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Ageing with HIV: Clinical and Organisational Challenges and the Role of Physical Activity in Healthy Ageing

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Abstract

Background. Combination antiretroviral therapy (ART) has transformed HIV into a manageable chronic condition. Consequently, the population of people living with HIV (PLWH) is ageing rapidly, with over 50% aged 50 or older in many high-income settings.

Objective. To characterise the clinical and organizational challenges at the intersection of HIV and biological ageing, highlight regular physical activity as a modifiable determinant of healthy ageing, and summarise emerging models of integrated HIV-geriatric care.

Methods. A narrative review of English-language literature (PubMed/MEDLINE) and current EACS and WHO guidelines was conducted. Search terms covered HIV, ageing, multimorbidity, frailty, polypharmacy, neurocognitive disorders, cardiovascular disease, physical activity, and care models. Landmark studies, systematic reviews, and meta-analyses were prioritised.

Results. Chronic inflammation ("inflammaging"), immunosenescence, ART toxicity, and traditional risk factors drive accelerated biological ageing in PLWH. This manifests as premature multimorbidity, increased cardiovascular, metabolic, and bone disease burden, HIV-associated neurocognitive disorder (HAND), non-AIDS cancers, and frailty. Polypharmacy complicates management, while traditional HIV services remain ill-equipped. Regular aerobic and resistance exercise represents a safe, cost-effective intervention that improves cardiorespiratory fitness, muscle strength, body composition, and physical function.

Conclusions. Caring for ageing PLWH requires a shift toward integrated, multidisciplinary, geriatric-informed models. Essential elements include screening for comorbidities and frailty,

medication reviews, physical activity promotion, and adopting frameworks like WHO ICOPE, which should be urgently implemented in national care systems, including Poland's.

Keywords: HIV, ageing, healthy ageing, physical activity, exercise, multimorbidity, frailty, polypharmacy, HIV-associated neurocognitive disorder, models of care, comprehensive geriatric assessment

1. Introduction

Since the acquired immunodeficiency syndrome (AIDS) was first described in 1981, more than 75 million people worldwide have been infected with the human immunodeficiency virus (HIV), and the virus continues to be transmitted, predominantly through sexual contact but also through mother-to-child transmission and exposure to contaminated needles [1]. The clinical course of untreated infection ranges from an acute retroviral syndrome, through a prolonged phase without symptoms, to opportunistic infections and the skin, nerve, muscle and whole-body complications that define AIDS [1]. Early and accurate diagnosis, relying on fourth-generation blood tests and point-of-care (bedside) testing and combined with combination antiretroviral therapy (ART), has fundamentally altered the natural history of the infection [1][2].

The consequence of this success is profound. HIV infection has become a chronic, manageable condition, and the life expectancy of PLWH who are diagnosed early and treated effectively now approaches that of the general population. As a result, the HIV population is ageing rapidly. In many high-income settings, people aged 50 years and older already constitute the majority of PLWH, and the proportion continues to rise, both because those infected in earlier decades are surviving into older age and because new diagnoses are increasingly made later in life [3][4][5][6]. Modelled UNAIDS estimates indicate that HIV prevalence among adults aged 50 and above roughly doubled across successive age groups in the two decades following the mid-1990s [3].

This demographic transition creates challenges that neither classical infectious-disease medicine nor traditional geriatrics (the medicine of old age) is designed to address. Older PLWH experience an excess burden of age-related conditions (cardiovascular disease, metabolic disorders, osteoporosis, neurocognitive impairment and cancer) that frequently appear earlier and cluster more densely than in HIV-negative people of the same age [7][8][9][10]. Superimposed on this multimorbidity are polypharmacy (the use of many medicines at once), a high risk of drug-drug interactions, frailty and other geriatric syndromes. Meeting these needs requires a reorganisation of care towards integrated, multidisciplinary and geriatric-informed models, and it places renewed emphasis on the modifiable determinants of healthy ageing, particularly physical activity.

Research objective. The aim of this review is to characterise the clinical and organisational challenges that arise at the intersection of HIV infection and ageing, to consider the role of physical activity in healthy ageing with HIV, and to summarise the evidence base for emerging models of integrated HIV-geriatric care.

Research problem. What are the principal clinical consequences of ageing in people living with HIV, and which models of care, including lifestyle interventions such as physical activity, are best suited to address them?

2. Materials and Methods

2.1. Design and data sources

This is a narrative review. A structured search of the PubMed/MEDLINE database was performed for English-language articles, complemented by the current guidelines of the European AIDS Clinical Society (EACS) and the World Health Organization (WHO).

2.2. Search strategy and study selection

Search terms combined controlled vocabulary and free text relating to "HIV", "human immunodeficiency virus" and "antiretroviral therapy" with terms describing ageing and its clinical consequences: "ageing", "older adults", "multimorbidity", "inflammaging", "immunosenescence", "cardiovascular disease", "metabolic complications", "osteoporosis", "HIV-associated neurocognitive disorder", "non-AIDS-defining cancers", "polypharmacy", "drug-drug interactions", "frailty", "geriatric syndromes" and "models of care". Priority was given to landmark studies, systematic reviews, meta-analyses, large cohort studies and

consensus guidelines, with an emphasis on publications from 2013 to 2026, while classical foundational papers were retained where relevant. Reference lists of retrieved articles were screened to identify additional sources.

2.3. Data analysis

Owing to the narrative design, no formal quality-scoring instrument or quantitative synthesis was applied; the review aims to provide an integrated clinical and organisational overview rather than a pooled estimate of effect. Findings were organised thematically by disease domain and by model of care.

3. Results

3.1. Epidemiology of the ageing HIV population

The ageing of the HIV population is one of the most significant epidemiological shifts of the ART era. Analyses of UNAIDS estimates and survey data demonstrate a sustained, roughly two-fold increase in HIV prevalence among people aged 50 and over since the mid-1990s, with approximately 4.2 million people in this age group living with HIV globally by 2013 [3]. Both modelled estimates and cross-sectional survey data converge on the same conclusion: surveillance systems and services must adapt to a population that is growing older [3].

This trend reflects two complementary dynamics. First, effective ART allows people diagnosed in earlier decades to survive into their sixth, seventh and eighth decades. Second, a substantial and increasing proportion of new diagnoses occur in older adults; United States surveillance data for 2007 already indicated that roughly one in six new HIV diagnoses (16.8%) arose in adults over the age of 50 [6]. A systematic review and meta-analysis found that nearly half of newly diagnosed infections in the United States now occur in people over 50, and that diagnosis and treatment in older adults are systematically delayed by clinical misconceptions and overlapping comorbidities [4].

Older adults are especially vulnerable to late or missed diagnosis because both patients and clinicians frequently underestimate the risk of acquiring HIV in later life [6]. Late diagnosis has direct clinical consequences. Delayed presentation is associated with a lower CD4 nadir (the lowest recorded CD4⁺ T-lymphocyte count, reflecting the greatest degree of immune depletion), greater immune damage and a higher subsequent burden of age-related disease. Reviews of local and global demographic data emphasise that older PLWH are under-

represented in prevention campaigns, epidemiological surveillance and clinical trials, leaving important evidence gaps [5]. As the population continues to age, cardiovascular disease, osteoporosis and dementia are becoming defining features of the HIV clinic, requiring collaboration between infectious-disease specialists and geriatricians [6].

3.2. Accelerated and accentuated ageing: inflammaging and immunosenescence

Chronological age alone does not explain the excess burden of disease. That fact is central to understanding the ageing HIV population. Suppressing the virus is not the whole story. Even with durable viral suppression, PLWH still exhibit residual chronic immune activation and inflammation (collectively termed “inflammaging”), together with premature immunosenescence (the age-related decline in immune function) [7][8]. These processes are thought to accelerate biological ageing. A person living with HIV may be biologically several years older than their chronological age.

In a cohort of 828 adults with sustained viral suppression, higher cellular immune activation was independently associated with the presence of multimorbidity and with the risk of new age-related conditions, while a soluble marker of inflammation (soluble tumour-necrosis-factor receptor I) predicted mortality. This supports the idea that chronic inflammation and immunosenescence, rather than age alone, drive multimorbidity in PLWH [7]. Reviews of HIV as a chronic condition similarly conclude that it is associated with chronic inflammation and accelerated immunosenescence, which manifest clinically as an earlier onset and higher prevalence of age-related diseases and frailty than in the general population [8]. Because older PLWH are markedly heterogeneous, identifying those at greatest risk and offering an individualised, holistic and multidisciplinary approach is essential [8].

Even under effective ART, persisting immune dysregulation, marked by depletion of naive T-cells and disordered secretion of signalling molecules (cytokines), raises the long-term risk of kidney impairment, premature atherosclerosis, insulin resistance and metabolic bone disease [9]. Comprehensive reviews of ageing with HIV increasingly focus on biomarkers of accelerated biological ageing, including epigenetic “ageing clocks” (biomarkers that estimate biological age from patterns of DNA methylation), which may allow earlier identification and monitoring of individuals at risk of age-related disease [10]. The distinction between “accelerated” ageing (the same diseases occurring earlier) and “accentuated” ageing (a higher prevalence at any given age) remains an area of active investigation. Either way, both point to the need for proactive screening rather than reactive treatment.

3.3. Multimorbidity and cardiovascular disease

3.3.1. The multimorbidity burden

Multimorbidity dominates the picture. It is the co-occurrence of two or more chronic conditions, and it is the defining clinical challenge of the ageing HIV population. Age-related comorbidities cluster earlier and more densely in PLWH, and markers of immune activation, senescence and inflammation are independently associated with both the presence of multimorbidity and with new age-related disease [7]. The clinical implication is that older PLWH should be treated as complex, multimorbid individuals requiring coordinated management, rather than as patients with a single infection [8].

3.3.2. Cardiovascular disease

Cardiovascular disease (CVD) is now one of the leading causes of death among PLWH in the ART era [11][12]. Its underlying mechanisms are multifactorial. HIV proteins such as Tat, Nef and gp120 accelerate atherosclerosis (the build-up of fatty plaques in the arteries) through direct and indirect mechanisms, including damage to the inner lining of blood vessels (endothelial dysfunction), chronic inflammation, immune activation and metabolic disturbance [11]. ART, while primarily life-prolonging, also contributes to the rising prevalence of chronic conditions such as CVD [11].

Cross-sectional studies of adults aged 50 and older confirm a higher prevalence of subclinical (not yet symptomatic) atherosclerosis in PLWH than in HIV-negative controls [13]. Cardiovascular risk in people ageing with HIV is driven both by traditional factors (age, smoking, high blood pressure) and by HIV-specific factors such as the duration of ART exposure and the CD4 nadir [14]. Consequently, cardiovascular risk-assessment tools derived from the general population may underestimate true risk in PLWH, and assessment must incorporate HIV-specific variables rather than relying solely on standard scores [14]. The combination of traditional risk factors with the effects of HIV and ART substantially elevates cardiovascular risk, demanding multidisciplinary management and familiarity with complex therapeutic options [12].

3.4. Metabolic, skeletal and renal complications

As PLWH live longer on effective ART, recognition of the metabolic complications of chronic infection has grown. These include disordered blood lipids (dyslipidaemia), diabetes mellitus, osteoporosis and cardiovascular disease [15]. The cause is twofold. These complications arise both from HIV infection itself and, paradoxically, from the otherwise highly effective antiretroviral treatment [15]. Because most are modifiable or preventable, active surveillance and screening are warranted [15].

A landmark analysis described how the focus of HIV care had moved from the treatment of opportunistic infections to the management of metabolic complications such as lipodystrophy (abnormal body-fat distribution), dyslipidaemia and insulin resistance, which affect a large proportion of patients on combination therapy; it coined the phrase “the price of success” to capture the long-term metabolic cost of treatment [16]. Practical clinical reviews describe the core metabolic comorbidities of the ART era, namely dyslipidaemia, fat redistribution (lipodystrophy), insulin resistance and diabetes, and reduced bone mineral density, together with screening algorithms and management strategies [9][15]. Regular monitoring of metabolic parameters and cardiovascular risk is a recurring recommendation across this literature [9][15]. Reduced bone mineral density and osteoporosis warrant particular attention in older PLWH, because they compound the risk of falls and fractures already associated with frailty and geriatric syndromes.

3.5. HIV-associated neurocognitive disorder in older adults

Despite control of the virus, HIV-associated neurocognitive disorder (HAND), a spectrum of difficulties with memory, attention and thinking, remains a common complication in PLWH. The pattern has shifted: frank dementia is now less frequent, but milder forms of neurocognitive impairment predominate [17]. People aged 50 and over are the fastest-growing segment of the HIV population. Within this group the prevalence of HAND has not fallen, and may even have risen, with more severe cognitive deficits in older patients [18].

The development of HAND in the ART era is multifactorial. It reflects injury to the central nervous system sustained before treatment, chronic immune activation, the potential toxicity of antiretroviral drugs to nerve cells, and age-related comorbidities such as cardiovascular disease and diabetes [17]. As the HIV population ages, the boundary between HAND and neurodegenerative dementias, particularly Alzheimer’s disease, becomes increasingly blurred

[17][19]. A longitudinal study comparing older adults with HAND, patients with mild cognitive impairment due to early Alzheimer's disease, and healthy controls found that the volume of the hippocampus distinguished the two disorders, with HAND characterised by greater frontal and cerebellar shrinkage and early Alzheimer's disease by more pronounced language and memory impairment [20]. These findings point to the need for validated brain-imaging and neuropsychological biomarkers to differentiate HAND from early Alzheimer's disease in older PLWH [19][20].

3.6. Malignancies: from AIDS-defining to non-AIDS-defining cancers

The epidemiology of cancer in PLWH has changed dramatically. In countries with wide ART coverage, the incidence of the three classic AIDS-defining malignancies (Kaposi sarcoma, non-Hodgkin lymphoma and cervical cancer) has dropped substantially, yet the risk remains disproportionately elevated, at approximately 800, 10 and 4 times the rates seen in HIV-negative individuals, respectively [21]. At the same time, non-AIDS-defining cancers (NADC) have become a growing source of illness and death [21][22].

The burden of common age-related, non-virus-associated cancers such as prostate and lung cancer now exceeds that of virus-associated cancers among PLWH; ageing, behavioural factors and HIV-specific biological mechanisms jointly shape the incidence and outcomes of NADC [22]. A retrospective cohort followed over 28 years documented a dramatic decline in AIDS-defining cancers alongside a rising prevalence and incidence of NADC, driven by the ageing of the population and persistent inflammation [23]. Comprehensive reviews confirm that NADC are a significant cause of illness and death in the ageing HIV-positive population, with elevated incidence rates compared with the general population [24]. This shift calls for reorienting cancer screening and prevention programmes away from AIDS-defining cancers and towards the age-related, non-AIDS-defining cancers that now predominate [22][23].

3.7. Polypharmacy and drug-drug interactions

The accumulation of multiple chronic conditions inevitably leads to polypharmacy. An older person with HIV typically takes antiretroviral drugs alongside multiple medicines for coexisting cardiovascular, metabolic, skeletal and geriatric conditions. The prevalence of polypharmacy rises with age and multimorbidity, and frequently exceeds 50% in older PLWH [25]. As life expectancy improves, the risks of multimorbidity, polypharmacy and harmful drug interactions increase in parallel [26].

Older adults are especially vulnerable. Ageing changes how the body handles medicines, which increases the risk of drug interactions and adverse effects [26]. An early cross-sectional analysis of the HIV Outpatient Study demonstrated that both the extent of polypharmacy and the risk of interactions between antiretroviral and non-antiretroviral drugs increased with age, and it was among the first to document the scale of the problem systematically [27]. In a Spanish study of HIV-positive patients aged 65 and over, the prevalence of polypharmacy (five or more medicines) and of potential drug interactions was high, with age, the number of comorbidities and the number of medicines being the principal risk factors [28].

Certain classes of antiretroviral drug, notably protease inhibitors, the pharmacokinetic booster cobicistat (a CYP3A inhibitor used to enhance drug levels rather than an antiretroviral in its own right) and the older non-nucleoside reverse transcriptase inhibitor efavirenz, carry a particularly high risk of interaction with cardiovascular, lipid-lowering and central-nervous-system medicines [26]. A comprehensive review of polypharmacy management in PLWH described its prevalence, associated factors, effects on ART outcomes and on nutritional and geriatric status, and the available interventions, concluding that a structured approach, including regular medication review, is a key element of care [25]. Six years' experience of a dedicated multidisciplinary outpatient clinic demonstrated that regular medication review involving a clinician, a pharmacist and an interaction specialist significantly improved treatment safety and may serve as a model for other centres caring for ageing PLWH [29].

3.8. Frailty and geriatric syndromes

Frailty, a state of increased vulnerability to stressors that results from cumulative decline across multiple body systems, is a central concept in the care of older PLWH. Foundational cohort work using a frailty index (a validated measure that counts accumulated health deficits) demonstrated that PLWH carry a higher frailty burden than HIV-negative individuals of the same age. The burden is greater among those with a lower CD4 nadir and a longer duration of infection, and frailty emerges as much as a decade earlier than in the general population [30].

A systematic review and meta-analysis of studies in PLWH aged 50 and over estimated a pooled prevalence of frailty of approximately 11% and of pre-frailty of approximately 47%; both figures are higher than in the general population and occur at younger ages, implying a need for routine geriatric assessment [31]. Earlier systematic reviews using the Fried phenotype (a five-item physical frailty scale) similarly reported an elevated prevalence of frailty, with predictors including a low CD4 nadir, a longer duration of infection, low physical activity and

depression [32]. Cross-sectional studies confirm both a high prevalence of frailty and poorer physical function (weaker grip strength, slower walking speed and lower physical activity) in older adults with HIV [33].

Frailty is more than a descriptive label. It carries real prognostic weight. The multicentre FUNCFAIL study demonstrated that frailty, the geriatric syndromes assessed in that cohort (including depression, cognitive impairment, falls and malnutrition) and multimorbidity each had a negative effect on mortality and quality of life in older PLWH; of the three factors, frailty exerted the greatest adverse effect [34]. Frailty is also independently associated with a higher risk of HAND. This suggests it may act as a biological link between immunosenescence and neurocognitive impairment, and may serve as a screening marker for cognitive risk [35]. Contemporary cohort data from high-income settings, such as the Canadian CHANGE HIV cohort, reaffirm that a low CD4 nadir is a primary predictor of frailty, which shows the long-term impact of early immunological damage and the importance of timely ART initiation [36]. These findings support the routine incorporation of comprehensive geriatric assessment (CGA) into standard care [34]. Frailty and reduced physical function are not fixed, however: they are among the most modifiable of the challenges reviewed here, and regular physical activity has the strongest evidence for reversing them (Section 3.10).

3.9. Models of integrated HIV-geriatric care

The clinical challenges outlined above expose a structural problem. HIV services were designed for a younger population, and they are poorly configured to manage accelerated ageing, frailty and multimorbidity [37][38]. There is, as yet, no gold-standard model of care for older PLWH. A scoping review has, however, systematised existing approaches and identified the key components of effective models: multidisciplinary working, comprehensive geriatric assessment and the integration of infectious-disease and geriatric expertise [38].

Expert consensus from clinics in North America and the United Kingdom has described three broad models of geriatric consultation for PLWH: an outpatient consultation or referral pathway; an integrated HIV-geriatrics clinic; and dually trained specialists within a single centre. A patient-centred approach and interdisciplinary expertise were universally identified as the essential ingredients of success [39]. Qualitative evaluation of the Golden Compass programme at the University of California, San Francisco, which brings together HIV, geriatric and cardiology expertise with pharmacy and social-work support in one place, found that both patients and clinicians rated the service highly, attributing gains in function and well-being to

its holistic, geriatric-informed approach, which in turn strengthened patients' trust in their care team [40]. Contemporary reviews of innovative models confirm that integrating the principles of geriatrics into HIV care yields promising results in patient satisfaction, detection of geriatric syndromes and quality of life, describing a spectrum of models from geriatric consultation to fully integrated HIV-geriatric clinics [37].

National and international guidance is beginning to reflect this shift. The 2017 Italian guidelines were a pioneering attempt to integrate HIV care with the principles of geriatrics, offering recommendations on frailty assessment, comprehensive geriatric assessment and polypharmacy management, while noting that the principles and goals of starting ART in older patients remain the same as in the general HIV population [41]. The framing of HIV as a model of accelerated and accentuated ageing has prompted calls for a new discipline of “geriatric HIV medicine”, in which comprehensive geriatric assessment is held to be the only adequate approach to managing the multidimensional state of frailty in ageing PLWH [42][43]. More recently, the WHO Integrated Care for Older People (ICOPE) framework, which centres on intrinsic capacity (the composite of an individual's physical and mental capacities) and functional ability, has been proposed as a complement to standard HIV monitoring and as a tool for the early identification of individuals at risk of functional decline [44].

Authoritative guidelines increasingly incorporate the needs of older PLWH. The major revision of the EACS guidelines (version 13.0, 2025) is organised into a section on HIV management and prevention and a section on comorbidities and other clinical topics, with updated recommendations on switch strategies, prophylaxis, vaccination and the management of comorbidities in older PLWH. Recommended first-line regimens include tenofovir (as TDF or TAF) with lamivudine or emtricitabine plus an integrase inhibitor (dolutegravir or bictegravir) or doravirine [45]. The WHO consolidated guidelines likewise emphasise the need to adapt health systems to a growing population of ageing PLWH requiring management of multimorbidity [46]. A key review published in JAMA argued that standard HIV regimens and guidelines are insufficient for ageing PLWH, and recommended the integration of geriatric assessment and multidisciplinary collaboration as the standard of care [47]. Cross-sectional evidence that a high proportion of older PLWH have at least one geriatric syndrome, more often than in the general population, provides a clinical rationale for making comprehensive geriatric assessment a routine part of care [48].

3.10. Physical activity and exercise: a modifiable factor in healthy ageing with HIV

Physical activity is one of the most effective and least expensive interventions available for the problems described above. Physical inactivity and the progressive loss of muscle mass and strength (sarcopenia) both accelerate frailty and worsen cardiovascular, metabolic and bone health. Regular exercise does the opposite: it acts on many of these domains at once, which is what a multimorbid population needs. Physical activity therefore links the clinical management of ageing with HIV to the wider fields of lifestyle medicine and rehabilitation.

The evidence base in PLWH is now substantial. A systematic review and meta-analysis of aerobic (endurance) exercise, conducted using the Cochrane Collaboration protocol, found that supervised aerobic training performed at least three times per week for several weeks improves cardiorespiratory fitness and aspects of body composition and quality of life, and is safe for medically stable adults living with HIV [49]. A companion review of progressive resistive (strength) exercise reached similar conclusions, reporting gains in muscle strength, body weight and body composition without adverse effects on immune or virological status [50]. Both reviews therefore indicate that the two main modes of exercise are effective and safe in adults with HIV.

These benefits extend to older adults, in whom they matter most. A randomised trial of moderate- versus high-intensity combined aerobic and resistance exercise in adults aged 50-75 years with and without HIV found that both intensities produced clinically meaningful improvements in physical function, and that older PLWH improved to a degree comparable with their HIV-negative peers. The ageing body's response to training therefore appears to be preserved in treated HIV infection [51]. More recently, the MOVING study showed that a 12-week multicomponent programme (combining aerobic, resistance, balance and flexibility work) improved frailty status (moving several frail participants to a pre-frail or robust category), improved physical performance and preserved muscle mass in older adults with HIV, while participants who adhered poorly lost muscle, which shows that sustained participation is essential [52].

These disease-specific findings sit within broader public-health guidance. The WHO 2020 guidelines on physical activity and sedentary behaviour recommend that all adults, including those living with chronic conditions, undertake at least 150-300 minutes of moderate-intensity (or 75-150 minutes of vigorous-intensity) aerobic activity per week, together with muscle-

strengthening activity on two or more days. For older adults they add multicomponent activity that emphasises balance and strength to prevent falls, and they stress that doing some activity is better than none [53]. Applied to ageing PLWH, these targets offer a concrete, low-cost intervention that simultaneously addresses cardiovascular risk, metabolic and bone health, frailty, mood and, plausibly, cognition.

Several practical caveats apply. Exercise programmes for older PLWH should be individualised and, where frailty or cardiovascular disease is present, preceded by appropriate clinical assessment; adherence is the main determinant of benefit and requires ongoing support; and physical activity complements, rather than replaces, ART and the management of comorbidity. Even so, the promotion of physical activity, ideally embedded within integrated, multidisciplinary care and supported by physiotherapy and rehabilitation services, deserves to be a routine and explicit part of care for the ageing HIV population.

3.11. Practical elements of a geriatric-informed HIV service

Synthesising the evidence, several practical components recur across successful models of care for ageing PLWH:

- **Systematic comorbidity screening from age 50:** routine assessment of cardiovascular risk (incorporating HIV-specific factors), metabolic parameters, bone mineral density, kidney function, and age- and sex-appropriate cancer screening [14][15][2][22].
- **Frailty and functional assessment:** periodic evaluation using a validated frailty measure and elements of comprehensive geriatric assessment, given the prognostic weight of frailty for mortality and quality of life [31][34][48].
- **Cognitive screening:** structured evaluation for HAND, with awareness of its overlap with neurodegenerative dementias in older adults [17][20].
- **Structured medication review:** regular review of the full medication list by a clinician-pharmacist team to identify and prevent clinically significant drug-drug interactions and inappropriate prescribing [25][29].
- **Promotion of physical activity and exercise:** routine assessment of physical activity levels and structured, individualised exercise prescription (aerobic and resistance

training, with balance work for older adults), supported where possible by physiotherapy and rehabilitation [49][50][51][52][53].

- **Multidisciplinary coordination:** close collaboration between infectious-disease specialists, geriatricians, cardiologists, pharmacists, physiotherapists, mental-health professionals and social workers [39][40].
- **Adoption of validated frameworks:** use of the WHO ICOPE approach and the comorbidity recommendations of the current EACS guidelines to standardise care [44][45].

4. Discussion

The evidence reviewed here has direct implications for the organisation of HIV care in Poland and other Central-European settings. As the Polish HIV cohort ages, infectious-disease services will increasingly encounter patients with cardiovascular disease, metabolic disorders, neurocognitive impairment, cancer, polypharmacy and frailty. Yet the models of care best suited to these needs (integrated HIV-geriatric clinics, comprehensive geriatric assessment and structured medication review) remain unevenly implemented. The international experience suggests several priorities: systematic screening for comorbidity and frailty from the age of 50; routine medication review to detect and prevent clinically significant drug-drug interactions; closer collaboration between infectious-disease specialists, geriatricians, cardiologists, pharmacists and mental-health professionals; and the adoption of frameworks such as WHO ICOPE and the comorbidity recommendations of the EACS guidelines [37][39][44][45]. Because no single model has been established as superior, local services can reasonably begin with the most feasible option, a geriatric consultation pathway, and progress towards fuller integration as capacity allows [39].

Physical activity deserves particular emphasis in this agenda. Among all the interventions discussed, structured exercise is unusual in acting on several problems at once (frailty, cardiovascular and metabolic risk, bone health and psychological well-being) at very low cost and with a strong safety record in PLWH [49][50][51][52]. Aligning HIV care with the WHO physical-activity targets, and building simple exercise counselling, physical-function testing and referral to physiotherapy into routine visits, is a pragmatic and scalable step that is well within reach of Central-European health systems [53]. It also places HIV care within the wider

fields of health promotion, sport and rehabilitation, where the tools to support active ageing already exist.

This review has limitations. It is a narrative rather than a systematic review, and much of the cited evidence derives from high-income settings that may differ from the Polish healthcare system in resources and organisational structure. Some exercise trials in older PLWH are small, and long-term adherence outside trial conditions is uncertain. The heterogeneity of the older HIV population, and the still-evolving distinction between accelerated and accentuated ageing, mean that individualised assessment remains essential. Nonetheless, the convergence of evidence across epidemiology, mechanism, comorbidity, lifestyle intervention and health-services research points clearly towards the required direction of care.

5. Conclusions

Antiretroviral therapy has been remarkably successful. The defining clinical challenge in HIV medicine is no longer the treatment of opportunistic infections; it is the management of an ageing, multimorbid population. Chronic inflammation and immunosenescence drive accelerated and accentuated biological ageing, producing an excess and early burden of cardiovascular, metabolic, neurocognitive and cancer-related disease, compounded by polypharmacy, frailty and geriatric syndromes [7][8][10]. Traditional HIV services are not configured for these needs.

Meeting the needs of the ageing HIV population requires a fundamental change towards integrated, multidisciplinary and geriatric-informed care. The essential elements are clear: systematic screening for comorbidity and frailty, comprehensive geriatric assessment, structured medication review, active promotion of physical activity, and the adoption of validated frameworks such as WHO ICOPE and current EACS guidance [37][44][45][47]. Because frailty and physical function are among the most modifiable of these challenges, embedding physical activity and exercise into routine HIV care is a particularly high-value, low-cost priority [49][50][51][52][53]. Implementing these changes, including within the Polish healthcare system, is now urgent if the therapeutic gains of the ART era are to translate into healthy, functional ageing for people living with HIV.

DISCLOSURE

AUTHORS'S CONTRIBUTION

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Methodology: TK, MK, PK, GP, KI

Software: TK, PK, GP, DG, AU

Check: TK, MK, PK, MM, HB

Formal Analysis: TK, KI, AG, MKu, WGK

Investigation: TK, PK, AG, GP, DG

Resources: TK, HB, WGK, MM, AU

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Conflicts of Interest

The author(s) declare no conflict of interest.

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