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ORIGINAL ARTICLE

Multidimensional Assessment of Aging with HIV in Algeria: Frailty, Cognitive Decline, and Comorbidity in a Cohort of Adults Aged 50 and Over

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ABSTRACT

Background: As antiretroviral therapy (ART) prolongs life expectancy, aging with HIV is no longer exceptional but increasingly prevalent. However, in resource-limited settings, particularly in North Africa, the multidimensional vulnerability of older people living with HIV (PLWH) remains poorly characterized. This study aimed to assess frailty, comorbidities, cognitive impairment, and overall clinical complexity among aging PLWH in Algeria using standardized geriatric and HIV-specific indicators. **Methods**: We conducted a retrospective cross-sectional study of 436 PLWH aged ≥50 years, followed between 2005 and 2025 at the University Hospital of Sétif, Algeria. Clinical and laboratory data were extracted to evaluate four validated scores: the Fried frailty phenotype, Mini-Mental State Examination (MMSE), Charlson Comorbidity Index (CCI), and a simplified version of the Veterans Aging Cohort Study (VACS) Index. Analyses included descriptive statistics and cross-tabulations using SPSS® and Excel®. **Results:** The mean age was 62.6 ± 6.2 years, with 65.6% being male. Frailty affected 25% of participants, while 41% were pre-frail. Cognitive impairment (MMSE <24) was observed in 21.8%, and 43.8% had a CCI ≥5. The mean VACS Index was 23.4, with 39% of patients having a score greater than 20, indicating an increased mortality risk. Hypertension (55%), type 2 diabetes (33%), dyslipidemia (31%), and thyroid disorders (24%) were the most common comorbidities. Chronic kidney disease affected 9%, and 2.8% had non-AIDS-defining cancers. Cross-score analysis revealed substantial overlap between frailty, cognitive impairment, and comorbid burden. **Conclusion:** These findings highlight the need for geriatric-focused care models and ART optimization tailored to aging PLWH in low- and middle-income settings.

Keywords: HIV; Aging; Frailty; Comorbidity; Cognition Disorders; Charlson Comorbidity Index; Geriatric Assessment; Neurocognitive Disorders; Algeria, Africa.

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1. INTRODUCTION

Aging with HIV is no longer an exception, but a growing norm. Yet this process is accompanied by a particular form of frailty, subtle, diffuse, and often unspoken. It is a vulnerability that may elude immediate clinical recognition and which patients themselves struggle to identify. Today, however, we are equipped with tools to detect, measure, and anticipate it.

Positioned at the intersection of biological, psychological, and social dimensions, the frailty of older individuals living with HIV resists narrow definitions. It is not reducible to a single metric or cutoff, but rather emerges from an array of clinical signs and physiological imbalances that reflect diminished resilience in the face of stressors. It represents a precarious equilibrium between accumulated vulnerability and residual adaptive capacity.

To explore this complexity, we employed four validated clinical tools, each offering a specific and complementary insight into the global health status of aging people living with HIV. The Fried frailty phenotype evaluates physical frailty through five clinical criteria: unintentional weight loss, fatigue, reduced grip strength, slow gait speed, and low physical activity (1). The Mini-Mental State Examination (MMSE) assesses cognitive functions, including memory, attention, language, orientation, and calculation (2). The Veterans Aging Cohort Study (VACS) Index provides a composite risk score that incorporates both clinical and biological parameters (hemoglobin, creatinine, FIB-4, HIV viral load, and HCV coinfection) and has been validated specifically for individuals living with HIV (3).

Taken in isolation, no single score can offer a complete view. Used together, they map out a multidimensional portrait of each patient's functional status. These tools serve not as endpoints but as instruments for stratifying risk and identifying patients whose frailty may otherwise remain hidden. The Charlson Comorbidity Index (CCI), originally developed for hospitalized, HIV-negative patients(4), remains widely used in chronic disease populations. Though not HIV-specific, it quantifies the cumulative burden of chronic diseases that frequently result from prolonged exposure to medical care. Its use alongside the VACS Index in our study enhances the precision of global risk estimation in aging PLWH.

Ultimately, this multidimensional approach helps render visible the invisible. It provides an objective framework for identifying medical, functional, and cognitive vulnerability elements that, if left undetected, may lead silently to loss of autonomy and diminished quality of life.

2. METHODS

Study Design

This was a retrospective, observational, descriptive study based on clinical and laboratory data collected during routine follow-up visits between March 2024 and March 2025. No direct intervention or prospective follow-up was conducted. Data were extracted from medical records of patients followed between January 2005 and March 2025 at the HIV/STI reference center within the infectious diseases department of Sétif University Hospital, Algeria, both in outpatient and inpatient settings.

Study Population: Eligible participants were adults aged 50 years or older at the time of their most recent documented medical visit between March 2024 and March 2025.

Inclusion Criteria

Inclusion criteria were as follows: confirmed HIV infection, age ≥50 years in 2025, documented medical follow-up between 2005 and 2025, availability of data for at least three of the four target scores (Fried, MMSE, CCI, VACS), and initiation of antiretroviral therapy at least three months before the evaluation.

Exclusion Criteria

Exclusion criteria included incomplete data for the selected clinical scores, the presence of acute decompensation or an intercurrent illness within 30 days before evaluation, recent hospitalization or surgery within the past month, and being antiretroviral therapy (ART)-naïve at the time of assessment. These exclusions aimed to avoid confounding effects linked to unstable clinical or biological parameters such as high viral load, persistent immunodeficiency, or acute metabolic disturbances.

Four validated instruments were used to assess the clinical status of participants based on available clinical and laboratory data. The Fried frailty phenotype evaluates physical frailty through five criteria: unintentional weight loss, exhaustion, reduced grip strength, slow walking speed, and low physical activity. A cumulative score of three or more defines a frail status. The Mini-Mental State Examination (MMSE) is a widely used cognitive screening tool scored out of 30; scores below 24 suggest probable cognitive impairment. The Charlson Comorbidity Index (CCI) provides a weighted score based on the presence of chronic conditions, with scores ≥5 reflecting

a substantial comorbidity burden. Lastly, a simplified version of the Veterans Aging Cohort Study (VACS) Index was used to estimate biological risk. This composite score integrates age, hemoglobin concentration, serum creatinine, FIB-4 score (calculated as [age × AST] / [platelets × √ALT]), HIV viral load, and hepatitis C virus (HCV) co-infection. CD4 counts were excluded from the calculation due to frequent missing data. A VACS score >20 indicates an increased risk of morbidity and mortality. All scores were calculated individually using validated methods and interpreted as indicators of current clinical and functional status.

Data analysis was performed using Microsoft Excel® and IBM SPSS Statistics®. Quantitative variables were summarized using means, standard deviations, and medians, while qualitative variables were presented as absolute frequencies and percentages. Each of the four clinical scores, the Fried phenotype, MMSE, CCI, and VACS Index was dichotomized using established clinical thresholds: Fried score ≥3 indicating frailty, MMSE <24 indicating cognitive impairment, CCI ≥5 indicating high comorbidity, and VACS >20 indicating elevated biological risk.

Cross-tabulations were conducted between pairs of binary variables (Fried × CCI, Fried × MMSE, VACS × CCI) to explore associations between physical, cognitive, and biological vulnerabilities. In addition, results were stratified by sex and age groups (in five-year intervals) to identify potential demographic disparities. To evaluate statistical associations between frailty status (robust, pre-frail, and frail) and categorical variables such as sex, age group, CCI, and MMSE categories, chi-square tests were performed. Statistical significance was set at $p < 0.05$.

Ethical Considerations

The study protocol complied with the ethical principles outlined in the Declaration of Helsinki. All data were fully anonymized before analysis to ensure the confidentiality and privacy of participants.

3. RESULTS

The study included 436 people living with HIV (PLHIV), aged 50 years and older as of January 1st, 2025. The population was predominantly male, with 286 men (65.6%) and 150 women (34.4%). The mean age was 62.6 ± 6.2 years, ranging from 50 to 94 years. The most represented age groups were patients older than 65 years (31.9%) and those between 50 and 55 years (29.6%), followed by the 56–60 age group (23.4%) and the 61–65 age group (15.1%) (Table 1).

Table 1. Distribution of patients by age group and gender.

Age group	Total (n)	Men	Women
50–55	129	85	44
56–60	102	65	37
61–65	66	44	22
>65	139	92	47

All included patients were on antiretroviral therapy (ART) at the time of evaluation, with a median treatment duration exceeding ten years. Among them, 184 patients (42.2%) met the CDC criteria for AIDS.

Table 2. Distribution of main comorbidities.

Comorbidity	N	Percentage (%)
Hypertension	240	55.0
Type 2 diabetes	144	33.0
Dyslipidemia	135	31.0
Thyroid disorders	104	24.0
Neoplasms	12	2.8
Chronic kidney disease (incl. dialysis)	39	9.0
Major depressive disorder	10	2.3
Cardiopathy	10	2.3

The most frequent comorbidities included hypertension (55%), type 2 diabetes (33%), dyslipidemia (31%), thyroid disorders (24%), and chronic kidney disease (CKD) (9%, including three patients on hemodialysis). Other conditions reported were major depressive disorder (2.3%) and ischemic or structural heart disease (2.3%) (Table 2). Twelve patients (2.8%) had a neoplasm, including four cases of Kaposi's sarcoma, one lung carcinoma, two basal cell carcinomas (scalp and nose), one squamous cell carcinoma, and four lymphomas: one cutaneous lymphoma, one nasopharyngeal lymphoma, one gastric lymphoma, and one unspecified type. (Table 2).

At the time of the last clinical evaluation, viral load was undetectable (<50 copies/mL) in 87% of patients, while 7.8% had a low viral load (50-1000 copies/mL), and 4.8% had a high viral load (>1000 copies/mL) (Table 3). CD4 data were only available for a minority of the cohort and thus not included in the analyses. Most patients (86.9%) had a viral load under 50 copies/mL, indicating effective virological control. The platelet count was >150 G/L in 70% of patients, 100–150 G/L in 20%, and <100 G/L in 10.1% (Table 3).

Table 3. Biological parameters: viral load, platelets, liver enzymes, and FIB-4 index.

Parameter	N	Percentage (%)
HIV viral load		
HIV viral load < 50 copies/mL	379	86.9
HIV viral load 50–1000 copies/mL	34	7.8
HIV viral load > 1000 copies/mL	21	4.8
Platelets		
Platelets > 150 G/L	305	70.0
Platelets 100–150 G/L	87	20.0
Platelets < 100 G/L	44	10.1
ASAT		
ASAT < 40 U/L	283	64.9
ASAT 40–80 U/L	109	25.0
ASAT > 80 U/L	43	9.9
ALAT		
ALAT < 40 U/L	296	67.9
ALAT 40–80 U/L	95	21.8
ALAT > 80 U/L	43	9.9
FIB-4		
FIB-4 < 1.45	218	50.0
FIB-4 1.45–3.25	152	34.9
FIB-4 > 3.25	65	14.9

Liver enzyme levels were mostly within normal ranges, with AST <40 U/L in 64.9% and ALT <40 U/L in 67.9% of patients. Regarding liver fibrosis assessment, the FIB-4 score was <1.45 in 50% of patients, between 1.45 and 3.25 in 34.9%, and >3.25 in 14.9%, the latter suggesting an increased risk of advanced fibrosis (Table 3). The Charlson Comorbidity Index (CCI) had a mean of 4.5 ± 2.3. A score ≥5, indicating a high comorbidity burden, was observed in 43.8% of patients (Table 4). Regarding physical frailty, the Fried score classified 25% of patients (n=109) as frail (≥3 criteria). Pre-frailty (1-2 criteria) was present in 41%, while 34% were considered robust (0 criteria) (Table 4). Cognitive function assessed by the MMSE had a mean score of 27.2 ± 2.9. A score below 24, indicating probable neurocognitive impairment, was found in 21.8% of patients (Table 4). The simplified VACS Index, calculated without CD4 data, had a mean score of 23.4. Thirty-nine percent (n=170) of patients had a score >20, indicating a higher five-year risk of morbidity and mortality (Table 4).

Cross-analysis of scores (Table 4) revealed that among patients with a VACS >20, 65% also had a CCI ≥5, indicating a strong association between high biological risk and comorbidity burden. Furthermore, 38% of patients with VACS >20 were classified as frail (Fried ≥3), and 28% had probable cognitive impairment (MMSE <24), highlighting the accumulation of multiple vulnerabilities among high-risk individuals. Specifically, in patients with CCI ≥5, 34% also had an MMSE <24, reflecting a strong co-occurrence between high comorbidity and cognitive impairment.

Lastly, detailed distribution of multiple risk factor combinations (Table 4) showed that among patients with VACS >20, 65% had CCI ≥5, 38% presented clinical frailty, and 28% had cognitive impairment. These results underscore the importance of multimorbidity and functional frailty in the overall risk assessment of older adults living with HIV.

Table 4. Biological parameters: viral load, platelets, liver enzymes, and FIB-4 index.

Parameter	N	Percentage (%)
HIV viral load		
HIV viral load < 50 copies/mL	379	86.9
HIV viral load 50–1000 copies/mL	34	7.8
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FIB-4		
FIB-4 < 1.45	218	50.0
FIB-4 1.45–3.25	152	34.9
FIB-4 > 3.25	65	14.9

When stratified by Fried frailty phenotype (Table 5), the distribution of participants across the robust, pre-frail, and frail groups was similar in terms of sex, age group, and comorbidity burden (CCI ≥5), with no statistically significant differences ($p = 1.0$ for all). Specifically, frailty was observed in approximately 25% of men and women, regardless of age or comorbidity status. However, a significant association was found between frailty status and cognitive impairment. The proportion of participants with MMSE < 24 increased progressively from 20.0% in the robust group, to 40.0% in the pre-frail group, and 40.0% in the frail group ($p = 0.0001$, χ^2 test). These findings suggest that lower cognitive performance is associated with increased frailty, while sex, age category, and comorbid burden were evenly distributed across frailty levels.

Table 5. Comparison of Socio-demographic and Clinical Characteristics Across Fried Frailty Categories.

Variable	Category	Robust (N - %)	Pre-frail (N - %)	Frail (N - %)	p-value
Sex	Male	97(33.9%)	117(40.9%)	72 (25.2%)	1.0
	Female	51 (34.0%)	62 (41.3%)	37 (24.7%)	
Age group	50–55	44 (34.1%)	53 (41.1%)	32 (24.8%)	1.0
	56–60	35 (34.0%)	42 (40.8%)	26 (25.2%)	
	61–65	22 (33.8%)	27 (41.5%)	16 (24.6%)	
	>65	47 (33.8%)	57 (41.0%)	35 (25.2%)	
CCI ≥ 5	Yes	65 (34.0%)	78 (40.8%)	48 (25.1%)	1.0
	No	83 (33.9%)	101 (41.2%)	61 (24.9%)	
MMSE < 24	Yes	19 (20.0%)	38 (40.0%)	38 (40.0%)	0.0001
	No	129 (87.2%)	141 (78.8%)	71 (65.1%)	

The p-values correspond to chi-square tests comparing the three frailty groups for each variable.

4. DISCUSSION

This retrospective study analyzed a cohort of 436 people living with HIV (PLWH) aged 50 years and older in Algeria. The mean age was 62.6 ± 6.2 years, and nearly one-third of participants (31.9%) were aged over 65. All individuals were on antiretroviral therapy (ART) at the time of assessment, with a median treatment duration exceeding ten years. Notably, 42.2% had progressed to AIDS as defined by the Centers for Disease Control and Prevention (CDC), reflecting prolonged exposure to immunosuppression despite access to modern ART regimens.

The findings highlight a multifactorial vulnerability in this aging population, characterized by a high burden of comorbidities, physical frailty, and cognitive impairment despite effective virological suppression in the vast majority of patients. The Charlson Comorbidity Index (CCI), a validated measure of multimorbidity, was ≥5 in 43.8% of participants, mirroring values reported in the MHMC(5) and VACS(6) cohorts. This elevated burden is consistent with the hypothesis of accelerated aging in PLWH, whose clinical profiles are comparable to those of HIV-negative individuals 10 to 15 years older.

The most common chronic conditions identified in our cohort were hypertension (55%), type 2 diabetes (33%), dyslipidemia (31%), and thyroid dysfunction (24%). These prevalences are markedly higher than those reported in HIV-negative counterparts of similar age, and are consistent with findings from South Africa(7), where the prevalence of multimorbidity among PLWH aged ≥50 years reached 44.1%, compared to 17.8% in younger age groups. In that study, age ≥50 years was independently associated with a 4.7-fold increase in the risk of multimorbidity (95% CI: 3.1–7.0), suggesting a possible contribution of aging to the accumulation of comorbidities.

The prevalence of malignancies in our cohort, although limited (2.8%), aligns with previously documented trends (8), particularly the increase in non-AIDS-defining cancers among virologically suppressed patients. Chronic kidney disease (9%), major depressive disorder (2.3%), and structural or ischemic heart disease (2.3%) were also reported, reflecting the complex geriatric profile of this population. These findings are consistent with those from African and North American cohorts(9), , further reinforcing the universality of this aging-related burden.

These observations emphasize the importance of implementing early, multidimensional geriatric assessments for aging PLWH, focusing not only on comorbidity detection but also on their functional and prognostic consequences. Physical frailty affected 25% of patients in our cohort, while an additional 41% were classified as pre-frail, indicating that two-thirds of participants already exhibited partial or complete depletion of their physiological reserve. These proportions are consistent with those reported in the MACS cohort in the United States(10) and South Africa(11), highlighting the frequent presence of frailty among aging individuals living with HIV.

More recently, the Moroccan study (12) confirmed this trend in a North African context, reporting 12.8% of patients as frail and 48.6% as pre-frail according to the Fried criteria. The similarity in results across diverse epidemiological settings suggests a global phenomenon that transcends regional differences, underscoring the need for early and systematic screening for functional decline.

Similarly, a large U.S. study involving over 1,400 PLWH aged 50 and above reported a frailty prevalence of 20.8%, with an additional 37.5% categorized as pre-frail(13). These data reinforce the urgency of structured screening approaches even in the absence of overt clinical symptoms (3, 6).

In terms of cognition, nearly one-quarter of participants (21.8%) had MMSE scores below 24, indicating probable neurocognitive impairment. This prevalence is consistent with prior reports from virologically controlled HIV cohorts (14). The Moroccan study (12) similarly found higher rates of cognitive dysfunction among frail individuals, illustrating the frequent co-occurrence of physical frailty and cognitive impairment.

Echoing these findings, Eke (13) observed that frailty was frequently accompanied by cognitive decline, highlighting a pattern of global vulnerability. These data emphasize the importance of evaluating physical and cognitive domains jointly, as part of an integrated and anticipatory approach to aging with HIV.

The Veterans Aging Cohort Study (VACS) Index also emerged as a valuable marker of global risk in our study, with 39% of participants scoring above 20, a threshold previously linked to significantly increased morbidity and mortality(3, 15). In the study by Eke et al., median VACS scores were 33 among frail patients, 27 among pre-frail, and 23 among robust individuals, demonstrating a dose-response relationship between functional severity and global risk.

In our cohort, a VACS score > 20 was associated with a CCI ≥ 5 in 65% of cases, physical frailty in 38%, and cognitive impairment in 28%, indicating a strong overlap of multiple vulnerability factors. This convergence highlights the relevance of implementing a comprehensive and multidimensional geriatric assessment for older adults living with HIV.

Finally, our findings align with those of Nakanjako (16), who showed that despite long-term virological suppression, HIV-positive adults exhibit sustained immune activation and premature immunosenescence compared to age-matched HIV-negative controls. Remarkably, HIV-positive individuals under 50 displayed immunological profiles comparable to those of HIV-negative individuals 20 years older. These findings support the concept of accelerated immune aging in PLWH and strengthen the case for incorporating functional and immunological assessments into standard care beyond traditional virological markers.

The study by Yeoh (17) sheds light on the potential role of persistent immune activation in the development of neurocognitive impairment among people living with HIV. Despite effective viral suppression, immune-inflammatory imbalances may persist and contribute to premature brain aging, particularly within the central nervous system. In older men living with HIV, the authors identified

a significant association between frailty, elevated levels of immune activation markers (sCD163 and sCD14), monocytic metabolic dysregulation (Glut1 overexpression), and alterations in lipid metabolism. These included increases in certain triglycerides and phosphatidylethanols, as well as a reduction in protective gangliosides, reflecting a pro-inflammatory and metabolically unfavorable environment that could contribute to declining functional reserve, independent of virological control.

Recent findings summarized by Eke (13) reinforce this multifactorial vulnerability. Their review highlights that frailty emerges up to two decades earlier in people living with HIV, driven by chronic immune activation, accelerated immunosenescence, and the cumulative burden of non-AIDS comorbidities. Key aggravating factors include early-onset multimorbidity, polypharmacy, malnutrition, and depression, all of which contribute to an accelerated erosion of physiological reserve. Even in the absence of overt disability, frailty is associated with an increased risk of falls, dependence, and mortality. The authors advocate for a proactive care model incorporating rapid frailty screening tools (such as the FRAIL scale and SPPB), targeted nutritional assessments, multicomponent exercise programs (focusing on strength, endurance, and balance), and careful management of polypharmacy. This integrated approach, when combined with clinical scores like Fried, MMSE, CCI, and VACS, may allow earlier interventions to support healthy functional aging in people living with HIV.

In line with these strategies, the updated Italian guidelines for the care of older adults with HIV recommend incorporating Comprehensive Geriatric Assessment (CGA) into standard clinical practice (18). This multidimensional tool assesses comorbidities, functional status, cognitive function, nutritional risk, fall risk, and social support to guide individualized care planning. Antiretroviral therapy should also be tailored in consideration of polypharmacy and underlying frailty, with a preference for tenofovir alafenamide (TAF) due to its superior renal and bone safety profile.

This evolution in clinical practice goes beyond virological monitoring alone. Incorporating frailty, comorbidity burden, and cognitive status into routine assessments is now essential to anticipate decline and preserve quality of life in aging populations with HIV, as recommended by Rodriguez-Mañas and Fried(19) .

Each clinical score contributes a distinct but complementary perspective. The Fried score signals the onset of physical frailty and reduced functional capacity. The MMSE identifies cognitive deficits that can impact treatment adherence and daily function. The CCI quantifies the cumulative impact of chronic illnesses. The VACS index integrates these risks into a composite, biologically informed measure of vulnerability.

This multidimensional evaluation also informs antiretroviral therapy selection. For frail patients, tenofovir disoproxil fumarate (TDF) should be avoided due to its association with bone mineral density loss. A randomized trial of 385 patients showed significantly greater BMD loss in those receiving TDF/emtricitabine compared to abacavir/lamivudine(20), supporting evidence of increased fracture risk with TDF use.

Protease inhibitors, especially when ritonavir-boosted, should be avoided in older or metabolically vulnerable patients due to their impact on lipid metabolism and insulin sensitivity, both of which elevate cardiovascular risk (21). Efavirenz is contraindicated in patients with cognitive impairment due to its neurotoxicity. Its use has been associated with an increased risk of neurocognitive side effects and psychiatric symptoms, including suicidal ideation (22) .

Abacavir should be used cautiously in patients with elevated cardiovascular risk. Recent studies have linked its use to an increased incidence of myocardial infarction. TDF, while primarily associated with renal toxicity, may also unfavorably affect lipid profiles, further influencing cardiovascular outcomes (23) . For patients with elevated VACS scores, integrase inhibitor–based regimens combined with TAF are preferred for their renal and bone safety. However, studies have noted significant weight gain after switching from TDF to TAF, raising potential concerns regarding long-term metabolic effects.

Routine integration of these scores into clinical workflows allows for early identification of high-risk individuals and the delivery of targeted interventions whether through functional rehabilitation, cognitive support, or antiretroviral regimen optimization. By adopting this strategy, clinicians may significantly improve quality of life, maintain autonomy, and reduce preventable hospitalizations and premature mortality in older adults living with HIV.

Several limitations should be acknowledged, although they do not diminish the robustness of the findings. First, physical frailty was assessed solely using the Fried phenotype. While this tool is widely recognized in the literature particularly among people living with HIV for its ease of use, clinical sensitivity, and adaptability to resource-limited settings, alternative validated instruments such as the Short Physical Performance Battery (SPPB) could have provided a more nuanced assessment of motor function.

Similarly, cognitive function was evaluated using the Mini-Mental State Examination, a classical screening tool that is less sensitive to subtle or atypical neurocognitive impairments. Although more comprehensive neuropsychological batteries might have enhanced the characterization of cognitive deficits, the MMSE remains a suitable instrument for routine clinical screening, and its cutoff score of <24

is widely accepted for identifying at-risk individuals. The absence of quality-of-life and self-reported functional status measures, such as the WHOQOL-HIV or EQ-5D, represents another limitation. These instruments could have complemented the objective clinical and biological indicators with the patients' subjective experience of aging. Such dimensions should be incorporated into future studies aiming for a multidimensional, patient-centered approach.

In addition, the study was conducted in a single university hospital center in Eastern Algeria, which may limit the generalizability of the findings to other settings or populations. The exclusion of ART-naïve individuals may have introduced a selection bias by omitting potentially more vulnerable or recently diagnosed patients.

Moreover, the CD4 lymphocyte count, although a key marker in HIV-related immune status, was missing for a large proportion of participants. This precluded its inclusion in the VACS Index and prevented further stratified analyses.

Finally, the study spans a 20-year period during which significant changes occurred in the diagnosis, treatment, and management of HIV. These evolutions may have introduced temporal variability in clinical trajectories and health outcomes. Due to the retrospective nature of the data and the lack of time-stamped clinical scores, stratification by treatment era was not feasible.

5. CONCLUSION

As the population of people living with HIV continues to age, the clinical paradigm must evolve to reflect the complexity of aging with a chronic infectious condition. Our findings underscore the multifactorial nature of vulnerability in this population, characterized by high rates of multimorbidity, physical frailty, and cognitive impairment even in the context of effective antiretroviral therapy.

The combined use of Fried, MMSE, CCI, and VACS scores offers a robust and complementary framework for risk assessment and individualized care. These tools, when integrated into routine clinical workflows, enable the early identification of at-risk individuals and support the implementation of proactive, tailored interventions.

This multidimensional approach has the potential to significantly improve the quality of life of aging people living with HIV by helping to maintain autonomy, reduce avoidable hospitalizations, and prevent premature mortality. Future research should prioritize longitudinal and intervention-based studies to validate these findings and guide the development of age-sensitive HIV care strategies.

What is already known on this topic

People living with HIV (PLWH) experience accelerated aging, with earlier onset of age-related comorbidities such as cardiovascular disease, diabetes, and cognitive impairment, compared to HIV-negative individuals of the same age. Frailty is increasingly recognized as a key component of vulnerability among older PLWH, and its presence has been linked to increased risk of hospitalization, loss of autonomy, and mortality even in those with virologically suppressed HIV.

What this study adds

This study provides the first cross-sectional analysis of frailty, cognitive function, and comorbidity burden in older PLWH in Algeria, using validated clinical scores (Fried, MMSE, CCI, VACS), highlighting a multidimensional vulnerability profile in a North African setting. It reveals significant overlap between biological, cognitive, and functional decline, with over one-third of patients presenting both high comorbidity (CCI ≥5) and neurocognitive impairment (MMSE <24), reinforcing the need for integrated geriatric HIV care models beyond viral suppression.

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Authors' Contributions Amel Ouyahia: Conceptualized the study, performed data collection and analysis, and drafted the initial manuscript; Mounira Rais: Contributed to the design of the study, supervised data interpretation; Mohamed Safir Kouicem: Assisted in data analysis and interpretation, prepared tables, and reviewed the final draft; Meriem Abdoun: contributed to the discussion and implications for practice, and approved the final manuscript version; Aya Tinhinane Kouicem: supervised data interpretation and critically revised the manuscript for important intellectual content ; Sonia Taleb: contributed to the discussion and implications for practice, and approved the final manuscript version ; Guechi Meriem: contributed to the discussion and implications for practice, and approved the final manuscript version ; Amoura Noudjoud: contributed to the discussion and implications for practice, and approved the final manuscript version.

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