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Principal Component Analysis of Factors Affecting CD 4 Count Level of HIV/AIDS Patients at Mainland Hospital Yaba, Lagos Nigeria

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Abstract This work highlights the importance of CD4 counts in the study and management of HIV/AIDS. Data for the study were obtained through the use of 29 items structured questionnaire administered on 200 volunteered HIV/AIDS patients at Lagos Mainland Hospital Yaba, Lagos, Nigeria. The variables identified for the study were categorised into demographic characteristics (educational level, marital status, age and gender) and some selected HIV/AIDS administrative variable (HIV/AIDS confirmation period, type of antiretroviral drug being used, duration of use of antiretroviral administration, and nature of patient job).Kaiser–Meyer–Olkin (KMO) test of sampling adequacy was conducted which gave a coefficient of 0.650 and Bartlett's test or sphericity of Chi-square p-value 0.00 indicating that the variables are correlated enough to provide reasonable basis for factor analysis. Correlation test was conducted to ensure non existence of multicolinearity among the components by correlation matrix and the components found to have high correlation coefficient had one removed. A principal component analysis was performed to determine the principal components among the identified components. Findings from total variance explained and the screen plot identified four components (type of antiretroviral drug being taken, duration of HIV/AIDS confirmation, duration of antiretroviral drug application, patient age,) as the principal components to the determination of CD4 count in HIV/AIDS patients at the hospital. The study recommended that HIV/AIDs patients should be encouraged to commence early application of antiretroviral drug once traces of HIV/AIDS is detected, and that research should be intensified on the efficiency level of the different antiretroviral drug in the different patient.

Keywords: *antiretroviral drug, CD4 count, demographic characteristics, HIV/AIDS, principal component*

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1. Introduction

CD4 cells are a type of lymphocyte white blood cell, an important part of the immune system and sometimes called T-cells. There are two main types of CD4 cells. T-4 cells, also called CD4+, are "helper" cells. They lead the attack against infections. T-8 cells (CD8+) are cytotoxic or"suppressor" cells that end the immune response. Tests for CD4 and/or CD8 cells are most often used to help monitor disease progression in human immunodeficiency virus (HIV),CD4 cell tests are normally reported as the number of cells in a cubic millimeter (mm^3) of blood, and the normal counts are usually between 500 and 1600. Since the CD4 cell counts are so variable, most health care providers prefer to look at the CD4 cell percentages in patients, the percentage is more stable than the number of CD4 cells. The normal percentage range is between 30% and 60%. Different laboratories use different ranges and there are no guidelines for treatment decisions based on CD4%. However, a CD4% below 14% is a definition of AIDS. CD4/CD8 ratio is also used to help evaluate and track the progression of HIV infection and disease.

CD4 counts have been shown, scientifically, to be indicators of stage of progression to AIDS, from asymptomatic to pre-AIDS ("AIDS-related complex") to full-blown AIDS and then death. Public health guidelines, recommends the commencement of HIV/AIDS preventive therapy when CD4 count of a patient is under 200 cells per cubic millimeter of blood. Some physicians usually consider treatment earlier, at a CD4 count 350cells/mm^3. The US Centers for Disease Control and Prevention (1993) considers person as HIV-infected when the CD4 counts is below 200 cells/mm^3or a CD4% less than 14% to have AIDS (stage III HIV infection), regardless of whether they have any sign or symptoms.

Akinsegun *et al.* [1] reported that there is an inverse relationship between CD4 count and degree of immunosuppression as contained in his study on CD4 count pattern and demographic distribution of treatment-Na¨ıve HIV Patients in Lagos, Nigeria

Although, lower CD4 count has been identified with sever health condition, but it is often times a reliable assurance of efficacy of medication applied on patient during organ transplant, it helps to evaluate the effect of immunosuppressive medications. In transplantation, the immune system must be suppressed so that it does not attack the transplanted organ and cause rejection. In such situation it becomes desirable to have low levels of CD4 cells. A CD4 count may be repeated periodically to monitor the effectiveness of therapy.

1.1. Problem Statement

Many medical theories have reported that the main target of human immunodeficiency virus is the number of CD4 cells, which decreases as the HIV infection progresses. Akinsegun *et al*. [1] reported that there is an inverse relationship between CD4 count and degree of immunosuppression . CD4 count is used to monitor HIV disease progression and to define the risk for mother-to-child transmission. According to Robert *et al*. nearly all deaths occurred in patients with fewer than 50 CD4 cells/mm^3. Thus, CD4 cells are usually destroyed more rapidly than other types of lymphocytes and the absolute counts vary continuously. Antiretroviral drugs are an extremely well tested class of medicines; it has proven to be effective in slowing down the progression of AIDS and in reducing HIV related illness and death. Antiretroviral therapy (ART) is usually administered based on a patient's CD4 count. GARPR (2012) reported an increase in the statistics of male and female patients on ART between 2006 through to 2011, this shows an increasing patronage in the application of antiretroviral therapy in the treatment of HIV/AIDS. Amatya *et al.* [3] inferred that CD4(+)-lymphocyte counts (LCs) play a major role in the management and monitoring of HIV infection. Variability in CD4(+) LCs has been reported to occur as a result of measurement techniques and/or biological variations. Katubulushi *et al*. [9] reported that all types of white blood cells (WBCs) measured in the complete blood count and platelets decreased significantly among workers exposed to <1 ppm benzene. Similarly, lymphocyte subset analysis also showed a significant decrease in CD4+ T cells, CD4+/CD8+ ratio, and B cells.

The HIV/AIDS scourge has been tamed and managed successfully with the advent of widely accepted use of antiretroviral (ARV) drugs, which has resulted in a manageable rate of the chronic illness. Anti-retroviral therapy (ART) helps to reduce the likelihood that an infected individual transmits the virus to another person thereby increasing the life expectancy of the infected people. WHO [21] recommended CD4 counts of <350 cells/mm^3 for all HIV/AIDS patients as a pre-requisite treatment. Lawn *et al.* [12], Coetzee *et al.* [5], and Van Damme *et al.* [20] identified the challenges of delivering ART in low income countries? due to shortage of healthcare staff, non availability of drugs, weak health systems and laboratory capacity; and poor health data management systems. The study aimed at analyzing those factors that enhances the CD4 counts using antiretroviral therapy among HIV/AIDS patients at Yaba Mainland Hospital in Lagos, Nigeria using principal component analysis.

1.2. Goal and Purpose of the Study

Following the knowledge of World Health Organisation recommendation of 2010, that CD4 counts of <350 cells/mm^3 for all HIV/AIDS patients is a pre-requisite for treatment. Different scholars identified the challenges of delivering Anti-retroviral therapy in low income countries like Nigeria. The awareness of this challenge formed the principal goal of the study, to identify the prominent factors involved in the application of ART to treat HIV/AIDS patients which can improve the patient CD4 count level. It therefore studied the patients' demographic characteristic distribution by gender, age, educational level and occupation, the influence of the demographic characteristics on the CD4 counts and to separate the principal factors among the several factors that needed to be given greater attention when treating the HIV/AIDS patients.

The significance of this study is based on the fact that many other studies on HIV/AIDS have focused on the effects of certain factors and contacting the disease (HIV/AIDS). This study, considered the effect of both demographic and medical treatment on CD4 counts of AIDS patient, the major issue in the treatment of HIV/AIDS.

1.3. The Study Area

The study area is located approximately between latitudes 6^{o}22' 30'N and 6^{o}30'30N and longitudes 3^{o}22'0Eand 3^{o}24'0Ein Lagos Mainland Local Government Area (LGA) of Lagos, Nigeria. It is bounded in the East by Lagos Lagoon, in the North by the Shomolu LGA, in theSouth by Apapa and Lagos Island LGA's and in the West by Surulere (Figure 1).

It occupies a total land area of about 19.62sq.km with a population density of approximately 32,083.03per sq.km [10]. The climate istropical type with an average mean daily temperature of about 30°C and mean annual rainfall of about 1,532mm while the relative humidity is about 80% all the year round [17]. The population is about 629,469 people [15].

2. Materials and Methods

The study participants involve patients receiving treatments at Yaba Mainland Hospital; the patients both male and female comprise the outpatient on clinical consultation at the hospital, since the hospital has no in-patient facility. The participants were addressed on the purpose of the study, their level of required cooperation and guaranteed confidentiality as regards information to be provided. Consequent of which the patients they gave their consent of participation.

Data for the study were obtained through the use of 29 items structured-interviewer questionnaire administered on 200 volunteered HIV/AIDS patients at Lagos Mainland Hospital Yaba, Lagos, Nigeria. The variables identified for the study were categorised into demographic characteristics (educational level, marital status, age and gender) and some selected HIV/AIDS administrative variable (HIV/AIDS confirmation period, type of antiretroviral drug being used, duration of use of antiretroviral administration, and nature of patient job).

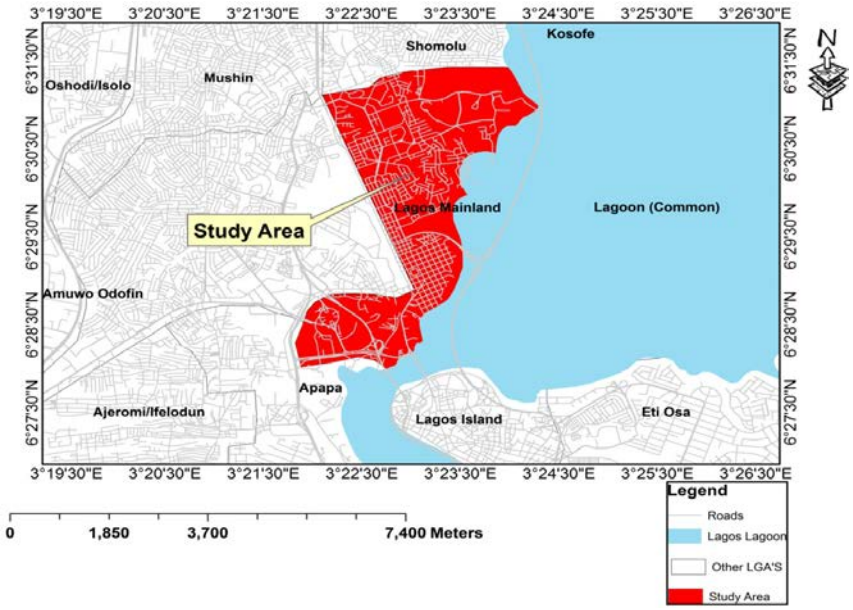

Figure 1. Study area

The data collected were processed by sorting and keying of the data into statistical package for necessary analysis. Statistical Package for Social Science (SPSS version 20) was used, using both descriptive (percentage frequency distribution) and inferential (Correlation test and Principal Component Analysis) statistical tool. Kaiser–Meyer–Olkin (KMO) test of sampling adequacy was conducted which gave a coefficient of 0.650 and Bartlett's test or sphericity of Chi-square with p-value of 0.00 indicating that the variables are correlated enough to provide reasonable basis for factor analysis. The Spearman correlation test was conducted to ensure non existence of multicolinearity among the components by correlation matrix and the components were found to have high correlation coefficient. A principal component analysis was performed to determine the principal components among the identified variables.(More information is still necessary). The questionnaire administration response rate is 91%, an indication of positive effect of pre-administration address had with the patients. A total of 220 questionnaires were administered to the volunteered participants in the study, out of which 200 were returned.

3. Results and Discussion

The results of the demographic characteristics distribution (Table 1) show that, 60.5% were female and 39.5% male, 53% were single, 34.5% married and other divorced/widow. The finding as regards gender ratio distribution conforms to the findings of Akinsegun *et al.* [1] in Benin City, Nigeria. Similarly, it also conform the study conducted by NACA in 2010 where, women showed a higher HIV prevalence than men and also the prevalence of HIV among female injecting drug users(IDUs) was almost seven times that of male in the ratio of 21%: 3% respectively. On educational status, 61.5% had secondary level education, 31% had tertiary level education and 2.5% had no education. The average age range is given between 21-25 years old for the female patients and between 26 – 31 years old for the male.

Table 1. Demographic Characteristics Distribution of the Respondents

S/N	Variables	Frequency (F)	Percentage(%)
1	Gender:		
	Male	79	39.5
	Female	121	60.5
2	Marital Status:		
	Single	106	53.0
	Married	69	34.9
	Divorced	18	9.0
	Widow/Widower	7	3.5
3	Education:		
	No Education	5	2.5
	Primary	10	5.0
	Secondary	123	61.5
	HND/BSc.	62	31.0
4	Profession:		
	Artisan	136	68
	Professional	26	13
	Business	38	19
5	HIV/AIDS status known to friends:		
	Yes	45	22.5
	No	155	77.5
6	Where was status confirmed?		
	General Hospital	72	36
	Private Hospital	128	64

Field Work 2013.

A good percentage of the patient 68% (136) were artisans (hairdresser, taylor/fashion designer/trading), 19% (38) were into business and 13% (26) were professionals. The findings also show that 36% (72) of the patients confirmed their status at government general hospital, while 64% (128) claimed to have confirmed their status at private hospitals. The study also found that 77.5% (155) of the patients admitted to have their status undisclosed to their friends while the remaining 22.5% (45) revealed it to their friends.

Factor analysis (FA) is a multivariate statistical technique used to reduce dataset for the purpose of predicting a response [8]. FA also attempts to explain the common variance shared by the observed variables and tries to find the underlying factors that are responsible for the interrelationships between observed variables [8]. The interpretation of factor loadings is an important process because the loadings represent the degree to which that variable, or parameter, is influenced by that factor [8]. According to Liu *et al.*, [13], factor loadings can be classified as strong, medium and weak corresponding to values of >0.75, 0.75 > 0.5and 0.5 > 0.3, respectively. In this study, a factor loading of 0.75 was chosen as the parameter that influences that factor. Furthermore, the success of FA requires correlation analysis in order to determine the factorability of the data, or the amount of inter-correlation between parameters [8]. The correlation analysis is as shown in the table below.

Table 2. Correlation matrix of the variables

		1	2	3	4	5	6	7	8	9	10
1	Age	1	-.211	.480	.311	.546	.054	-.014	.049	.611	.534
2	Gender		1	-.044	-.329	.033	.058	-.247	-.165	-.004	.002
3	Marital Status			1	.413	.342	.126	-.240	-.192	.405	.405
4	Educational Level				1	.315	.074	-.075	-.189	.346	.374
5	How long have you been HIV confirmed					1	.019	.007	-.041	**.914**	.863
6	Which of the ART drug do you take						1	-.198	.088	.023	.017
7	What is your current level of CD4 count							1	.317	-.001	-.012
8	Has your CD4 count ever increase								1	-.040	-.125
9	How long have you been diagnosed HIVAID									1	**.926**
10	How long have you been using ART drug										1

Correlation coefficient is at 0.05 level of significant.

Remark: It will be observed that there exist a high correlation between component 9 and 10, resulting in the correlation of 0.926 which indicates a sign of multicolinearity. Hence, component 9 (How long have you been diagnosed of HIV/AIDS?) was removed.

In addition, the determination of the appropriate number of factors that needs to be extracted is also important in FA so as to explain the variance in the data set. This can be achieved using screen plot i.e. a visual test where the eigenvalues, which measure the significance of the factor are plotted against the factors [8]. Hence, the number of factors selected corresponds to the point at which the eigenvalues go below one (Figure 2) [8].

Screen Plot as displayed in the fig.2 provides the visual assessment of the number of components to retain, it accounts for the components above the elbow (the point after which the remaining eignevalues decreases in linear fashion).

From this, only four components are retained, which quite agrees with the previous decision to retain age; how long have you been confirmed of HIV/AIDS; how long have you been using Antiretroviral drug and which type of antiretroviral drug being taken.

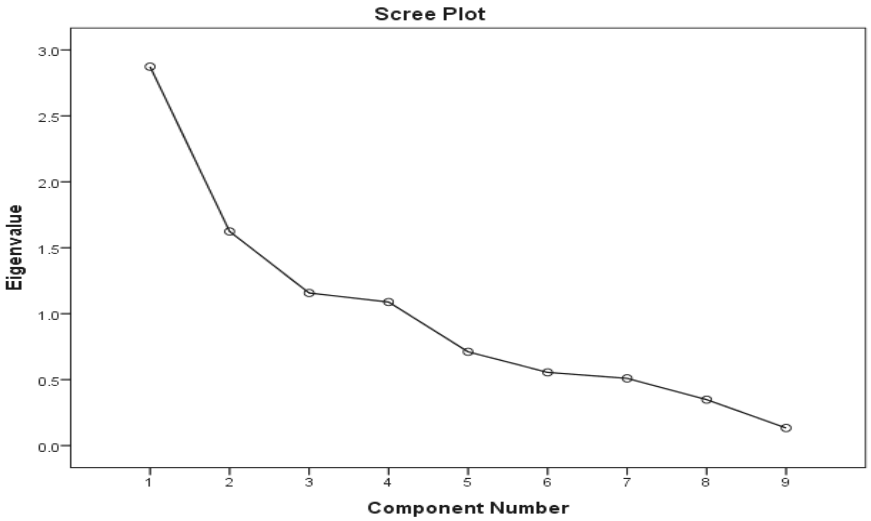

Figure 2. Screen Plot of variables

The descriptive statistics and communalities of the variables is presented in Table 3. The result shows that based on the PCA, variables with corresponding larger standard deviation are regarded as being better component. Hence, age, “how long have you been confirmed”, “how long have you been using the antiretroviral drug”, and

"which of the antiretroviral drugs do you take" are the significant components of CD 4 counts. This is further confirmed by the communalities extraction as indicated Table 3.

Table 3. Descriptive Statistics and Communalities of the Variables

SN		Mean	Std Dev.	Extraction
1	Age	3.88	1.439	0.613
2	Gender	1.61	0.490	0.802
3	Marital Status	1.63	0.791	0.616
4	Educational Level	2.21	0.647	0.701
5	How long have you been confirmed?	3.26	1.316	0.856
6	Which of the antiretroviral drugs do you take	2.00	1.096	0.858
7	What is the current level of your CD 4 counts?	2.15	0.538	0.680
8	Has your CD 4 count ever increased?	1.96	0.196	0.765
9	How long have you been using the antiretroviral drugs?	2.38	1.242	0.852

Remark: From the PCA, the extraction explained the proportion of variables that can be explained by the magnitude of standard deviation. Hence, four variables are found to be significantly represented in the common factor space, these are Age; how long have you been confirmed? ; which of the antiretroviral drugs do you take? and how long have you been using the antiretroviral drugs?

Assessing the Total Varaince Explained : Eignevalue is an index of the strength of the component, the amount of variance it accounts for. It's expressed as the sum of squared loadings for the component.

Table 4. Total Variance Explained by Eigenvalue Index

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
component	Total	% of Varia	Cumm. %	Total	% of Varian	Cumm. %
1	2.873	31.925	31.925	2.873	31.925	31.925
2	1.624	18.040	49.965	1.624	18.040	49.965
3	1.157	12.858	62.822	1.157	12.858	62.822
4	1.089	12.096	74.919	1.089	12.096	74.919
5	.711	7.901	82.820			
6	.555	6.169	88.989			
7	.509	5.661	94.650			
8	.348	3.870	98.520			
9	.133	1.480	100.000			

Remark: From the eigenvalue table above four components cumulative percentage to equal 75%. Hence the first four components are retained.

4. Component Matrix Extraction

The Eigenvalues (Total) measures the variance in all the variables which is accounted for by that factor. It is the ratio of explanatory importance of the factors with respect to the variables. An eigenvalue of I or more indicate that PCs account for more variance than accounted by one of the original variables in standardized data. This is commonly used as a cutoff point for which PCs are retained.

The correlation between the original data and each principal component were computed. The interpretation of the principal component is based on the variables that are most strongly correlated with each component (Table 5). Each component has percentage variance of 31.925% for age, 18.040% for "how long have you been confirmed", 12.858% for "how long have you been using the antiretroviral drug", and 12.096% "which of the antiretroviral drugs do you take".

Table 5. Factor analysis component Matrix

S/N		F_1	F_2	F_3	F_4
1	Age	**.732**	.236	.058	.135
2	Gender	-.087	**-.595**	**.651**	.128
3	Marital Status	**.698**	-.294	-.205	-.007
4	Educational Level	**.**570	.054	**-.587**	-.168
5	How long have you been HIV?AIDs confirmed?	**.833**	.193	.353	-.019
6	Which of the antiretroviral drug do you take?	.146	-.206	-.269	**.850**
7	What is your current level of CD4 count?	-.186	**.779**	.127	-.146
8	Has your CD4 count ever increased?	-.209	**.651**	.127	.531
9	How long have you been using Antiretroviral drug?	**.851**	.118	.337	-.013

Remark: Regardless of sign, a correlation value above 0.5 is deemed important. Hence, from the table above, a maximum of four components can be extracted from a component. Therefore, component 1 loading gives

Eigenvalue of factor 1:

$$.732^2 + .698^2 + .833^2 + .851^2 = 2.873 \quad (1)$$

5. Findings

A principal component analysis was performed to determine the principal components among the identified components. Findings from total variance explained and

the screen plot identified four components (type of antiretroviral drug being taken, duration of HIV/AIDS confirmation, duration of antiretroviral drug application, and patient age) as the principal components to the determination of CD4 count in HIV/AIDS patients at the hospital.

The study has been able to establish that four components namely, Age; type of antiretroviral drug being taken; duration of the patient confirmation (how long have you been confirmed of HIV/AIDS); and duration of ART application (how long the patients have been using Antiretroviral drug) as the significant factors that enhances the CD4 count level in HIV/AIDS patient.

It is also found that age has a significant effect on the CD4 count of patient undergoing treatment. This tends to be in agreement with finding from Laah [11] which identified early age of sex as being responsible for the relatively high prevalence of HIV/AIDS among women in Nigeria.

6. Conclusion

With the findings from the study, much as the treatment of HIV/AIDS is important to Governments and agencies globally, it is important to consider factors that help the effective treatments being giving to the patients. It is therefore becomes important to know that, apart from the issue surrounding the type of anti-retroviral therapy, other factors like, duration of HIV/AIDS confirmation, duration of antiretroviral drug application, and patient age are very important in the treatment of the patients.

7. Recommendation

The study recommended that all hospital patients should be subjected to compulsory HIV/AIDS test as part of consultation conditions. Discovered HIV/AIDS patients should be encouraged to commence early application of antiretroviral drug once traces of HIV/AIDS is detected, and that research should be intensified on the efficiency level of the different antiretroviral drug in the different patient.

Government should formulation synergy to encourage operational relationship between public and private medical centers with particular reference in the treatment of HIV/AIDS patients. Continue public enlightenment should persists to encourage promotion of information on the disease.

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