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Sarcopenia and its Determinants in Adults with HIV Infection from Centre of Excellence in HIV Care at New Delhi- an Exploratory Study

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Abstract

The enormous advances in (ART) in the last two decades have made infection by Human Immunodeficiency Virus (HIV) a chronic manageable disease. As the longevity of people living with HIV (PLHIV) is increasing, more and more PLHIV on Antiretroviral treatment (ART) are developing non-AIDS-defining diseases, and one of them is sarcopenia.

The purpose of this study was assessment of sarcopenia in PLHIV and its determinants. The results may help practitioners for early detection and proper management of sarcopenic PLHIV in ART centres. The study was conducted in the Department of Medicine at the ART centre at Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi, under the National AIDS Control Programme of the Government of India and the institution is a designated Centre of Excellence (C.O.E.) in HIV care. Eighty consecutive PLHIV presenting to the ART centre at Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi. Subjects were considered as having sarcopenia if they had any one of following:

1. Positive SARC-F questionnaire

2. Loss of muscle mass

3. Loss of muscle strength

4. Loss of physical performance.

Out of 30 subjects who had sarcopenia 17 (56.7%) had a positive SARC-F score while 13(43.3%) had negative SARC-F score. All those subjects who had a positive SARC-F score had sarcopenia and all of them also had loss of muscle strength and loss of physical performance hence SARC-F questionnaire had 100% positive predictive value. However, it has a poor sensitivity because 43.3% of subjects who had sarcopenia tested negative by SARC-F.

On univariate analysis only CD4 count, viral load, duration of HIV diagnosis, duration of ART emerged as strong predictors of sarcopenia in PLHIV. By multivariate logistic analysis only CD4 count in PLHIV was identified as a predictor of sarcopenia.

Keywords: Sarcopenia; ART; PLHIV; AIDS; Pathophysiology

Introduction

The enormous advances in (ART) in the last two decades have made infection by Human Immunodeficiency Virus (HIV) a chronic manageable disease. As the longevity of PLHIV is increasing, more and more PLHIV on Antiretroviral treatment (ART) are developing non-AIDS-defining diseases, and one of them is sarcopenia. Sarcopenia was originally defined as an age-associated loss of muscle mass. Recently a number of European and international groups have redefined Sarcopenia as 'being a decline in muscle function (either walking speed or grip strength) associated with loss of muscle mass' [1]. Sarcopenia can significantly affect quality of life for individual living with HIV. The combination of HIV-related factors such as chronic inflammation and potential side effect of ART can accelerate muscle loss in PLHIV, making them more susceptible to sarcopenia. This can result in increased susceptibility to infections, impaired daily functioning, compromise immune system, exacerbate frailty, a lower quality of life and increased risk of death. Sarcopenia is divided into two categories: Primary and secondary sarcopenia. Primary sarcopenia is age related sarcopenia that no other cause except aging while sarcopenia is considered 'secondary' when causal factors other than (or in addition to) aging like physical inactivity, disease or nutritional deficiency are evident [2].

The pathophysiology of sarcopenia involves a complex interplay of various factors such as aging, chronic inflammation, mitochondrial dysfunction, insulin resistance, neurological factors and physical inactivity. Sarcopenia in PLHIV has specific pathophysiological aspects influenced by direct viral effects and associated factors like immunodeficiency, ART and chronic inflammation [3].Multiple methods exist to identify and assess sarcopenia. CT and MRI are the procedures of choice for assessment of sarcopenia and muscle mass. If muscle mass is to be a part of the diagnostic definition of sarcopenia, then measuring it needs to be feasible for both research and in clinical practice, and feasible in older people. Anthropometric methods are simple but lack precision and are prone to overestimation. Muscle strength is assessed by handgrip strength using a Jamar dynamometer. Physical performance is assessed by Gait speed, 400 m walk test, time up-and-go test, stair climb test and balance test. The SARC-F questionnaire is considered as one of the best available tools to be used in primary care for screening of sarcopenia [4].

The overall prevalence of sarcopenia in PLHIV is 5% - 41% with pooled prevalence of 24.1%. Prevalence of sarcopenia is Six times higher in PLHIV compared to general population [5]. It is more prevalent in elderly PLHIV and women. Among individuals on ART, multiple factors have been associated with sarcopenia in cross sectional studies. Some are traditional HIV measures, including lower current CD4 cell count, detectable viral load, history of AIDS, and longer time since diagnosis, as well as hepatitis C coinfection, low body mass index (BMI) and high BMI. HIV--positive individuals who are sarcopenic are also more likely to have lower socioeconomic status, unemployed, and lower family income. Among people who are drug abusers and those with advanced HIV disease are more likely to be sar-

copenic, whereas those without advanced HIV disease are not more likely to be sarcopenic [6].

Early recognition & intervention are the key to improve outcomes in sarcopenic PLHIV. Screening patients for improvement in their physical functions and activities of daily living should be a routine part of sarcopenia management. Exercise interventions and nutritional approach play a significant role in the management of sarcopenia in PLHIV. Exercise interventions have the most significant improvement on sarcopenia. Other evidence goes further to suggest that the combination of both exercise and nutrition is superior to resistance and aerobic exercise. The role of pharmaceutical agents is still under investigation in the management of sarcopenia [7].

The purpose of this exploratory study is assessment of sarcopenia in PLHIV and its determinants. The results may help practitioners for early detection and proper management of sarcopenic PLHIV in ART centre.

Aims and Objectives

- 1. To assess prevalence of sarcopenia in PLHIV
- 2. To evaluate the risk factors for sarcopenia in these patients.

Materials and Methods

The study was conducted in the Department of Medicine at the ART centre at Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi, under the National AIDS Control Programme of the Government of India and the institution is a designated Centre of Excellence (C.O.E.) in HIV care.

Study Design: Observational, Cross-sectional study.

Sample Size Estimation: In a study by Patricia Echeverria et al, the overall prevalence of sarcopenia among PLHIV was 25.7%. Assuming prevalence p= 25%, a confidence interval of 95% and margin of error of 5%, z = 1.96, the estimated sample size is n= 288. As a sample of convenience, we included 80 consecutive PLHIV presenting to the ART centre at Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi.

Ethics Committee Approval: The study was approved by the Institutional Ethics Committee (IEC) of Maulana Azad Medical College and associated Hospitals vide

F.1/IEC/MAMC/MD/MS 92/04/2022/No.338 and registered under CTRI with registration number: CTRI/2023/11/059882 [Registered on 15/11/2023].

Inclusion Criteria

- Any PLHIV 18 years of age or above.
- PLHIV on ART for more than one year.
- Willing to give consent for participation in the study.

Exclusion Criteria

Seriously-ill, hospitalised patients, patients with medical conditions like PLHIV with Type 1 DM, neurological impairment that prevents Sarcopenia assessment.

Methodology

All the subjects underwent a comprehensive clinical assessment. Detailed history was taken with detailed physical examination. All subjects underwent laboratory investigations-Complete blood count, Liver function tests, Kidney function test, Fasting blood sugar, lipid profile and urine microscopy. CD4 count and HIV-1 plasma viral load was done in all subjects. Additional investigations were performed as clinically indicated.

All subjects were subjected to sarcopenia assessment by evaluating:

1. Sarc-F Questionnaire- A self-reporting five--part survey to screen patient for sarcopenia. It has five components each has score (0-2). The recommended cutoff value used for sarcopenia assessment was >=4 points [8].

2. Assessment of Muscle Mass: Muscle mass was assessed by anthropometric measurements which include Body mass index (Kg/m^2), [9] Calf circumference, mid upper arm circumference and Triceps skinfold thickness [10].

3. Assessment of Muscle Strength: Muscle strength was assessed by using a Jamar dynamometer and repeated chair stand test. Grip strength value <27kg in men and <16kg in women was used as cutoff to define sarcopenia [2]. The cutoff time used to distinguish sarcopenia was >15 sec to sit and then stand repeatedly for five times as quickly as possible in repeated chair stand test [2].

4. Assessment of Physical Performance: Physical performance of study subjects was assessed by gait speed and 400 m walk test. In the 4-metre gait speed test, men and women who had gait speed <=0.8m/sec was used as cutoff for sarcopenia [1]. All the subjects who were unable to complete the 400-m walking distance within 15 min, without sitting, leaning, or with the help of another person were considered as having sarcopenia [1].

Subjects were considered as having sarcopenia if they had any one of following:

- 1. Positive SARC-F questionnaire
- 2. Loss of muscle mass
- 3. Loss of muscle strength
- 4. Loss of physical performance

Patients were divided into two groups (sarcopenia present and sarcopenia absent). A comparison was made between the two groups in several socio-demographic and medical history. HIV-1-related variables were included in the analyses of this study: time since HIV-1 diagnosis, nadir CD4 count, BMI, presence and number of comorbidities, ART regimen, duration of ART, adherence, HIV-1 transmission risk factors, alcohol consumption, marital status, education, and family income. Comorbidities were defined as symptoms not related to acquired immunodeficiency syndrome (AIDS), or also known as non-AIDS defining illnesses (NADA); examples of which are diabetes mellitus and cardiovascular diseases.

Assessment of Risk Factors Associated With Sarcopenia

The following factors were evaluated for association with sarcopenia:

- Socio-demographic- age, gender, residence- urban vs rural, education, employment, monthly income, family structure etc.
- Clinical- weight/ height/ BMI/ WHO clinical stage/ co morbidities/ co infections/ opportunistic infections.
- CD4 count and plasma HIV 1 Viral load
- ART related: duration, drugs, regimen, and toxicity (if any).

Statistical Analysis

Categorical variables were presented in numbers and percentage (%) and Continuous variables were presented as mean +/- SD and median. Normality of data was tested by Kolmogorov Smirnov test. If the normality was rejected then non parametric test was used.

Statistical tests were applied as follows-

Quantitative variables were compared using unpaired t-test / Mann-Whitney test (when the data sets are not normally distributed) between the two groups.

Qualitative variables were correlated using chi-square test / Fisher's exact test.

Univariate logistic regression was used for assessing the risk factors. A p value of

<0.05 was considered statistically significant.

The data was entered in MS Excel spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 25.0.

Results

After screening based on the inclusion and exclusion criteria, a total of 80 subjects of which 48(60%) were male and 32(40%) were females, mean age 46.21±13.22 years [range 21-81 years] were enrolled in the study to assess sarcopenia among the PLHIV and its determinants. All study subjects were in WHO stage T1. The demographic profile, HIV related profile, laboratory characteristics, co-

morbidities and BMI are detailed in table 1 and association of risk factors are shown in table 2.

Table 1: The Demographic Profile, HIV Related Profile, Laboratory Characteristics, Comorbidities and BMI of Enrolled PL-HIV Subjects

Parameters	**Number of patients (%)**
	N=80
Mean age	46.21±13.22 years
Gender	
Male	48 (60%)
Female	32 (40%)
Occupation	
Unemployed	35 (43.8%)
Employed	45 (56.2%)
Socioeconomic status	
Upper lower class	40 (50%)
Lower class	22 (27.5%)
Lower middle class	15 (18.8%)
Upper middle class	3 (3.8%)
Upper class	0 (0.0%)
Education	
Illiterate	26 (32.5%)
literate	54 (67.5%)
Family Income (rupee)	
<10000	34 (43.6%)
≥10000	44 (56.4%)
Marital status	
Married	61 (76.3%)
Unmarried	8 (10%)
Separated	1 (1.3%)
Widowed	10 (12.5%)
Substance abuse	
Positive history	30 (37.5%)
Negative history	50 (62.5%)
Mode of HIV transmission	
Heterosexual	60 (75%)
IV drug use	6 (7.5%)
Blood products	4 (5%)

Unknown	6 (7.5%)
MSM	3 (3.8%)
IV drug with high-risk sexual behaviour	1 (1.3%)
Duration since HIV diagnosis	
<5 years	7 (8.8%)
>5 years	73 (91.2%)
Duration since ART initiation	
<5 years	9 (11.2%)
>5 years	71 (88.8%)
ART Regimen	
1st line	71 (88.8%)
2nd line	8 (10.0%)
3rd line	1 (1.3%)
CD4 count (cells/ mm^3)	
<200	8 (10%)
200-500	36 (45.0%)
>500	36 (45.0%)
Plasma HIV-1 viral load	
<1,000 copies/ml	74 (92.5%)
>1,000 copies/ml	6 (7.5%)
Past opportunistic infection	
Present	69 (86.2%)
Absent	11 (13.8%)
Comorbidities	
None	68 (85%)
Diabetes	8 (10%)
Hypertension	3 (3.8%)
Coronary Artery Disease	1 (1.2%)
Body mass index (kg/m^2)	
Underweight (<18.5)	15 (18.8%)
Normal (18.5-22.9)	45 (56.3%)
Overweight (23-24.9%)	13 (16.3%)
Obese ((≥25)	7 (8.8%)
Loss of muscle mass	**56 (70%)**
Loss of muscle strength	20 (25%)
Loss of physical performance	26 (32.5%)

Positive SARC-F score	**17(21.3%)**
Sarcopenia	**58 (72.5%)**
Sarcopenia (excluding muscle mass)	**30 (37.5%)**

Anthropometry Has Very Poor Specificity for Identification of Sarcopenia

Sarcopenia was evaluated by assessing loss of muscle mass, loss of muscle strength, loss of physical performance and SARC-F questionnaire among all the study subjects. Those fulfilling no criteria were classified as non-sarcopenic while those fulfilling any one criteria were classified as sarcopenic. It was observed that 58(72.5%) of study population had sarcopenia if any 1 of 4 criteria is present. Loss of muscle mass was found in 70% of study population which significantly increased prevalence of sarcopenia up-to 72%. If loss of muscle mass (that was measured by anthropometry) was excluded from the criteria then 37.5% of study population was having sarcopenia as summarised in table-28 and figure-30. As outlined in global literature, anthropometry has very poor specificity for identification of sarcopenia. For assessment of risk-factors we considered sarcopenia excluding loss of muscle mass.

SARC-F Questionnaire

Out of 30 subjects who had sarcopenia 17 (56.7%) had a positive SARC-F score while 13(43.3%) had negative SARC-F score. All those subjects who had a positive SARC-F score had sarcopenia and all of them also had loss of muscle strength and loss of physical performance hence SARC-F questionnaire had 100% positive predictive value. However, it has a poor sensitivity because 43.3% of subjects who had sarcopenia tested negative by SARC-F.

Table 2: Factors Associated With Sarcopenia in PLHIV

FACTORS	P-VALUE
Age (years)	**0**
Gender	0.239
Occupation	0.66
Education	0.5
Socioeconomic status	0.323
Substance abuse	
Smoking	0.294
Alcohol	0.075
IV Drug	0.88
Monthly income	**0.019**
Pasma viral load (copies/ml)	**0.002**
CD4 COUNT (cells/ mm^3)	**0.001**
ART Regimen	0.055
Duration of hiv disease (months)	0.182
Duration of art (months)	0.268
Past opportunistic infection	**0.019**
Co- morbidities	0.5

BMI (KG/M^2)	**0.001**

Risk Factors of Sarcopenia in Plhiv

In our study statistically significant association was present between Age, CD4 count, Viral load, monthly income, BMI and past opportunistic infection. On other hand gender, occupation, education, socioeconomic status, substance abuse, ART regimen, duration of HIV disease, duration of ART and co-morbidities does not have statistically significant association with sarcopenia in PLHIV

Predictors of Sarcopenia

Univariate logistic regression analysis was done to determine the predictors of sarcopenia (Table-3). CD4 count, viral load, duration of HIV diagnosis, duration of ART emerged as strong predictors of sarcopenia in PLHIV. The significance of these associations must be interpreted with moderation keeping in mind the small sample size.

Table 3: Univariate Logistic Regression to Find Out Significant Risk Factors of Sarcopenia

SARCOPENIA			CD4 COUNT	VIRAL LOAD	DURATION OF HIV DIAGNOSIS	DURATION OF ART INITIATION
NO SARCOPENIA	N		50	50	50	50
	Mean		591.12	16.3	122.199	107.797
	Std. Deviation		362.52	115.258	52.7454	46.8036
	Minimum		202	0	23	22.9
	Maximum		2466	815	241.5	210.9
	Percentiles	25	403.25	0	81.733	74.633
		50	512	0	115.283	105
		75	691.75	0	162.975	131.942
SARCOPENIA	N		30	30	30	30
	Mean		391.67	5046.33	166.577	143.109
	Std. Deviation		219.392	25420.6	67.0204	59.8572
	Minimum		102	0	58.3	25.2
	Maximum		876	139513	303.7	237.3
	Percentiles	25	193.5	0	100.117	97.908
		50	321	0	167.467	140.417
		75	558	348.75	228.283	178.5
P VALUE			**0.003**	**0.001**	**0.007**	**0.011**

Discussion

Muscle mass was assessed by using anthropometry only- which included BMI, mid upper arm circumference, calf circumference, triceps skin fold thickness and it was found that 56 (70%) of study subjects had loss of muscle mass. Muscle mass is not a very specific reflection of sarcopenia as it provides an incomplete picture. Assessment of muscle mass by anthropometry alone has drawbacks like limited precision, no insight into muscle function and age

and ethnic variations. It also does not differentiate between muscle and fat within body. In our study 18.8% of PLHIV were underweight which highlights the poor nutritional status of our patients that can influence muscle mass. All these factors lead to an over assessment of sarcopenia. DEXA is a valuable tool in assessing muscle mass due to its ability to measure both bone mineral density and muscle mass. However, it also has some limitations like cost, accessibility and radiation exposure. We do not have access to DXA at our institution and so did not include it in the study for muscle mass assessment.

Due to the high prevalence of poor muscle mass, using this as the sole criterion (that too anthropometry based) for diagnosis of Sarcopenia was not prudent. By this measure, 72.5% of subjects were detected to have sarcopenia- a likely over-assessment.

In the further analysis, we excluded the loss of muscle mass by anthropometry as sole criterion for assessment of sarcopenia. Only loss of muscle strength, loss of physical performance and a positive response on SARC-F questionnaire were used for assessing sarcopenia. The prevalence of sarcopenia then reduced from 72.5% to 37.5%. Hence assessment of loss of muscle mass by using anthropometry alone has very poor predictive value for sarcopenia. Muscle mass, if used as a parameter of sarcopenia, should be assessed by using either DEXA or MRI. Out of the 30 patients who were detected to have sarcopenia by any one of other methods, 28 (93.33%) also had loss of muscle mass by anthropometry. Anthropometry is simple and easy to perform in busy clinic settings. However, its low positive predictive value for sarcopenia is a matter of worry. Still, since nearly all those who had sarcopenia also had poor muscle mass by anthropometry, it can be an important initial clue for further detailed assessment of muscle performance and strength in PLHIV.

The prevalence of sarcopenia among PLHIV is quite variable across studies. Yet, it is universally accepted that PLHIV have more sarcopenia than their normal healthy peers. One of the reasons for this variability in prevalence is the difference in the methods used to evaluate sarcopenia. There is a large heterogeneity in the parameters used to assess sarcopenia and the diagnostic criteria used. In our subjects, 37.5% had sarcopenia. This means that more than one third of PLHIV are sarcopenic, which is quite a large burden. There are no previous studies on assessment of Sarcopenia in PLHIV from India for comparison. Why a significant proportion of our subjects had sarcopenia needs further detailed investigation. A number of factors could be implicated. Foremost among these is the poor nutrition in our patients. Inadequate protein intake, insufficient calories and deficiencies in essential nutrients can contribute to muscle wasting, impaired overall muscle health and increasing the likelihood of developing sarcopenia. Other factors that may contribute are physical inactivity, chronic inflammation, ART, metabolic changes with aging, co-infections, immunosenescence and hormonal imbalance like change in testosterone levels.

Out of 30 subjects who had sarcopenia 17 (56.7%) had a positive SARC-F score while 13(43.3%) had negative SARC-F score. All those subjects who had a positive SARC-F score had sarcopenia and all of them also had loss of muscle strength and loss of physical performance hence SARC-F questionnaire had 100% positive predictive value. However, it has a poor sensitivity because 43.3% of subjects who had sarcopenia tested negative by SARC-F. Hence, the SARC-F score alone cannot be used as diagnostic method for assessment of sarcopenia. On the other hand, if SARC-F score is indicative of sarcopenia, then the subject should be investigated further with other methods of muscle performance assessment.

The socio-demographic, clinical, immunological parameters that predicted sarcopenia were also assessed. In our study, 76.9% of the population >60 years were having sarcopenia, in comparison to 7.1% of the population <30 years. It indicates that there is a significant association between age and sarcopenia in PLHIV (p=.000). Sarcopenia is present across all ages in PLHIV but sarcopenia increases with increase in age and sarcopenia is more common in aged PLHIV. This finding reinforces the premise that sarcopenia is a concept related to ageing. The prevalence of sarcopenia in the younger PLHIV could be explained in two ways. Either the pathogenesis of sarcopenia is related to processes other than ageing like ongoing inflammation that is seen in PLHIV. Or it can be explained on the basis that PLHIV experience accelerated ageing. Whatever the reason,

sarcopenia occurs frequently in PLHIV and is especially prevalent in the older PLHIV. Health care practitioners managing PLHIV should be aware of this so that they are very alert to the very subtle clinical symptoms and signs that may indicate sarcopenia. Aged PLHIV (age>50 years) must be screened for sarcopenia. Further, health promotional interventions must be prescribed to them so as to delay or prevent the onset of sarcopenia.

A significant association between CD4 count and prevalence of sarcopenia was observed. With the decrease in CD4 count, the prevalence of sarcopenia increased (**p=0.001**). 100.0% of study subjects with CD4 count <200 cells/ mm^3 had sarcopenia compared to the 27.8% subjects with CD4 count >500 cells/ mm^3**.** HIV plasma viral load also had a significant association with sarcopenia: -, 100% of the virologically unsuppressed subjects had sarcopenia while only 32.4% of virologically suppressed subjects had sarcopenia.

The association between CD4 count and viral load with sarcopenia in PLHIV is complex. CD4 count is a measure of immune system health, and lower CD4 counts are generally indicative of more advanced HIV disease and immune system compromise. In advanced disease, individuals may experience higher level of chronic inflammation, which contribute to muscle wasting and sarcopenia in PLHIV. HIV viral load refers to amount of virus present in blood stream. Elevated viral load indicates increased viral replication which leads to advance HIV disease and more severe complications in PLHIV like sarcopenia. It is essential to recognize that viral load is an important marker in managing PLHIV and its complications and attaining VL suppression at the earliest is crucial for managing and preventing sarcopenia in PLHIV.

The NACP phase-V calls for the attainment of the UNAIDS targets of 95-95-95 by 2025, where 95% of all people living with HIV know their HIV status, 95% of all people diagnosed with HIV infection receive sustained antiretroviral therapy (ART) and 95% of all people receiving ART achieve viral suppression by 2025. Key strategies to attaining the 95-95-95 targets (other than increased testing) include early initiation of ART and routine VL monitoring of PLHIV. With the "treat all" policy of WHO being adopted by our National Guidelines, there is great emphasis on ensuring early linkage of PLHIV into care.

There was a significant relationship between average monthly income and the prevalence of sarcopenia. We demonstrated that mean monthly income 10000 rupees. Lower monthly income is associated with decreased access to nutritious food, limited access to healthcare and fitness facilities, occupational hazards and poor healthcare affordability which challenge the management of PLHIV and ultimately lead to progression of disease and increases the risk of complications. Efforts to address sarcopenia in PLHIV in lower income countries should involve a comprehensive approach, including strategies to improve nutrition, increase access to physical activity, and enhance healthcare affordability. Public health initiatives and policies that promotes healthy aging, nutritional support, and equitable access to healthcare can contribute to reducing the impact of sarcopenia across lower socioeconomic group.

In our study 18.8% of all study subjects had a BMI<18.5 kg/m^2 i.e. were undernourished. There was a statistically significant association between BMI and sarcopenia (p=0.001). All underweight subjects had sarcopenia while 26.7% of subjects with normal BMI had sarcopenia.

Low BMI can be related to loss of muscle mass leading to a weak muscle grip or weight loss, both of these factors contributing to sarcopenia. Obesity on the other hand is also associated with an increased risk of sarcopenia because excess fat contributes to inflammation and insulin resistance. So, both overweight/obesity and undernutrition are risk factors for sarcopenia while maintaining a normal BMI is generally associated with better health outcomes which prevents sarcopenia. Majority of our study subjects were undernourished, this highlights the fact that even in a tertiary care hospital as ours, years after introduction of ART, and malnourishment still is a concern for a majority of PLHIV. There are probably multiple social determinants of this.

In our study past history of pulmonary tuberculosis had a significant association with sarcopenia in PLHIV (p=.019). 77.8% of study subjects with the past history of pulmonary tuberculosis has sarcopenia. Chronic infection and inflammation can lead to muscle wasting and loss of

muscle mass. Not only active opportunistic infection but also past infection makes PLHIV more prone to develop sarcopenia. It is essential for healthcare provider to address these issues through appropriate medical interventions and comprehensive care for individual with either history of past opportunistic infection or with active infection.

Limitations

Our study had some limitations. The cross-sectional study design was a one-time observation and the study could not statistically establish any causal or temporal relationship between HIV-1-related risk factors and sarcopenia. Further, subjects were not longitudinally followed up for critical outcomes such as disability and death. The sample size was also small restricted by the time frame of this study. The statistical power and generalizability of this study are limited due to the small sample size (n=80). Moreover, the study sample was restricted to patients from one centre from Northern part of India, which may not be representative of patients from other settings. More studies with a larger data size and follow up is required to study the effect of sarcopenia in the long run and to strengthen the findings of our study.

Conclusion

In conclusion the enormous advances in anti-retroviral treatment (ART) in the last two decades have made infection by Human Immunodeficiency Virus (HIV) a chronic disease. More PLHIV on ART are now developing non-AIDS-defining diseases like non communicable diseases and cancers. PLHIV face a unique set of challenges such as geriatric syndromes, frailty, sarcopenia, social neglect, psychological issues, decreased adherence, poly pharmacy and increased risk of multi morbidities. An emerging concept of health outcomes is that of Sarcopenia. It is recognised as a parameter of ageing and is in itself a comprehensive health indicator. Sarcopenia is associated with increased risk of falls, fractures and functional decline leading to higher morbidity rate in PLHIV. Additionally, sarcopenia is also linked to higher mortality, especially in older PLHIV. Long-term outcomes may include decreased quality of life, compromised ability to perform daily activities, increased vulnerability to infections, impacting independence and exacerbating comorbidities associated with aging.

Sarcopenia is feasible and useful as an integrative marker for organizing care and for comprehensively measuring the impact of illness and treatment on overall health status. Sarcopenia is increasingly being studied in PLHIV and is now being evaluated as a health indictor in these subjects. But there are challenges in defining sarcopenia among PLHIV and also in delineating the methods / tests to be employed for its diagnosis.

It is important to have simple screening methods, that can be readily used in busy public health clinics, that require less financial investment, and minimal training of the health care team. It is also critical to address the issue: Do we need to screen for sarcopenia in all PLHIV and at what intervals do we assess?

Considering the significant burden of screening, we can focus on certain groups of people among PLHIV. These sub groups are more vulnerable for sarcopenia as demonstrated by our study and include aged PLHIV, women, those with lower monthly income, PLHIV with low CD4 count, higher viral load and in whom the BMI is low. These are the PLHIV whom we should prioritize for screening for sarcopenia. Preventive strategies go along with treatment interventions and should be initiated as early as possible before the loss of skeletal muscle mass, strength, and function will occur. Exercise interventions and nutritional approach play a significant role in the management of sarcopenia in PLHIV.

This was an exploratory study to assess sarcopenia among PLHIV from India.

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