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Research Article

Body Mass Index Status Determines Absolute $CD4^+$ Count in Adult HIV/AIDS Patients on Antiretroviral Therapy in Zambia

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Abstract

Objective: To determine if Body Mass Index would predict absolute CD4 count to suggest its contribution towards immune augmentation and viral suppression among the victims of HIV/AIDS.

Design and methods: The researchers conducted a cross sectional-quantitative study involving 174 adult HIV/AIDS patient participants who were enrolled over a period of 18 months at Ndola Teaching Hospital in Ndola, Zambia. Participants were subjected to clinical assessments with anthropometry, viral load, $CD4^+$ count and plasma fat measurements at control and repeated on a follow-up visit. The Wilcoxon rank sum analysis was used to analyze the quantitative parameters while the Chi square analysis was applied to analyze nominal variables by sex respectively. The main research question was addressed by establishing the association between Body Mass Index and CD4 count, adjusted for potential confounders using the multiple linear regression model.

Results: The BMI was within the normal range for both male and female gender, although notably higher in the females [median=22.9; interquartile (20.4,27.5) kg/m^2] than in the males [median=21; interquartile (18.8,23.9) kg/m^2], p=0.01. The median $CD4^+$ counts were found to be lower than the lower limit of the normal for the laboratory reference range of (500-1500 cells/ul) in both genders. There was a positive correlation between $CD4^+$ count and the BMI in both unadjusted [Coef=0.05; 95%, CI(0.03,-0.08), p=0.00] and adjusted [Coef=0.04; 95% CI(0.00,0.07), p=0.03] models respectively. Similarly, there was a positive correlation between $CD4^+$ count and the BMI [Coef=0.04; 95% CI(0.00,0.08), p=0.04], reported in the adjusted model for the female gender.

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Conclusion: Body mass index was found to be positively correlated with absolute CD4 count, and more substantively so by female gender.

Keywords: Body mass index, $CD4^+$ count, HIV/AIDS, Immune augmentation, Malnutrition, Viral load.

Introduction

Background to the problem

Although the HIV prevalence has been declining over years falling by 19% between 2003 and 2015 [1] and a further decline suggested from 12.9% in 2016 to the current 11.1% [2], HIV has continued to be a disease of great public health concern and negatively impacting the health sector in Zambia. HIV/AIDS often presents with a wide range of opportunistic infections and co-morbidities which if left unattended can result in mortality.

Therefore, a comprehensive approach in the management of HIV/AIDS is expected to achieve better results than biasing the care towards the provision of antiretroviral therapy. Previous studies have revealed that low CD4 counts, advanced WHO clinical stage, anemia, immune reconstitution inflammatory syndrome and malnutrition have been associated with poor clinical outcomes on course antiretroviral therapy [3-6]. Among the adults living with HIV and starting anti-retroviral therapy in Lusaka Zambia a review showed that 33% of patients were undernourished and 9% were severely malnourished [7]. In other research people living with HIV/AIDS are known to develop multiple nutrient deficiencies, both micro- and macronutrients. Micronutrient deficiencies have been reported in HIV/AIDS and known to contribute towards HIV disease progression and mortality [8]. The purpose of our research was therefore to explore the potential part that BMI plays towards immune augmentation in HIV/AIDS victims on anti-retroviral treatment.

Literature review

Malnutrition causes dysfunctions in the immune system also increases susceptibility of the host to infections [9]. In a study by Li X, et al., Body Mass Index is proposed to play a part in immune mechanisms among the HIV-infected individuals on antiretroviral therapy [10]. They report from their longitudinal cohort study that higher BMI could predict better immune reconstitution in HIV-infected subjects after HAART initiation. Similar reports have suggested that, the immune reconstitution influence by HAART is frequently greatest among subjects distinguished as overweight [11,12], and there is some evidence that a higher BMI is related with more robust CD4+ T-cell recovery in HAART-treated individuals [13].

On the contrary Tedaldi E, et al., report in their study findings that increased BMI was not related with decreased virologic and immunologic responses to initial HAART and that the responses were equal and inside anticipated reach among normal weight, overweight and obese victims at 3 to 9 months of study [14]. The variations in findings regarding the effects of BMI on the immune system following antiretroviral therapy initiation do underscore the need for further research. In other studies; a low control BMI and an attenuated $CD4^+$ cell response at 6 months had a compounding, negative effect after 6 months survival [15]. No difference was established in comparing

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victims with a BMI more than and less than 18.5 kg/m² in those who failed to gain at least 50 cells/μL at 6 months following commencement of ART in a study from Cote d'Ivoire [16].

Research design and methods

The study was a cross sectional design. The methods were quantitative. The independent variable was Body Mass Index while the main outcome variable was absolute CD4 count. The target population were adult HIV/AIDS patients receiving care from the HIV clinic, who are qualified also consented to take part in the research. Researchers enrolled up to 174 participants using a simple random sampling technique. The participants were followed up at baseline, 2 weeks and 3 months intervals.

History taking, physical assessments and anthropometric measurements were conducted using the Zambian Ministry of Health certified and standardized questionnaires in HIV care. The FacsCount machine was used for CD4 count measurement.

The baseline characteristics of participants by gender were analyzed with the help of Wilcoxon rank sum and chi-square analysis for quantitative and norminal variables respectively. The main research question was addressed by establishing the association between Body Mass Index and CD4 count, adjusted for potential confounders using the multiple linear regression model. The statistical software package used to analyze the data was STATA version 12.

Ethical certification was sought and permitted ted by the TDRC Research Ethics Committee in Ndola and the National Health Research Authority in Lusaka, Zambia.

Results

The total number of participants whose results were analyzed in the study was 174. Of the 174 subjects, 107(61%) were female and 67(39%) were males.

The study population was characterized by a generally young age group, with males being older [40 (37.5,42.4) years] than females [37(34.5,38.7) years], p=0.02 as shown in Table 1. The BMI was within the normal range for both male and female gender, although notably higher in the females [median=22.9; interquartile (20.4,27.5) kg/m²] than in the males [median=21; interquartile (18.8,23.9) kg/m²], p=0.01.

The median $CD4^+$ counts were found to be lower than the lower limit of the normal for the laboratory reference range of (500-1500 cells/ul) in both genders. The value was especially lower in the males [median=246; interquartile (168,408) cells/ul] than in the females [median=357; interquartile (231,543) cells/ul], p=0.002.

Results in Table 2 suggested a positive correlation between $CD4^+$ count and the BMI in both unadjusted [Coef=0.05; 95% CI(0.03,-0.08), p=0.00] and adjusted [Coef=0.04; 95% CI(0.00,0.07), p=0.03] models respectively. In Table 3, results similarly suggested a positive correlation between $CD4^+$ count also the BMI [Coef=0.04; 95% CI(0.00,0.08), p=0.04] as reported in the modified model for the female gender.

This is also depicted in Figure 1, a hemi scatter plot matrix.

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Variable	Female N=107(61%)	Male N=67(39%)	P
Age (years)	37(34.5,38.7)	40(37.5,42.4)	0.02
BMI (kg/m²)	22.9(20.4,27.5)	21(18.8,23.9)	0.01
$CD4^+$count (cells/ul)	357(231,543)	245.5(167.5,407.5)	0.002
VL (copies/ml)	355(20,6770)	254(23,2694)	0.84
TC (mmol/l)	3.86(3.02,4.62)	3.53(3.06,4.61)	0.65
Triglyceride (mmol/l)	1.19(0.87,1.51)	0.96(0.71,1.60)	0.25
LDL-c (mmol/l)	2.31(1.58,2.90)	1.86(1.36,2.80)	0.19
HDL-c (mmol/l)	1.33(1.13,1.51)	1.4(1.21,1.55)	0.15
Opportunistic infection			
Present	15(15.2%)	17(27%)	0.06
Co-morbidity			
Present	14(14.1%)	2(3.23%)	0.02
Smoke status			
Yes	2(3.08%)	9(23.1%)	0.001
Alcohol status			
Yes	16(16.2%)	23(37.1%)	0.003

Table 1: Baseline characteristics. Values are median (interquartile range) unless otherwise stated, BMI: Body Mass Index; $CD4^+$: Cluster Differential; LDL: Low Density Lipoprotein-cholesterol; HDL: High Density Lipoprotein-cholesterol; TC: Total cholesterol; VL: Viral Load.

Independent Variables	Unadjusted estimates (95% CI)	P-value	Adjusted estimates (95% CI)	p- value
BMI	0.05(0.03 0.08)	0	0.04(0.00 0.07)	0.03
$tChol_2$	0.04(-0.08 0.16)	0.49	-0.79(-2.21 0.64)	0.28
$Trig_2$	-0.08(-0.34 0.18)	0.54	0.06(-0.35 0.47)	0.77
$HDLc_2$	0.04(-0.93 1.02)	0.93	0.69(-0.95 2.34)	0.41
$LDLc_2$	0.05(-0.08 0.18)	0.41	0.81(-0.62 2.24)	0.26
$lnVL_2$	-0.10(-0.14 -0.05)	0	-0.09(-0.14 -0.03)	0.01
Age_n	0.00(-0.02 0.01)	0.96	-0.01(-0.03 0.01)	0.32
Gender	0.40(0.09 0.71)	0.01	0.34(-0.06 0.74)	0.1
SmoSt	-0.04(-0.52 0.43)	0.86	0.22(-0.41 0.85)	0.49
AlSt	-0.21(-0.57 0.14)	0.23	-0.19(-0.65 0.27)	0.42

Table 2: Multiple linear regression taking $CD4^+$ as the dependent variable on a log scale. Using multiple linear regression, adjusted for BMI, plasma fat, viral load, age, gender, smoke status and alcohol status.

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Independent variables	Adjusted estimates (95% CI)	p-value
BMI	0.04(0.00 0.08)	0.04
$tChol_2$	-6.43(-19.50 6.65)	0.33
$Trig_2$	1.13(-1.54 3.79)	0.4
$HDLc_2$	6.50(-6.58 19.58)	0.32
$LDLc_2$	6.43(-6.63 19.48)	0.33
lnVL2	-0.11(-0.18 -0.04)	000
Age_n	0.00(-0.03 0.02)	0.68
SmoSt	-0.02(-1.38 1.35)	0.98
AlSt	-0.19(-0.90 0.51)	0.59

Table 3: Multiple linear regression taking $CD4^+$ as the dependent variable on a log scale by female gender. Using multiple linear regression, adjusted for BMI, plasma fat, viral load, age, smoke status and alcohol status.

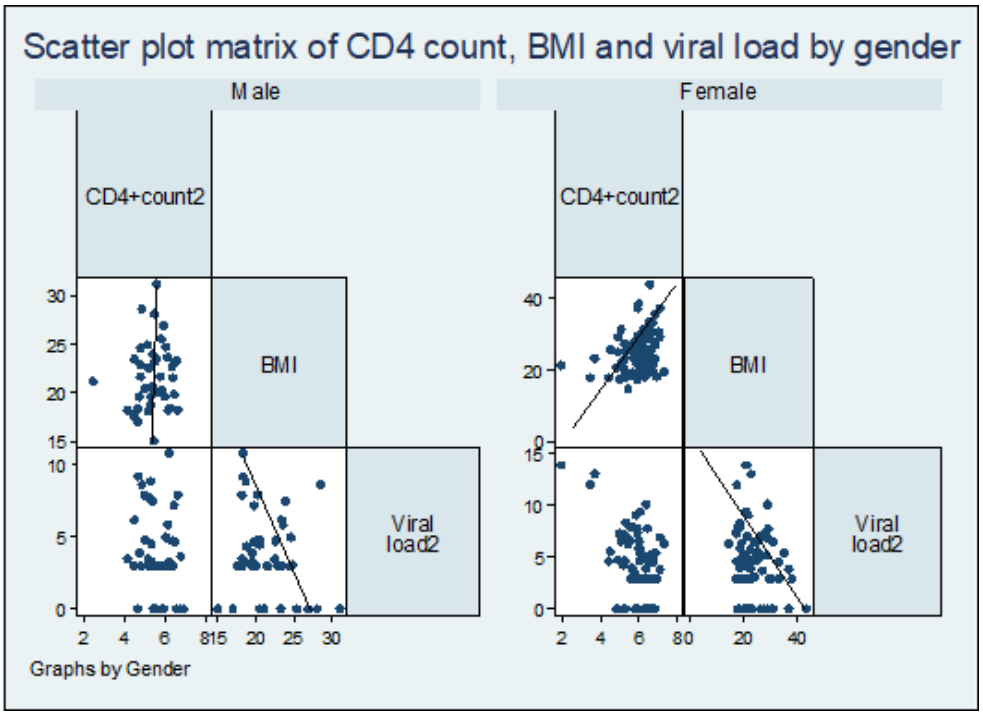

Figure 1: Hemi-Scatter plot matrix.

Discussion

Body mass index (BMI) profiles

The median BMIs of 22.9 kg/m² and 21 kg/m² for females and males respectively and the 17% proportion of subjects with low BMI in our study suggests relatively improved BMI profiles in contrast with prior findings in other settings [17,18], where malnutrition in the form of low BMIs ranging from 10% to 33% in sub-Saharan Africa has been announced. Findings have been revealed in a survey conducted in Lusaka, Zambia where person with a low Body mass index represented an important quantity of those representing for HIV care

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around. In this survey, 33% of victims beginning cART had a BMI <18.5 kg/m² and 9% had a BMI <16.0 kg/m² [7].

Further contrast can be drawn with a research done by Nyirenda C, et al., [19], in which the median BMI of 19.6 kg/m² for each gender was reported. It is also possible however, that the differences in the socio-economic status of the subjects in the settings under comparison may in part explain the noticeable disparities in the BMIs.

Regression for $CD4^+$ count and BMI

The observation that BMI was remarkably associated with absolute $CD4^+$ count in both the unadjusted and adjusted estimates is in keeping with findings from prior studies suggesting a positive role in immune recovery. In a study by Barth R, et al., a BMI in the lowest quartile (<17.1 kg/m²) was related with failure to reach a $CD4^+$ count ≥ 200 cells/ul at 12 months [20]. In other settings, no relation between body mass index also the magnitude of $CD4^+$ cell rehabilitation was found; however, a low body mass index was as important independent predictor of expiry for several years following commencement of antiretroviral therapy [21]. Our study findings also correspond with those revealed in a study by Koethe J, et al., found that probably important opposite relation between baseline BMI and after 6 months hazard for mortality only in the company of those victims with $CD4^+$ count <100 cells/ul rise in the first 6 months of ART. Higher baseline BMI have also been shown to predict better immune reconstitution in HIV infected victims after HAART initiation according to the study by Li X, et al., [10]. In this study, subjects having a high baseline BMI had an independently positive effective impact on 30-month $CD4^+$ T lymphocyte rehabilitation (p=0.028), but not 12-month $CD4^+$ T lymphocyte gain (p=0.104).

Conclusion

Body mass index status was obtained to be significantly correlated with absolute CD4 count, and predominantly so by female gender. This finding of the role of a healthy BMI may justify the need to conduct clinical trials involving appropriate nutritional supplementations and may provide more evidence of its benefit towards immune reconstitution in HIV disease. The finding further underscores the need for regular monitoring of BMI and its application as a key component in the comprehensive management of HIV/AIDS patients.

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Conflict of interest

The authors announce that there was no conflict of interest regarding the publication of the manuscript.

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Author contributions

The concept, design, data acquisition, analyses and interpretation of study findings were conducted by Christopher Nyirenda. All coauthors contributed towards the content, review and ultimate write-up of the manuscript.

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