the management of non-communicable diseases among PLHIV.

Abbreviations: AIDS = acquired immunodeficiency syndrome, cART = combined antiretroviral therapy, CVD = cardiovascular disease, FBS = fasting blood sugar, FET = Fisher exact test, HbA1C = glycosylated hemoglobin, HDL = high density lipoprotein, HIV = Human Immunodeficiency Virus, LDL = low density lipoprotein, OR = odds ratio, PLHIV = people living with HIV, TG = triglycerides.

Keywords: aging, comorbidity, HAART, HIV, Lebanon

1. Introduction
The use of combined antiretroviral therapy (cART) significantly reduced the morbidity and mortality associated with Human Immunodeficiency Virus (HIV) infection. The former contributed to an increase in the life expectancy of people living with HIV (PLHIV) approaching that of HIV-negative individuals. Globally, the proportion of people aging with HIV is increasing and is estimated to reach 21% by 2020. While new cases of
PLHIV above 50 years of age are declining, the Centers for Disease Control and Prevention recently reported 1 in 6 HIV diagnoses in this group; moreover, almost 50% of PLHIV are 50 years of age and older. The age of the majority of PLHIV globally is projected to be under the age of 55 years in 2050 compared to <35 years in 2010. Specifically, the number of adolescent and young people living with HIV (15-24 years) is projected to decline by 61% between 2010 and 2050. These data suggest a dramatic demographic shift among PLHIV.

With the success of cART, the rate of non-acquired immunodeficiency syndrome (AIDS) comorbidities are increasing in treated PLHIV leading to an increased number of deaths exceeding those of AIDS-related deaths. These comorbidities include cardiovascular disease (CVD), liver disease, renal disease, diabetes, neurocognitive abnormalities, as well as non-AIDS defining malignancies. While biological aging among HIV-infected individuals is believed to start earlier compared to healthy subjects (55 vs 65 years, respectively), the impact of aging with HIV infection and subsequent pathways leading to disease manifestation is not fully understood. A number of parallels have been advanced to explain the relationship between HIV and aging. HIV-associated immune activation, host-genetic factors, behavioral factors (i.e., diet, exercise, and smoking) and drug-to-drug interactions in combination with cART have been suggested to cause these metabolic perturbations.

The HIV and Aging Consensus Project recommended screening HIV-infected individuals for diabetes, kidney functions, hypertension as well as cognitive impairment and depressive disorders. In addition, assessment of the Framingham Risk Score was also recommended along with cholesterol and blood pressure. A projected increased life-expectancy coupled with an expected increase in burden of non-communicable diseases would impact HIV management, treatment and control. With the absence of a chronic care model especially in limited resource countries, these non-AIDS morbidities pose a major risk on treated HIV-infected people progressing into an older population.

Globally, the number of PLHIV is at 38 million with 67% on antiretroviral therapy. The majority of new HIV infections reported in 2019 were among key populations (men having sex with men, sex workers, people who inject drugs, prisoners, transgenders) and their sexual partners. By the end of 2019, the UNAIDS estimated a cumulative number of 2700 PLHIV in Lebanon (2300 males and 500 females) with 63% on antiretroviral therapy. While Lebanon is considered a low HIV prevalence country (less than 0.1% of the total population), the rate of HIV infection is increasing yearly by an average of 100 new cases. Recent evidence clearly defines pockets of concentrated HIV epidemic and a high epidemic potential in Lebanon. The majority of PLHIV in Lebanon are ≥30 years old with more than 46% being 30 to 49 years old in 2017 compared to 31% in 2012. The paucity of data on PLHIV in Lebanon, especially among key populations, is a major challenge that hinders the comprehensive understanding of HIV trends and associated comorbidities. Currently, data are limited on the comorbidity profiles associated with people living and aging with HIV in the developing world in general, the Eastern Mediterranean region and Lebanon specifically. The aim of this study is to determine the trends and predictors of non-AIDS comorbid conditions among treated people living and aging with HIV in Lebanon and to assess the association between these predictors and comorbid conditions.

2. Methods

2.1. Study design, population, and data collection

Human subject approval was obtained for this cross-sectional study from the institutional review board (IRB) of the American University of Beirut (AUB) and the Lebanese American University (LAU). All voluntary participants provided a written informed consent. A standardized questionnaire was administered to a total of 105 treated adult HIV-infected individuals between November 2018 and December 2019. Demographic and behavioral data including lifestyle, smoking, physical activity, substance use and abuse, co-infections, chronic diseases (cardiovascular disease, hypertension, diabetes, lipid and metabolic disorders, cancer, mental health and others), first-degree family history (i.e. parents or siblings) of chronic diseases, co-medication data and mental health data were collected. Physical activity was classified as vigorous-intensity (carrying or lifting heavy loads, running, playing football and others) or moderate-intensity (swimming, playing volleyball and others) activity for at least 10 minutes continuously.

A one time blood draw was collected from 104 voluntary participants to measure the following clinical parameters: fasting blood sugar (FBS), glycosylated hemoglobin (HbA1C), cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), triglycerides (TG) and creatinine.

2.2. Measurement of anxiety, depression, and clinical parameters

We used the 9 item Patient Health Questionnaire (PHQ-9) to assess depression among our study participants as previously described. The response was rated as “0” (not at all), “1” (several days), “2” (more than half the days) or “3” (nearly every day). The severity of depressive symptoms was determined based on the summation of the scores ranging between 0 and 27. Scores of 5 to 9 points indicate mild levels of depressive symptoms, 10 to 14 points indicate moderate levels of depressive symptoms, 15 to 19 points indicate moderately severe levels of depressive symptoms, and 20 to 27 points indicate severe levels of depressive symptoms. 15 item Patient Health Questionnaire (PHQ-15), the somatic symptom module of 9 item Patient Health Questionnaire, was rated as “0” (not bothered at all), “1” (bothered a little), or “2” (bothered a lot). Similarly, the severity of somatization symptoms was determined based on the summation of the scores (0-30). Scores of 0 to 4, 5 to 9, 10 to 14 and ≥15 points indicate no somatization disorder, mild levels of somatization, moderate levels of somatization and severe levels of somatization, respectively. Similarly, the Generalized Anxiety Disorder-7 (GAD-7) item Assessment was used to measure symptoms of generalized anxiety. Briefly, the scale of GAD-7 item Assessment was rated from “0” (not at all) to “3” (nearly every day). The severity of anxiety was determined based on the summation of the scores (0 to 21). Scores of 0 to 4, 5 to 9, 10 to 14 and ≥14 points indicate no anxiety, mild anxiety, moderate anxiety, and severe anxiety, respectively.

The guidelines of the American Diabetes Association were used to classify the tested levels of FBS and HbA1C. The
reference range of clinical parameters were as follows: normal FBS level, <100 mg/dl; prediabetes FBS level, ≥100–<126 mg/dl; diabetes FBS level, ≥126 mg/dl; HbA1C levels <5.7%, between 5.7% and 6.4% and ≥6.5% were defined as normal, prediabetic and diabetic, respectively. Moreover, we followed the guidelines of the Centers for Disease Control and Prevention to report on total cholesterol, LDL, HDL and triglycerides (TG) with normal values of: <200 mg/dl, <100 mg/dl, ≥60 mg/dl, and <150 mg/dl, respectively.[36] Furthermore, normal serum creatinine levels were defined as 0.6 to 1.1 mg/dl in women and 0.7 to 1.3 mg/dl in men.

2.3. Statistical analysis

Data were summarized descriptively using counts and frequencies for categorical variables and mean, standard deviation and range for continuous variables. We examined the relationship between age, sex and risk factors of interest and non-AIDS associated comorbid conditions using $\chi^2$ and Fisher exact test (FET). When appropriate, we used the $t$ test to compare the levels of the clinical parameters among the study participants. Variables with $P$ values less than .2 using the univariate regression model were eligible for entering analysis using the multivariate regression model. Diabetes and CVD were considered rare events since they constitute less than 20% of our sample size. Consequently, we used exact logistic regression for rare events to test for any association between the participants’ risk factors and the aforementioned outcomes. These analyses were performed using STATA SE 13.0 (StataCorp LP, TX, USA).

3. Results

3.1. Sociodemographic, life style, behavioral, and clinical characteristics of the study participants

The majority of the study participants were >40 years old (68.5%) (mean age 48.14 ± 10.83 years), males (83%), and employed (59%). More than 50% of our cohort were heterosexuals and 33% were men having sex with men (Table 1). Our data showed that more than 57% of participants were smokers (cigarettes hookah, and/or e-cigarettes); we did not detect any significant difference between males and females (Table 1). Albeit less common than smoking, alcohol use was significantly higher among males ($P = .046$); moreover the use of recreational drugs (e.g., ecstasy, amphetamines, marijuana, cocaine heroin, and others) was reported by only males ($P = .039$). Marijuana/weed and cocaine were the most commonly used drugs (77% vs 47%); only 2 participants were injecting drug users (data not shown).

| Table 1 |
| --- |
| **Demographic and clinical characteristics of study participants.** |
|  |
| Males n (%) | Females n (%) | Total n (%) | $P$ value$^1$ |
| --- | --- | --- | --- |
| **Age in years (N=105)** | | | .041 |
| ≤40 | 31 (35.6) | 2 (11.1) | 33 (31.4) |
| >40 | 56 (64.4) | 16 (88.9) | 72 (68.6) |
| **Sexual history (N=101)** | | | .001 |
| Heterosexual | 37 (44) | 17 (100) | 54 (53.4) |
| MSM | 33 (39.3) | 0 (0) | 33 (32.7) |
| Bisexual | 14 (16.7) | 0 (0) | 14 (13.9) |
| **Tobacco use**$^*$ (N=105) | | | .062 |
| 50 (57.5) | 10 (55.6) | 60 (57.1) |
| **Alcohol use (N=104)** | | | .881 |
| 18 (20.7) | 2 (11.1) | 20 (19.2) |
| **Recreational drug use (N=104)** | | | .046 |
| 18 (20.7) | 0 (0) | 18 (17.3) |
| **Body weight consideration (N=105)** | | | .551 |
| Underweight | 10 (11.5) | 1 (5.6) | 11 (10.4) |
| Normal/healthy weight | 57 (65.5) | 11 (61.1) | 68 (64.8) |
| Overweight | 20 (23) | 6 (33.3) | 26 (24.8) |
| **Vitamins/supplements intake (N=104)** | | | .074 |
| 31 (35.8) | 10 (58.8) | 41 (39.4) |
| **Duration of HIV infection (N=103)** | | | .456 |
| <5 yrs ago | 9 (10.6) | 0 (0) | 9 (8.7) |
| 5-10 yrs ago | 34 (40) | 6 (33.3) | 40 (38.8) |
| >10 yrs ago | 42 (49.4) | 12 (66.7) | 54 (52.5) |
| **Duration of cART (N=105)** | | | .232 |
| ≤5 yrs ago | 14 (16.1) | 2 (11.1) | 16 (15.2) |
| 5-10 yrs ago | 36 (41.4) | 6 (33.3) | 42 (40) |
| >10 yrs ago | 37 (42.5) | 10 (55.6) | 47 (44.8) |
| **cART regimen (N=102)** | | | .775 |
| NRTI + NNRTI | 40 (47.1) | 7 (41.2) | 47 (46.1) |
| NRTI + INSTI | 39 (45.9) | 8 (47.1) | 47 (46.1) |
| Others (PI + NRTI and/or NNRTI) | 6 (7) | 2 (11.1) | 8 (7.8) |

$^*$ Tobacco use includes participants who smoke cigarettes, e-cigarettes and/or hookah; Vitamins/supplements include vitamin B, C, D, folic acid, omega 3, calcium, magnesium, and glucosamine.

$^1$ Pearson chi-square test.
When asked about diet, type and diversity (fruits, vegetables, and type of fatty acids) as well as frequency of meals (breakfast, lunch, and dinner), our study participants reported balanced and healthy diets with no significant difference between males and females (data not shown). Interestingly, participants were generally not physically active.

Unprotected sex was the main mode of HIV transmission in our group with no significant difference between males and females. Importantly, more than 50% contracted HIV more than 10 years ago. Similarly, the majority of participants (45%) were on cART for more than 10 years. All participants were adherent to cART (i.e., never stopped taking ART). The most frequently used cART regimens among participants were a combination of nucleoside/nucleotide reverse-transcriptase inhibitors (NRTIs) and non-nucleoside reverse-transcriptase inhibitors (NNRTIs) or a combination of NRTIs and integrase inhibitors (INSTIs). Only 8 participants were using other cART combinations, half of them were on a drug regimen containing a protease inhibitor (PI). The vast majority of participants (87%) received cART free of charge through the Lebanese National AIDS Program (data not shown). Our data reveal that co-infections, specifically sexually transmitted infections, were most prevalent among men having sex with men (data not shown).

### 3.2. Frequency of non-AIDS comorbidities among study participants

We measured the levels of FBS, HbA1C, lipid profile (cholesterol, LDL, HDL, and TG) and creatinine and compared these levels between participants ≤40 years and those >40 years (data not shown). While this was a cross-sectional assessment, these clinical parameters are important risk factors of high blood pressure, diabetes, and hyperlipidemia.[35,36] The mean levels of FBS, cholesterol, LDL, and TG were above normal in our cohort. The mean levels of FBS and TG were significantly higher among males >40 years and those ≤40 years (FET, \( P < .05 \)). Our data showed that the frequency of comorbid conditions was significantly higher among males >40 years than males ≤40 years (FET, \( P = .038 \)) (data not shown). Moreover, being on cART for more than 10 years was significantly associated with the frequency of these comorbid conditions among both males (FET, \( P = .008 \)) and females (FET, \( P = .01 \)) (data not shown). Hypertension (29.5%) and hyperlipidemia (29.5%) followed by diabetes (23.7%) and CVD (9.7%) were mainly reported among our study participants with no significant difference between males and females (Table 2). Following the above trend, anti-hypertensives and lipid-lowering agents were the most commonly used non-cART medications. When we compared the relationship between family history and having diabetes, hypertension, hyperlipidemia or CVD among all participants, we did not detect any significant difference (Table 2). However, when we compared the association between family history and the conditions above among PLHIV suffering from these conditions, we only detected a significant difference among those with hypertension (FET, \( P = .015 \)) (data not shown).

Nineteen percent of our participants >40 years old reported 1 or 2 comorbid conditions each followed by approximately 10% and 3% suffering from 3 and 4, respectively. As expected, PLHIV less than 40 years old suffered from less disease conditions whereby 15% suffered from 1 comorbidity with 3% living with 2 and 3 comorbid conditions, each (FET, \( P = .03 \)) (Fig. 1). Collectively, our results showed that the frequency of comorbid conditions increases with age among PLHIV; with hyperlipidemia and hypertension being most commonly observed among our cohort. When we grouped our participants into 3 age groups: 25 to 44 (n = 42), 45 to 59 (n = 44) and ≥60 (n = 19) years, we found that the majority of participants in the 25 to 44 age group (14.3%) and 45 to 59 age group (22.7%) have 1 comorbidity. On the other hand, 36.8% of participants in the ≥60 age group have 2 comorbid conditions (FET, \( P = .006 \)) (data not shown).

We then sought to determine the relationship between hyperlipidemia and hypertension and age while adjusting for confounders specifically family history of comorbid conditions and smoking. Our results showed that the odds ratio (OR) of

### Table 2

| Comorbidities          | Males n (%) | Females n (%) | Total n (%) | \( P \) value |
|------------------------|-------------|---------------|-------------|--------------|
| **Non-AIDS comorbidities and treatment.** |             |               |             |              |
| Hypertension           | 23 (26.4)   | 8 (44.4)      | 31 (29.5)   | .283         |
| Hyperlipidemia         | 22 (25.3)   | 9 (50)        | 31 (29.5)   | .069         |
| Diabetes               | 8 (9.2)     | 1 (5.6)       | 9 (8.6)     | .209         |
| CVD                    | 7 (8.1)     | 3 (16.7)      | 10 (9.3)    | .571         |
| **Family history**     |             |               |             |              |
| Hypertension           | 42 (48.3)   | 6 (33.3)      | 48 (45.7)   | .304         |
| Hyperlipidemia         | 5 (5.6)     | 3 (16.7)      | 8 (7.6)     | .302         |
| Diabetes               | 26 (29.9)   | 6 (33.3)      | 32 (30.5)   | .783         |
| CVD                    | 41 (47.1)   | 6 (33.3)      | 47 (44.8)   | .426         |
| **Non-cART medications** |             |               |             |              |
| Anti-hypertensives     | 23 (26.4)   | 8 (44.4)      | 31 (29.5)   | .158         |
| Lipid-lowering agents  | 22 (25.3)   | 9 (50)        | 31 (29.5)   | .048         |
| Hypoglycemic agents    | 9 (100)     | 0 (0)         | 9 (8.6)     | .1           |

cART = combined antiretroviral therapy, CVD = cardiovascular disease.

* Fisher exact test.
having hyperlipidemia among participants aged >40 years was significantly higher than those ≤40 years. We then determined the relationship between these comorbidities (hyperlipidemia and hypertension) and duration of HIV infection and cART treatment while adjusting for age, family history of the comorbid condition and smoking. Our results showed that participants who have been on cART for more than 10 years were 5 times more likely to have hyperlipidemia (OR 5; 95% CI: 1.08-22.7; \( P = .039 \)) and hypertension (OR 5.2; 95% CI: 0.98-28.15; \( P = .052 \)) (Table 3). Multivariate analyses, while adjusting for family history of diabetes, smoking and alcohol use, revealed a significantly increased odd of diabetes with longer duration of treatment (OR 5; 95% CI: 1.07-47.93; \( P = .0374 \)) (data not shown). When we added age as a confounding factor, the OR decreased to 2.3 with no significant difference observed between diabetes and prolonged duration of cART treatment (OR 2.3; 95% CI: 0.61-23.57; \( P = .248 \)) (data not shown). These results suggest that people aging with HIV are more likely to develop hyperlipidemia. Our results also suggest that prolonged duration of cART (i.e., >10 years) is associated with hyperlipidemia and hypertension. Our results are to be cautiously interpreted due to the small sample size.

3.3. The prevalence of anxiety, depression, and somatization among study participants

PLHIV are 2 to 3 times more likely to experience mental health disorders such as depression and anxiety compared to HIV-naïve individuals.\(^{131,37,38}\) Interestingly, our data showed that more than 80% of our participants did not experience anxiety, depression or somatic symptoms. These results were similar among those less than 40 and older as well as among males and females. Moreover, we did not detect any association between anxiety \((P = .891)\), depression \((P = .113)\) or somatic symptoms

![Figure 1. Frequency of comorbidities by age among PLHIV. The figure presents the percentages of participants ≤40 and >40 yrs old with no comorbidity, a single comorbidity or multimorbidity. \( P \) value <.05 was considered statistically significant. FET = Fisher exact test, PLHIV= people living with Human Immunodeficiency Virus.](image)

| Table 3 | Odds ratio of comorbidities with respect to age, sex, duration of HIV infection, and duration of cART treatment. |
|---------|---------------------------------------------------------------------------------------------------------------|
|         | Hyperlipidemia                                                                                                  | Hypertension                                                                 |
| <40 yrs (Reference) | OR (95% CI) = 1.83-31.98; \( P = .005 \)                                                                 | OR (95% CI) = 2.2 (0.59-7.86); \( P = .242 \)                                |
| >40 yrs | 7.6 (1.83-31.98)                                                                                               | 2.2 (0.59-7.86)                                                               |
| Female (Reference)‡ | 0.4 (0.11-1.63)                                                                                               | 0.3 (0.07-1.43)                                                               |
| Male |                                                                                                               | 0.3 (0.07-1.43)                                                               |
| Duration of HIV infection† | 1.05 (0.09-12.82)                                                                                               | 1.3 (0.08-18.39)                                                             |
| <5 yrs ago (reference) | 8.13 (0.82-80.22)                                                                                              | 5.2 (0.37-72.55)                                                             |
| 5-10 yrs ago | 0.9 (0.18-5.03)                                                                                               | 1.3 (0.08-18.39)                                                             |
| >10 yrs ago | 5 (1.08-22.73)                                                                                                 | 5.3 (0.98-28.15)                                                             |

Variables with \( P \) values less than .2 using the univariate regression model were eligible for entering analysis using the multivariate regression model. 
95% CI = 95% confidence interval, cART = combined antiretroviral therapy, HIV = Human Immunodeficiency Virus, OR = odds ratio.

‡ Adjusted for family history of comorbid condition and smoking.

† Adjusted for age, family history of comorbid condition, and smoking.
count (>50 years), our data revealed a significant association between cART duration and development of non-AIDS associated comorbidities (CVD, Hypertension, Diabetes, Bone Fractures, and Renal Failure).

Moreover, alcohol use among PLHIV was associated with risky behaviors including unprotected sex. Higher frequency of mental health disorders including generalized anxiety, depression and somatization symptoms was also reported among PLHIV compared to healthy controls. Our study is a cross-sectional study without historic clinical and medical data to assess the evolution of comorbid conditions and pertinent risk factors across time. More than 50% and less than 20% of our enrolled participants were smokers and reported drug and alcohol use, respectively. In contrast to the previously published data, our study did not suggest any association between age and comorbidities and mental health disorders. Our results are to be cautiously interpreted due to the small sample size and the lack of a healthy HIV-naïve control group along with data on risk factors associated with metabolic disorders.

Our study has several limitations. Our study lacks a control group of HIV-negative individuals; thus, we were unable to compare the frequencies of comorbid conditions between our cohort and HIV-naïve individuals. However, limited data exist on the prevalence of metabolic disorders in Lebanon. Recently, hypertension was reported at 31% in a cross-sectional study; moreover, the prevalence of hypertension increased with increasing age and body mass index, and in the presence of previous CVD. A national study also reported the prevalence of type I diabetes mellitus was estimated at 0.1%, or almost 1% of all detected cases of diabetes mellitus in Lebanon. Our study is a cross-sectional study without historic clinical and medical data to assess the evolution of comorbid conditions and pertinent risk factors across time.

5. Conclusion

Further studies are needed to investigate the impact of aging on the prevalence of non-AIDS related comorbid conditions in PLHIV. These studies are important for the proper management and care of comorbid conditions among PLHIV in Lebanon. The integration of HIV programs with non-communicable diseases programs is necessary to reduce the burden of multi-morbidities among people living and aging with HIV.

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References

[1] Yoshimura K. Current status of HIV/AIDS in the ART era. J Infect Chemother 2017;23:12–6.
[2] Brooks JT, Buchacz K, Gebo KA, Mermin J. HIV infection and older Americans: the public health perspective. Am J Public Health 2012;102:1516–26.
[3] Kaplan-Lewis E, Aberg JA, Lee M. Aging with HIV in the ART Era. Semin Diagn Pathol 2017;34:384–97.
[4] Nakagawa F, May M, Phillips A. Life expectancy living with HIV: recent estimates and future implications. Curr Opin Infect Dis 2013;26:17–25.
[5] Autenrieth CS, Beck EJ, Stelzl D, Mallouris C, Mahy M, Ghyss P. Global and regional trends of people with HIV aged 50 and over: estimates and projections for 2000–2020. PLoS One 2018;13:e0207005–1207005.
[6] CDC. HIV and Older Americans. 2019. Available at: https://www.cdc.gov/hiv/group/age/olderamericans/index.html. Accessed June 26, 2020.
[7] Khalifa A, Stover J, Mahy M, Idele P, Lwamba C. Demographic change and HIV epidemic projections to 2030 for adolescents and young people aged 15-24. Glob Health Action 2019;12:1662685–1662685.
[8] Escota GV, O’Halloran JA, Powderly WG, Presti RM. Understanding mechanisms to promote successful aging in persons living with HIV. Int J Infect Dis 2018;66:56–64.
[9] Longnecker CT, Sullivan C, Baker JV. Immune activation and cardiovascular disease in chronic HIV infection. Curr Opin HIV AIDS 2016;11:216–25.
[10] Schouten J, Wit FW, Stolte JG, et al. Cross-sectional comparison of the prevalence of age-associated comorbidities and their risk factors between HIV-infected and uninfected individuals: the AGElHIV cohort study. Clin Infect Dis 2014;59:1787–97.
[11] Rockstroh JK, Mohr R, Behrens G, Spengler U. Human immunodeficiency virus and liver disease: an update. Hepatology 2015;62:1871–82.
[12] Torres TS, Cardoso SW, Velasque L, et al. Aging with HIV: an overview of an urban cohort in Rio de Janeiro (Brazil) across decades of life. Braz J Infect Dis 2013;17:324–31.
[13] Rosenthal J, Tyor W. Aging, comorbidities, and the importance of finding biomarkers for HIV-associated neurocognitive disorders. J Neurovirol 2019;25:673–85.
[14] Spudich SS. Immune activation in the central nervous system throughout the course of HIV infection. Curr Opin HIV AIDS 2016;11:226–33.
[15] Deeks SG, Lewin SR, Havlir DV. The end of AIDS: HIV infection as a chronic disease. Lancet 2013;382:1525–33.
[16] Mpondi BC. HIV infection in the elderly: arising challenges. J Aging Res 2020;2020:1240487.
[17] Fitch K, Feldpausch MN, Looby SE. Biomarkers and clinical indices of aging with HIV. Interdiscip Top Gerontol Geriatr 2017;42:47–58.
[18] Abou Hassan F, Bou Hamdan M, Melhem NM. The role of natural killer cells and regulatory T cells while aging with human immunodeficiency virus. AIDS Res Hum Retroviruses 2019;35:1123–35.
[19] Willig AL, Overton ET. Metabolic complications and glucose metabolism in HIV infection: a review of the evidence. Curr HIV/AIDS Rep 2016;13:289–96.
[20] Work Group for HIV Aging Consensus Panel. Summary report from the Human Immunodeficiency Virus and Aging Consensus Project: treatment strategies for clinicians managing older individuals with the human immunodeficiency virus. J Am Geriatr Soc 2012;60:974–9.
[21] UNAIDS 2020. Executive Summary: Seizing the Moment. Available at: https://www.unaids.org/sites/default/files/media_asset/2020-global-aids-report_executive-summary_en.pdf. Accessed June 26, 2020.
[22] UNAIDS 2020. UNAIDS Data 2020. Available at: https://www.unaids.org/sites/default/files/media_asset/2020-aids-data-book_en.pdf. Accessed June 26, 2020.
[23] Melhem NM, Rahhal N, Charide R, Kreidieh K, El-Khatib R. Human immunodeficiency virus and viral hepatitis among high-risk groups: understanding the knowledge gap in the Middle East and North Africa Region. World J Hepatol 2015;7:2169–30.
[24] Ministry of Public Health (MoPH) (2017). Epidemiology World AIDS Day 2017. Available at: https://www.moph.gov.lb/en/Pages/2/4000/aids. Accessed January 23, 2021.
[25] Chibanda D, Cowan F, Gibbon L, Weiss HA, Lund C. Prevalence and correlates of probable common mental disorders in a population with high prevalence of HIV in Zimbabwe. BMC Psychiatry 2016;16:55–155.
[26] Cramer PK, Gibbons LE, Willing JH, et al. Measuring depression levels in HIV-infected patients as part of routine clinical care using the nine-item Patient Health Questionnaire (PHQ-9). AIDS care 2010;22:874–85.
[27] Monahan PO, Shacham E, Reece M, et al. Validity/reliability of PHQ-9 and PHQ-2 depression scales among adults living with HIV/AIDS in western Kenya. J Gen Intern Med 2009;24:189–97.
[28] Rane MS, Hong T, Gove S, et al. Depression and anxiety as risk factors for delayed care-seeking behavior in human immunodeficiency virus-infected individuals in South Africa. Clin Infect Dis 2018;67:1411–8.
[29] Tuthill EL, Pellowski JA, Young SL, Butler LM. Perinatal depression among HIV-infected women in KwaZulu-Natal South Africa: prenatal depression predicts lower rates of exclusive breastfeeding. AIDS Behav 2017;21:1691–48.
[30] Nyongesa MK, Mwangi W, Wanjala SW, Mutua AM, Newton CRJC, Abubakar A. Prevalence and correlates of depressive symptoms among adults living with HIV in rural Kilifi, Kenya. BMC Psychiatry 2019;19:333–1333.
[31] Garrusi D, Danaei M, Abooaesir D. The prevalence and predictive factors of somatization and its relationship with anxiety and depression in Iran: Med Popul Stud 2016;50:94–40.
[32] Hinz A, Ernst J, Glaesmer H, et al. Frequency of somatic symptoms in the general population: normative values for the Patient Health Questionnaire-15 (PHQ-15). J Psychosom Res 2017;96:27–31.
[33] Hinz A, Klein AM, Braehler E, et al. Psychometric evaluation of the Generalized Anxiety Disorder Screener GAD-7, based on a large German general population sample. J Affect Disord 2017;210:338–44.
[34] American Diabetes Association (2020). Diabetes Diagnosis. Available at: https://www.diabetes.org/1a1/diagnosis. Accessed: November 10, 2020.
[35] Centers for Disease Control and Prevention (CDC) (2020). Getting Your Cholesterol Checked. Available at: https://www.cdc.gov/cholest erol/cholesterol_screening.htm. Accessed: November 10, 2020.
[36] Bernard C, Dabis F, de Rekeneire N. Prevalence and factors associated with depression in people living with HIV in sub-Saharan Africa: a systematic review and meta-analysis. PLoS One 2017;12:e0181960
[37] Ciesla JA, Roberts JE. Meta-analysis of the relationship between HIV and depression predicts lower rates of exclusive breastfeeding. AIDS Behav 2017;21:1691–48.
[38] American Diabetes Association (2020). Diabetes Diagnosis. Available at: https://www.diabetes.org/1a1/diagnosis. Accessed: November 10, 2020.
[39] Centers for Disease Control and Prevention (CDC) (2020). Getting Your Cholesterol Checked. Available at: https://www.cdc.gov/cholesterol/cholesterol_screening.htm. Accessed: November 10, 2020.
[43] Bigna JJ, Ndoadoumgue AL, Nansseu JR, et al. Global burden of hypertension among people living with HIV in the era of increased life expectancy: a systematic review and meta-analysis. J Hypertens 2020;38:1659–68.

[44] Castilho JL, Escuder MM, Veloso V, et al. Trends and predictors of non-communicable disease multimorbidity among adults living with HIV and receiving antiretroviral therapy in Brazil. J Int AIDS Soc 2019;22:e25233–125233.

[45] da Cunha GH, Franco KB, Galvão MTG, et al. Diabetes mellitus in people living with HIV/AIDS: prevalence and associated risk factors. AIDS Care 2020;32:600–7.

[46] Fan H, Guo F, Hsieh E, et al. Incidence of hypertension among persons living with HIV in China: a multicenter cohort study. BMC public health 2020;20:1–11.

[47] Masenga SK, Elijovich F, Koethe JR, et al. Hypertension and metabolic syndrome in persons with HIV. Curr Hypertens Rep 2020;22:1–8.

[48] Wong C, Gange SJ, Moore RD, et al. Multimorbidity among persons living with human immunodeficiency virus in the United States. Clin Infect Dis 2018;66:1230–8.

[49] Rogalska-Plotiska M, Grzeszczyk A, Rogalski P, Łuczajko M, Flisiak R. Metabolic syndrome in HIV infected adults in Poland. Kardiol Pol 2018;76:548–53.

[50] Wu P-Y, Chen M-Y, Hsieh S-M, et al. Comorbidities among the HIV-Infected Patients aged 40 years or older in Taiwan. PLoS One 2014;9:e104945.

[51] Gleason LJ, Luque AE, Shah K. Polypharmacy in the HIV-infected older adult population. Clin Interv Aging 2013;8:749–63.

[52] Chen R, Chen J, Tang Q, et al. Use of comediations and potential drug-drug interactions in people living with HIV in China. J Infect Chemother 2020;26:722–8.

[53] Fuster-RuizdeApodaca MJ, Castro-Granell V, Garin N, et al. Prevalence and patterns of illicit drug use in people living with HIV in Spain: a cross-sectional study. PLoS One 2019;14:e0211252–1211252.

[54] Giles ML, Gartner C, Boyd MA. Smoking and HIV: what are the risks and what harm reduction strategies do we have at our disposal? AIDS Res Ther 2018;15:26–126.

[55] Scott-Sheldon LAJ, Walstrom P, Carey KB, Johnson BT, Carey MP, Team MR. Alcohol use and sexual risk behaviors among individuals infected with HIV: a systematic review and meta-analysis 2012 to early 2013. Curr HIV/AIDS Rep 2013;10:314–23.

[56] Remien RH, Stitzert MJ, Nguyen N, Robbins RN, Pala AN, Mellins CA. Mental health and HIV/AIDS: the need for an integrated response. AIDS 2019;33:1411–20.

[57] Cherfan M, Blacher J, Asmar R, et al. Prevalence and risk factors of hypertension: a nationwide cross-sectional study in Lebanon. J Clin Hypertens (Greenwich) 2018;20:867–79.

[58] Bou-Orm I, Adib S. Prevalence and clinical characteristics of diabetes mellitus in Lebanon: a national survey. East Mediterr Health J 2020;26:182–8.