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Research Article

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Behavioral, Demographic, and Clinical Determinants of HIV Status in Zambian Women

Debebe Gebreyohannes[1]*, Ji Shen[2], Kelley Sams[2]

Abstract

The rate of the human immunodeficiency virus (HIV) infection shows a diminishing trend globally, but Sub-Saharan Africa faces an increasing intensity of mortality, morbidity, and burden of HIV. In Zambian women specifically, the intertwined behavioral, demographic, and clinical determinants have caused the incidence of infections. This study, therefore, aimed to determine the association between demographic, behavioral, and clinical determinants with HIV serostatus in Zambian women. Using the conceptual framework of the World Health Organization's Commission for Social Determinants of Health and the multivariate analysis of variance quantitative method, this study examined Zambian Demographic Health Survey data for Zambian women between two age groups (adolescents and adults). The findings showed statistically significant results in the association between HIV serostatus and self-perceived HIV risk for both groups and the association between education and HIV serostatus among women in both groups (p ≤.027). However, no statistically significant association existed between behavioral, demographic, and clinical determinants of HIV serostatus (p≤796). The findings imply the need to conduct prospective studies on such determinants to curb HIV incidence rates and improve women's community health in Africa.

Keywords: HIV serostatus; Determinants of HIV serostatus; Self-perceived HIV risk; Zambia

Introduction

The Human Immunodeficiency Virus (HIV) infects humans and leads to acquired immune deficiency syndrome (AIDS), a lethal disease that weakens the immune system [1]. Approximately 37 million people are living with HIV, and each year, about 2 million new infections and almost 1 million AIDS-related deaths occur [2]. Although infection rates of HIV/AIDS are decreasing globally, infection rates and prevalence have increased in Zambia and other Sub-Saharan African countries [3, 4]. Meager HIV prevention and insufficient access to clinical services are common issues in countries in this region. 90% of HIV infections in this region are due to low condom use and multiple sexual partners [5,6]. Within the above context, the purpose of this study was to assess the associations between behavioral, demographic, and clinical determinants of HIV serostatus in Zambian women. The findings from this study could inform methods to reduce new infections, deter mortality and morbidity associated with AIDS, and improve the quality of life for Zambian women living with HIV/AIDS.

Affiliation:

[1]University of Colorado Anschutz Medical Campus, Animal Care Technician, USA

[2]Department of Health Science, Walden University Instructor, USA

***Corresponding Author**

Debebe Gebreyohannes, University of Colorado Anschutz Medical Campus, Animal Care Technician, USA.

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Behavioral Factors

Behavioral factors-such as multiple sexual partners, unprotected sex, nondisclosure of HIV-positive serostatus, increased new HIV infections, and the spread of HIV for adolescent and adult women— contributes to the prevalence of HIV [7, 8]. Mathur et al. found that, for heterosexual couples, having multiple sexual partners alone contributed to 15% of female HIV-positive cases and increased HIV prevalence by 4% for 15- to 19-year-old Zambian women [9]. Other researchers have found a positive correlation between the rate of HIV infection and sexual risk-taking in adolescent and adult women [10]. Among all 15- to 49-year-olds, for example, risky sexual behaviors led to more significant increases in HIV prevalence for women than for men [11].

Demographic Factors

HIV serostatus correlates with demographic variables such as age, sex, and location. For example, Chanda-Kapata, et al.[12] and McCarraher et al. [13] found that women have higher HIV infection rates than men. Further, Okawa et al. [14] found that female adolescents did not understand HIV transmission methods, even though the adolescents were concerned about its effect on their future marriages. Kharsany [14] found consistent increases in HIV infection and transmission rates in Zambian women aged 18-49 years; these rates were six times higher than those of similarly aged Zambian men. Both HIV/AIDS infection rates and HIV-associated deaths are higher among women [15]. Research also suggests that the risk level is higher in urban areas than in rural ones [12,13]. People unaware of their HIV status face an elevated risk of spreading the virus. In Zambia, HIV affects 12.9% of the population, and an estimated 1.2 million women aged 15-49 years have HIV [16].

Clinical Factors

The clinical factors include HIV diagnosis, individuals' relationships with their healthcare providers, and access to counseling. Some factors serve as barriers to HIV testing and treatment, whereas access to counseling facilitated the prevention of the disease.

Materials and Methods

Population

The study population included Zambian women aged 18 to 49 years old who were permanent residents in eight provinces. The target population was from a demographic health survey conducted between 2009 and 2010. Specifically, it contained 1,441 responses from Zambian women aged 18 to 49 years old about fertility preferences, HIV status; fertility preferences; attitudes toward and knowledge about HIV, and attitudes toward and use of HIV services [17].

Sampling and Sampling Procedures

The sampling strategy divided each of the eight Zambian provinces into enumerative equal areas based on the 2000 Zambian population and housing census. All households had the chance to be selected as part of the Zambian Demographic Health Survey (ZDHS) sample. The sampling procedure stratified the ZDHS sample into urban and rural areas, creating 18 sampling strata within the eight provinces. Initially, the samplers began with the Census Supervisory Area (CSA), then moved to the Enumeration Areas (EAs), and finally independently selected EAs for all stratifications. The sampling frame included Zambian women aged 18 to 49 years old and excluded females younger than 18 years old, women older than 49 years old, and males of any age. The research sample was sub-sampled from the 2007 ZDHS. The sample was designed to provide specific indicators, including reproductive health indicators and HIV prevalence for each of the eight provinces in Zambia. Sorting the sample frame followed an implicit stratification and proportional allocation based on the geographical/administrative order and a probability proportional to size. Using implicit stratification allowed for sorting the population rather than sorting into groups to apply the continuous variables of Zambian adolescent women (aged 8–24 years) and adult women (aged 25–49 years). Stratification sampling was completed before the selection of the sample [18], which was guided by specific procedures. Households were listed from 319 EAs. From each EA, an average of 25 households was selected through equal probability systematic sampling. From the average total of those EAs, the ones in Northern province and Lusaka province were sub–sampled for this study. I used a power analysis to determine the sample size. More specifically, power analysis included the justification for the effect size, alpha level, power level, and citation source for calculating the sample size. The sample size calculation was 1,327 with a 92% power that met the eventual sample size criterion.

Ethical Procedures

Ethical procedures were the formal requirements for conducting this study. I gained access to the archived demographic data from the Walden University database and requested approval from the Walden University Institutional Review Board (IRB). The analysis of the data and the writing of the dissertation followed the IRB approval for the use of the data. The IRB provided no study reference ID for its ethics board approval.

For this study, a data-driven approach was applied using the ZDHS data available in the Walden University Inter-University Consortium for Political and Social Research (ICPSR) databases [19]. Quantitative variables were used in the study. The outcome variables were HIV serostatus (HIV positive, HIV negative, unknown status, and serodiscordant

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status). The independent variables were sexual activity, the number of sexual partners, condom use, fertility preferences (behavioral determinants), – age, gender, location, marital status, education, employment (demographic determinants), and – clinical services, and medication adherence (clinical determinants). The confounding variables in the survey data were handled using proportionate stratified sampling, which dealt with the selection of participants based on the stratum of the sampling frame to ensure appropriate sampling representation [20]. Version 25 of the Statistical Package for the Social Sciences (SPSS) was used for all analyses and statistical significance tests with a p-value ≤ 0.05.

The most common source of errors was missing data, coding errors, errors in data entry, inconsistency in responses, extreme outliers, abnormal distributions, and non-linear associations among quantitative variables [21]. Descriptive statistics for quantitative variables help to detect those errors using frequency tables, scatterplots, histograms, and observations of whether the distribution shapes are approximately normally distributed (Warner, 2013). SPSS (version 25) was used for conducting the analysis and managing missing data by list-wise or pairwise deletions [21]. Multivariate Analysis of Variance (MANOVA) statistical tests were used to test hypotheses. This study contained multiple independent variables and three dependent variables. As enumerated by Warner [21], the statistical analysis steps for MANOVA were followed in this study to assess the association between the independent variables and dependent variables. In addition, an extensive description of the statistical significance testing is provided in the result section in which the meanings of these test results are discussed in depth. No rationale supported the inclusion of potential covariates for the two-way MANOVA. Data analyzers were required to observe the normal distribution (to transform or remove outliers if they existed; linearity (deviation from linearity would have compromised the analysis); homogeneity of variances (test homoscedasticity); and homogeneity of variances and covariances (testing the homogeneousness of the variables in the manuscript) [21].

Results

The purpose of the study was to investigate the association between dependent variables (HIV serostatus) and independent variables (behavioral, demographic, and clinical determinants for Zambian women aged 18–49 years) using secondary data collected in 2009–2010 from the ZDHS. I compared adolescents (aged 18–24 years) to adults (25–49 years) to determine whether differences existed in the associations between dependent and independent variables between these age groups. MANOVA revealed a statistically significant ($p \leq 0.01$) association between self-perceived HIV risk and HIV serostatus for Zambian women aged 18–24 (see Table 1). A statistical significance difference existed in self-perceived HIV risk based on HIV serostatus, F (2, 1204) = 2.265, p < .001; Wik's Λ = 0.996, Partial η^2 = .652.

The multivariate analysis tested for associations between the dependent variables (HIV test result, ever-tested HIV, and ever-tested AIDS) and behavioral determinants (sexual partners, condom use, and self-perceived risk) for women aged 25–49. A statistically significant difference observed between self-perceived HIV risk and a linear combination of the three dependent variables. In this main effect, self-perceived HIV risk was statistically significant: Pillai's trace was 0.897, F(2, 2410) = 163.283, p ≤ .001; Wilks's lambda = 0.121, partial η2 = .448 (see Table 2).

Tests of between-subjects effects on behavioral determinants of HIV serostatus for Zambian women aged 25–49 years showed a statistically significant association between condom use and HIV test result [F(1, 1222) = 4.140, p = .04]; self-perceived HIV risk and HIV test result [F(1, 1222) = 6.195, p < .001, partial η^2 = .030]; and self-perceived HIV risk and ever tested HIV [F(1, 1222) = XX, p ≤.001, partial η^2 = .776]. Besides, a statistically significant difference existed in the association between self-perceived HIV risk and a linear combination of the three dependent variables. In this main effect, self-perceived HIV risk was statistically significant: F(2, 1222) = 532.897, p < .001; partial η^2 = .876 (see Table 3).

The tests of between-subjects effects on Zambian women aged 18-24 showed a statistically significant association between education and HIV serostatus F(3, 1245) = 5.992, p = .001, partialη^2 = 0.14 (see Table 4).

Table 5 indicates a statistically significant association between education and the linear combination of the dependent variable for Zambian women aged 25-49 years. In this main effect, education was statistically significant in its association with HIV serostatus: Pillai's trace was 0.015, F(9, 3651) = 2.099, p = .026; Wilks's lambda was 0.985, partial η^2 = .005.

The multivariate tests on synergistic associations between sexual partners, location, and government with HIV test results for Zambian women aged 18–24 years were not statistically significant (see table 7).

The multivariate tests on synergistic associations between behavioral, demographic, and clinical determinants of HIV serostatus for Zambian women aged 25–49 years indicated no statistically significant differences (see table 8).

Data Analyses

This study analyzed archival data from the Walden University datasets accessed through the university's website under Research and Quality for Research. Regarding the

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Table 1: Multivariate Tests on Behavioral Determinants of HIV Serostatus for Zambian Women Aged 18–24 Years.

			df			
Effect and test[a]	Value	*F*	Hypothesis	Error	*p*	Partial η^2
Intercept						
Pillai's trace	0.990	57,877 .883[b]	2	1204	.000	.990
Wilks's lambda	0.010	57,877 .883[b]	2	1204	.000	.990
Hotelling's trace	96.143	57,877 .883[b]	2	1204	.000	.990
Roy's largest root	96.143	57,877 .883[b]	2	1204	.000	.990
Sexual partners						
Pillai's trace	0.001	0.623[b]	2	1204	.537	.001
Wilks's lambda	0.999	0.623[b]	2	1204	.537	.001
Hotelling's trace	0.001	0.623[b]	2	1204	.537	.001
Roy's largest root	0.001	0.623[b]	2	1204	.537	.001
Condom use						
Pillai's trace	0.004	2.265[b]	2	1204	.104	.004
Wilks's lambda	0.996	2.265[b]	2	1204	.104	.004
Hotelling's trace	0.004	2.265[b]	2	1204	.104	.004
Roy's largest root	0.004	2.265[b]	2	1204	.104	.004
Self-perceived HIV risk						
Pillai's trace	0.897	163.283	12	2410	.000	.448
Wilks's lambda	0.121	375.987[b]	12	2408	.000	.652
Hotelling's trace	7.110	712.751	12	2406	.000	.780
Roy's largest root	7.089	1,423.669[c]	6	1205	.000	.876
Sexual Partners × Condom Use						
Pillai's trace	0.001	0.619[b]	2	1204	.539	.001
Wilks's lambda	0.999	0.619[b]	2	1204	.539	.001
Hotelling's trace	0.001	0.619[b]	2	1204	.539	.001
Roy's largest root	0.001	0.619[b]	2	1204	.539	.001
Sexual Partners × Self-Perceived HIV Risk						
Pillai's trace	0.001	0.256	4	2410	.906	.000
Wilks's lambda	0.999	0.256[b]	4	2408	.906	.000
Hotelling's trace	0.001	0.256	4	2406	.906	.000
Roy's largest root	0.001	0.512[c]	2	1205	.599	.001
Condom Use × Self-Perceived HIV Risk						
Pillai's trace	0.002	0.500	4	2410	.736	.001
Wilks's lambda	0.998	0.500[b]	4	2408	.736	.001
Hotelling's trace	0.002	0.500	4	2406	.736	.001
Roy's largest root	0.002	0.921[c]	2	1205	.398	.002
Sexual Partners × Condom Use × Self-Perceived HIV Risk						
Pillai's trace	0.000	0.175[b]	2	1204	.840	.000
Wilks's lambda	1.000	0.175[b]	2	1204	.840	.000
Hotelling's trace	0.000	0.175[b]	2	1204	.840	.000
Roy's largest root	0.000	0.175[b]	2	1204	.840	.000

[a]Design: Intercept + SEXPARTN + CONDOUSE + HIVSELFRISK + SEXPARTN * CONDOUSE + SEXPARTN * HIVSELFRISK + CONDOUSE * HIVSELFRISK + SEXPARTN * CONDOUSE * HIVSELFRISK.
[b]Exact statistic.
[c]The statistic is an upper bound on F that yields a lower bound on the significance level.

Table 2: Multivariate Tests on Behavioral Determinants of HIV Serostatus on Zambian Women Aged 25–49 Years.

			df			
Effect and test	**Value**	**F**	**Hypothesis**	**Error**	**p**	**Partial η²**
Intercept						
Pillai's trace	0.990	57,877.883[a]	2	1204	.000	.990
Wilks's lambda	0.010	57,877.883[a]	2	1204	.000	.990
Hotelling's trace	96.143	57,877.883[a]	2	1204	.000	.990
Roy's largest root	96.143	57,877.883[a]	2	1204	.000	.990
Sexual partners						
Pillai's trace	0.001	0.623[a]	2	1204	.537	.001
Wilks's lambda	0.999	0.623[a]	2	1204	.537	.001
Hotelling's trace	0.001	0.623[a]	2	1204	.537	.001
Roy's largest root	0.001	0.623[a]	2	1204	.537	.001
Condom use						
Pillai's trace	0.004	2.265[a]	2	1204	.104	.004
Wilks's lambda	0.996	2.265[a]	2	1204	.104	.004
Hotelling's trace	0.004	2.265[a]	2	1204	.104	.004
Roy's largest root	0.004	2.265[a]	2	1204	.104	.004
Self-perceived HIV risk						
Pillai's trace	0.897	163.283	12	2410	.000	.448
Wilks's lambda	0.121	375.987[a]	12	2408	.000	.652
Hotelling's trace	7.110	712.751	12	2406	.000	.780
Roy's largest root	7.089	1,423.669[b]	6	1205	.000	.876
Sexual Partners × Condom Use						
Pillai's trace	0.001	0.619[a]	2	1204	.539	.001
Wilks's lambda	0.999	0.619[a]	2	1204	.539	.001
Hotelling's trace	0.001	0.619[a]	2	1204	.539	.001
(table continues)						
Roy's largest root	0.001	0.619[a]	2	1204	.539	.001
Sexual Partners × Self-Perceived HIV Risk						
Pillai's trace	0.001	0.256	4	2410	.906	.000
Wilks's lambda	0.999	0.256[a]	4	2408	.906	.000
Hotelling's trace	0.001	0.256	4	2406	.906	.000
Roy's largest root	0.001	0.512[b]	2	1205	.599	.001
Condom Use × Self-Perceived HIV Risk						
Pillai's trace	0.002	0.500	4	2410	.736	.001
Wilks's lambda	0.998	0.500[a]	4	2408	.736	.001
Hotelling's trace	0.002	0.500	4	2406	.736	.001
Roy's largest root	0.002	0.921[b]	2	1205	.398	.002
Sexual Partners × Condom Use × Self-Perceived HIV Risk						
Pillai's trace	0.000	0.175[a]	2	1204	.840	.000
Wilks's lambda	1.000	0.175[a]	2	1204	.840	.000
Hotelling's trace	0.000	0.175[a]	2	1204	.840	.000
Roy's largest root	0.000	0.175[a]	2	1204	.840	.000

a. Design: Intercept + SEXPARTN + CONDOUSE + HIVSELFRISK + SEXPARTN * CONDOUSE + SEXPARTN *HIVSELFRISK + CONDOUSE * HIVSELFRISK + SEXPARTN * CONDOUSE * HIVSELFRISK.
b. Exact statistic.
c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Table 3: Multivariate Tests on Demographic Determinants of HIV Serostatus on Zambian Women Aged 18–24 Years.

			df			
Effect and test[a]	**Value**	***F***	**Hypothesis**	**Error**	***p***	**Partial η²**
Intercept						
Pillai's trace	0.927	5,109.357[b]	3	1215.000	.000	.927
Wilks's lambda	0.073	5,109.357[b]	3	1215.000	.000	.927
Hotelling's trace	12.616	5,109.357[b]	3	1215.000	.000	.927
Roy's largest root	12.616	5,109.357[b]	3	1215.000	.000	.927
Location						
Pillai's trace	0.002	0.914[b]	3	1215.000	.433	.002
Wilks's lambda	0.998	0.914[b]	3	1215.000	.433	.002
Hotelling's trace	0.002	0.914[b]	3	1215.000	.433	.002
Roy's largest root	0.002	0.914[b]	3	1215.000	.433	.002
Education						
Pillai's trace	0.015	2.099	9	3651.000	.026	.005
Wilks's lambda	0.985	2.106	9	2957.141	.026	.005
Hotelling's trace	0.016	2.111	9	3641.000	.025	.005
Roy's largest root	0.015	5.930[c]	3	1217.000	.001	.014
Marital status						
Pillai's trace	0.003	0.363	9	3651.000	.953	.001
Wilks's lambda	0.997	0.363	9	2957.141	.953	.001
Hotelling's trace	0.003	0.362	9	3641.000	.953	.001
Roy's largest root	0.002	0.964[c]	3	1217.000	.409	.002
Location × Education						
Pillai's trace	0.002	0.225	9	3651.000	.991	.001
Wilks's lambda	0.998	0.224	9	2957.141	.991	.001
Hotelling's trace	0.002	0.224	9	3641.000	.991	.001
Roy's largest root	0.001	0.496[c]	3	1217.000	.685	.001
Location × Marital Status						
Pillai's trace	0.004	0.588	9	3651.000	.808	.001
Wilks's lambda	0.996	0.588	9	2957.141	.808	.001
Hotelling's trace	0.004	0.588	9	3641.000	.808	.001
Roy's largest root	0.004	1.576[c]	3	1217.000	.193	.004
Education × Marital Status						
Pillai's trace	0.012	0.587	24	3651.000	.944	.004
Wilks's lambda	0.988	0.587	24	3524.471	.944	.004
Hotelling's trace	0.012	0.588	24	3641.000	.944	.004
Roy's largest root	0.010	1.449[c]	8	1217.000	.172	.009
Location × Education × Marital Status						
Pillai's trace	0.007	0.506	18	3651.000	.957	.002
Wilks's lambda	0.993	0.506	18	3437.024	.957	.002
Hotelling's trace	0.007	0.505	18	3641.000	.957	.002
Roy's largest root	0.005	1.039[c]	6	1217.000	.398	.005

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Table 4: Multivariate Tests on Demographic Determinants of HIV Serostatus on Zambian Women Aged 25–49 Years.

			df			
Effect and test[a]	**Value**	***F***	**Hypothesis**	**Error**	***p***	**Partial η²**
Intercept						
Pillai's trace	0.927	5,109.357[b]	3	1215.000	.000	.927
Wilks's lambda	0.073	5,109.357[b]	3	1215.000	.000	.927
Hotelling's trace	12.616	5,109.357[b]	3	1215.000	.000	.927
Roy's largest root	12.616	5,109.357[b]	3	1215.000	.000	.927
Location						
Pillai's trace	0.002	0.914[b]	3	1215.000	.433	.002
Wilks's lambda	0.998	0.914[b]	3	1215.000	.433	.002
Hotelling's trace	0.002	0.914[b]	3	1215.000	.433	.002
Roy's largest root	0.002	0.914[b]	3	1215.000	.433	.002
Education						
Pillai's trace	0.015	2.099	9	3651.000	.026	.005
Wilks's lambda	0.985	2.106	9	2957.141	.026	.005
Hotelling's trace	0.016	2.111	9	3641.000	.025	.005
Roy's largest root	0.015	5.930[c]	3	1217.000	.001	.014
Marital status						
Pillai's trace	0.003	0.363	9	3651.000	.953	.001
Wilks's lambda	0.997	0.363	9	2957.141	.953	.001
Hotelling's trace	0.003	0.362	9	3641.000	.953	.001
Roy's largest root	0.002	0.964[c]	3	1217.000	.409	.002
Location × Education						
Pillai's trace	0.002	0.225	9	3651.000	.991	.001
Wilks's lambda	0.998	0.224	9	2957.141	.991	.001
Hotelling's trace	0.002	0.224	9	3641.000	.991	.001
Roy's largest root	0.001	0.496[c]	3	1217.000	.685	.001
Location × Marital Status						
Pillai's trace	0.004	0.588	9	3651.000	.808	.001
Wilks's lambda	0.996	0.588	9	2957.141	.808	.001
Hotelling's trace	0.004	0.588	9	3641.000	.808	.001
Roy's largest root	0.004	1.576[c]	3	1217.000	.193	.004
Education × Marital Status						
Pillai's trace	0.012	0.587	24	3651.000	.944	.004
Wilks's lambda	0.988	0.587	24	3524.471	.944	.004
Hotelling's trace	0.012	0.588	24	3641.000	.944	.004
Roy's largest root	0.010	1.449[c]	8	1217.000	.172	.009
Location × Education × Marital Status						
Pillai's trace	0.007	0.506	18	3651.000	.957	.002
Wilks's lambda	0.993	0.506	18	3437.024	.957	.002
Hotelling's trace	0.007	0.505	18	3641.000	.957	.002
Roy's largest root	0.005	1.039[c]	6	1217.000	.398	.005

a. Design: Intercept + LOCATION + EDUCATION + MARITALST + LOCATION * EDUCATION + LOCATION * MARITALST + EDUCATION * MARITALST + LOCATION * EDUCATION * MARITALST.
b. Exact statistic.
c. The statistic is an upper bound on F that yields a lower bound on the significance level.

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Table 5: Multivariate Tests on Clinical Determinants of HIV Serostatus on Zambian Women Aged 18–24 Years.

Effect and test[a]	Value	F[b]	p	Partial η^2
Intercept				
Pillai's trace	0.986	43,506.206	.000	.986
Wilks's lambda	0.014	43,506.206	.000	.986
Hotelling's trace	71.380	43,506.206	.000	.986
Roy's largest root	71.380	43,506.206	.000	.986
Clinic services				
Pillai's trace	0.000	0.170	.844	.000
Wilks's lambda	1.000	0.170	.844	.000
Hotelling's trace	0.000	0.170	.844	.000
Roy's largest root	0.000	0.170	.844	.000
NGO Services				
Pillai's trace	0.003	1.658	.191	.003
Wilks's lambda	0.997	1.658	.191	.003
Hotelling's trace	0.003	1.658	.191	.003
Roy's largest root	0.003	1.658	.191	.003
Government services				
Pillai's trace	0.000	0.287	.751	.000
Wilks's lambda	1.000	0.287	.751	.000
Hotelling's trace	0.000	0.287	.751	.000
Roy's largest root	0.000	0.287	.751	.000
Clinic Services × NGO Services				
Pillai's trace	0.000	0.002	.998	.000
Wilks's lambda	1.000	0.002	.998	.000
Hotelling's trace	0.000	0.002	.998	.000
Roy's largest root	0.000	0.002	.998	.000
Clinic Services × Government Services				
Pillai's trace	0.000	0.006	.994	.000
Wilks's lambda	1.000	0.006	.994	.000
Hotelling's trace	0.000	0.006	.994	.000
Roy's largest root	0.000	0.006	.994	.000
NGO Services × Government Services				
Pillai's trace	0.001	0.597	.551	.001
Wilks's lambda	0.999	0.597	.551	.001
Hotelling's trace	0.001	0.597	.551	.001
Roy's largest root	0.001	0.597	.551	.001
Clinic Services × NGO Services × Government Services				
Pillai's trace	0.000	0.089	.915	.000
Wilks's lambda	1.000	0.089	.915	.000
Hotelling's trace	0.000	0.089	.915	.000
Roy's largest root	0.000	0.089	.915	.000

Note. Hypothesis *df* = 2. Error *df* = 1219. NGO = nongovernmental organization.
a. Design: Intercept + GOVTEST + CLINICTEST + NGOTEST + GOVTEST * CLINICTEST + GOVTEST * NGOTEST + CLINICTEST * NGOTEST + GOVTEST * CLINICTEST * NGOTEST
b. Exact statistic

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Table 6: Multivariate Tests on Clinical Determinants of HIV Serostatus on Zambian Women Aged 25–49 Years.

Effect and test[a]	Value	F^b	p	Partial η^2
Intercept				
Pillai's trace	0.986	43,506.206	.000	.986
Wilks's lambda	0.014	43,506.206	.000	.986
Hotelling's trace	71.380	43,506.206	.000	.986
Roy's largest root	71.380	43,506.206	.000	.986
Clinic services				
Pillai's trace	0.000	0.170	.844	.000
Wilks's lambda	1.000	0.170	.844	.000
Hotelling's trace	0.000	0.170	.844	.000
Roy's largest root	0.000	0.170	.844	.000
NGO Services				
Pillai's trace	0.003	1.658	.191	.003
Wilks's lambda	0.997	1.658	.191	.003
Hotelling's trace	0.003	1.658	.191	.003
Roy's largest root	0.003	1.658	.191	.003
Government services				
Pillai's trace	0.000	0.287	.751	.000
Wilks's lambda	1.000	0.287	.751	.000
Hotelling's trace	0.000	0.287	.751	.000
Roy's largest root	0.000	0.287	.751	.000
Clinic Services × NGO Services				
Pillai's trace	0.000	0.002	.998	.000
Wilks's lambda	1.000	0.002	.998	.000
Hotelling's trace	0.000	0.002	.998	.000
Roy's largest root	0.000	0.002	.998	.000
Clinic Services × Government Services				
Pillai's trace	0.000	0.006	.994	.000
Wilks's lambda	1.000	0.006	.994	.000
Hotelling's trace	0.000	0.006	.994	.000
Roy's largest root	0.000	0.006	.994	.000
NGO Services × Government Services				
Pillai's trace	0.001	0.597	.551	.001
Wilks's lambda	0.999	0.597	.551	.001
Hotelling's trace	0.001	0.597	.551	.001
Roy's largest root	0.001	0.597	.551	.001
Clinic Services × NGO Services × Government Services				
Pillai's trace	0.000	0.089	.915	.000
Wilks's lambda	1.000	0.089	.915	.000
Hotelling's trace	0.000	0.089	.915	.000
Roy's largest root	0.000	0.089	.915	.000

Note. Hypothesis *df* = 2. Error *df* = 1219. NGO = nongovernmental organization.

a. Design: Intercept + GOVTEST + CLINICTEST + NGOTEST + GOVTEST * CLINICTEST + GOVTEST * NGOTEST + CLINICTEST * NGOTEST + GOVTEST * CLINICTEST * NGOTEST

b. Exact statistic

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Table 7: Multivariate Tests on Synergistic Analysis of Behavioral, Demographic, and Clinical Determinants of HIV Serostatus for Zambian Women Aged 18–24 Years.

			df			
Effect and test[a]	**Value**	***F***	**Hypothesis**	**Error**	***p***	**Partial η²**
Intercept						
Pillai's trace	0.991	63,188.837[b]	2	1195.0	.000	.991
Wilks's lambda	0.009	63,188.837[b]	2	1195.0	.000	.991
Hotelling's trace	105.755	63,188.837[b]	2	1195.0	.000	.991
Roy's largest root	105.755	63,188.837[b]	2	1195.0	.000	.991
Sexual partners						
Pillai's trace	0.001	0.257	4	2392.0	.905	.000
Wilks's lambda	0.999	0.257[b]	4	2390.0	.905	.000
Hotelling's trace	0.001	0.257	4	2388.0	.905	.000
Roy's largest root	0.001	0.508[c]	2	1196.0	.602	.001
Location						
Pillai's trace	0.001	0.438[b]	2	1195.0	.645	.001
Wilks's lambda	0.999	0.438[b]	2	1195.0	.645	.001
Hotelling's trace	0.001	0.438[b]	2	1195.0	.645	.001
Roy's largest root	0.001	0.438[b]	2	1195.0	.645	.001
Government services						
Pillai's trace	0.870	460.457	4	2392.0	.000	.435
Wilks's lambda	0.130	1,058.488[b]	4	2390.0	.000	.639
Hotelling's trace	6.680	1,993.840	4	2388.0	.000	.770
Roy's largest root	6.679	3,994.196[c]	2	1196.0	.000	.870
Sexual Partners × Location						
Pillai's trace	0.004	1.285	4	2392.0	.273	.002
(table continues)						
Wilks's lambda	0.996	1.285[b]	4	2390.0	.273	.002
Hotelling's trace	0.004	1.285	4	2388.0	.273	.002
Roy's largest root	0.004	2.471[c]	2	1196.0	.085	.004
Sexual Partners × Government Services						
Pillai's trace	0.001	0.416[b]	2	1195.0	.660	.001
Wilks's lambda	0.999	0.416[b]	2	1195.0	.660	.001
Hotelling's trace	0.001	0.416[b]	2	1195.0	.660	.001
Roy's largest root	0.001	0.416[b]	2	1195.0	.660	.001
Location × Government Services						
Pillai's trace	0.000	0.039	4	2392.0	.997	.000
Wilks's lambda	1.000	0.038[b]	4	2390.0	.997	.000
Hotelling's trace	0.000	0.038	4	2388.0	.997	.000
Roy's largest root	0.000	0.077[c]	2	1196.0	.926	.000
Sexual Partners × Location × Government Services						
Pillai's trace	0.000	—[b]	0	0.0	—	—
Wilks's lambda	1.000	—[b]	0	1195.5	—	—
Hotelling's trace	0.000	—[b]	0	2.0	—	—
Roy's largest root	0.000	0.000[b]	2	1194.0	1.000	.000

a. Design: Intercept + SEXPARTN + LOCATION + GOVTEST + SEXPARTN * LOCATION + SEXPARTN * GOVTEST + LOCATION * GOVTEST + SEXPARTN * LOCATION * GOVTEST
b. Exact statistic
c. The statistic is an upper bound on F that yields a lower bound on the significance level.

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Table 8: Multivariate Tests on Synergistic Association of Behavioral, Demographic, and Clinical Determinants of HIV Serostatus for Zambian Women Aged 25–49 Years.

			df			
Effect and test[a]	**Value**	***F***	**Hypothesis**	**Error**	***p***	**Partial η²**
Intercept						
Pillai's trace	0.987	43575.177[b]	2	1183	.000	.987
Wilks's lambda	0.013	43575.177[b]	2	1183	.000	.987
Hotelling's trace	73.669	43575.177[b]	2	1183	.000	.987
Roy's largest root	73.669	43575.177[b]	2	1183	.000	.987
Self-perceived HIV risk						
Pillai's trace	0.011	1.292	10	2368	.229	.005
Wilks's lambda	0.989	1.294[b]	10	2366	.228	.005
Hotelling's trace	0.011	1.297	10	2364	.226	.005
Roy's largest root	0.011	2.597[c]	5	1184	.024	.011
Marital status						
Pillai's trace	0.000	0.051	6	2368	.999	.000
Wilks's lambda	1.000	0.051[b]	6	2366	.999	.000
Hotelling's trace	0.000	0.051	6	2364	.999	.000
Roy's largest root	0.000	0.102[c]	3	1184	.959	.000
NGO Services						
Pillai's trace	0.001	0.552[b]	2	1183	.576	.001
Wilks's lambda	0.999	0.552[b]	2	1183	.576	.001
Hotelling's trace	0.001	0.552[b]	2	1183	.576	.001
Roy's largest root	0.001	0.552[b]	2	1183	.576	.001
Self-Perceived HIV Risk × Marital Status						
Pillai's trace	0.008	0.329	28	2368	1.000	.004
Wilks's lambda	0.992	0.329[b]	28	2366	1.000	.004
Hotelling's trace	0.008	0.329	28	2364	1.000	.004
Roy's largest root	0.008	0.657[c]	14	1184	.817	.008
Self-Perceived HIV Risk × NGO Services						
Pillai's trace	0.002	0.186	10	2368	.997	.001
Wilks's lambda	0.998	0.186[b]	10	2366	.997	.001
Hotelling's trace	0.002	0.186	10	2364	.997	.001
Roy's largest root	0.002	0.370[c]	5	1184	.869	.002
Marital Status × NGO Services						
Pillai's trace	0.002	0.333	6	2368	.920	.001
Wilks's lambda	0.998	0.333[b]	6	2366	.920	.001
Hotelling's trace	0.002	0.333	6	2364	.920	.001
Roy's largest root	0.002	0.665[c]	3	1184	.574	.002
Self-Perceived HIV Risk × Marital Status × NGO Services						
Pillai's trace	0.002	0.264	10	2368	.989	.001
Wilks's lambda	0.998	0.264[b]	10	2366	.989	.001
Hotelling's trace	0.002	0.264	10	2364	.989	.001
Roy's largest root	0.002	0.527[c]	5	1184	.756	.002

Note. NGO = nongovernmental organization.

a. Design: Intercept + CONDOUSE + EDUCATION + CLINICTEST + CONDOUSE * EDUCATION + CONDOUSE * CLINICTEST + EDUCATION * CLINICTEST + CONDOUSE * EDUCATION * CLINICTEST

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

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instrumentation and operationalization of constructs, an on-site questionnaire was the basic data collection used for the ZDHS. The operationalization of the ZDHS data indicated weighted data but in the form of a weight variable which was used directly in the study analysis. The scores represented numeric values for the independent variables (behavioral, demographic, and clinical determinants of HIV serostatus). However, no operational definition was available for each variable. I used SPSS statistics 25 software for the data analyses, and the study dataset indicated the availability of data suitable for analyses in SPSS format. MANOVA was used to calculate the statistics of this research to determine how the independent categorical variables affected multiple continuous dependent variables. The statistical tool MANOVA compared the HIV serostatus independent variables with the dependent variables of behavioral, demographic, and clinical determinants. The combination of the multiple dependent variables allowed for obtaining a greater statistical power with a correlation of the dependent variables. Despite being collected in 2009—2011, the data were released on September 04, 2017. I obtained access to the database and conducted analyses in 2019 and completed the research work in February 2020. That time frame maintains the relevance of the epidemiological findings. Similarly, the validity of the associations remains valid for landscape demonstrating low substantial change during this time.

The MANOVA was chosen for this article to determine how the independent categorical variables affected multiple continuous dependent variables. I compared several groups with respect to multiple continuous variables. The authors compared several groups with respect to multiple continuous variables to assess the effect of the independent categorical variables' HIV serostatus (HIV positive, HIV negative) on continuous dependent variables behavioral, demographic, and clinical determinants." In this regard, MANOVA linearly combined the multiple dependent variables to produce a combination that best separated the independent variable groups with greater statistical power by identifying effects smaller than those identified as ineffective. The 2018–2019 demographic health survey showed that the rate of HIV prevalence increased in less educated adolescent girls and young women than in highly educated ones. This finding indicates that education serves as a strong indicator HIV infection rate status and demonstrates the epidemiological importance of this research article that used the 2009 and 2010 demographic health survey data [26].

Discussion

Behavioral Determinants of HIV Serostatus

For both women aged 18–24 years and women aged 25-49 years, a significant association existed between HIV serostatus and self-perceived HIV risk but not sexual partners or condom use. This finding aligns with Adeniyi et al. [19], who also examined behavioral, demographic, and clinical determinants and HIV serostatus. However, Adeniyi et al. [19] studied only one HIV serostatus variable compared to the three serostatus variables used in this study. The findings of this study revealed a link between the HIV test result variable and self-perceived HIV risk for women aged 18–24 years. Specifically, a strong association existed between the perception of no risk or small risk and HIV serostatus. Toska et al. [10] reported the presence of a direct association between HIV acquisition in adolescent women (aged 18-24 years) and having multiple sexual partners, although the finding was inconclusive. That finding aligned with a secondary analysis of a cross-sectional study conducted in Uganda, which indicated an association between self-perceived HIV risk and the incidence of HIV infection among women of all ages. Further elucidating the impact of self-perceived HIV risk, the findings of the current study could be used to inform a prevention strategy for Zambian women and probably women in similar settings and socioeconomic statuses in other parts of Sub-Saharan Africa. Rosenberg et al. [20], reporting on a population-based study, discussed how the spread of HIV had accelerated in older adults in South Africa and recommended the commencement of prevention activities for analogous communities in Sub-Saharan African countries.

Demographic Determinants of HIV Serostatus

The findings in this study showed a statistically significant association between education and HIV serostatus among women in both age groups. However, unlike in previous studies, no statistically significant differences existed in this study for the demographic variables of location and marital status, and the pairwise interactions of location and marital status, location and education, and marital status and education. Omonaiye et al.[21], Pinchoff et al. [7], and Okawa et al. [22] reported that age and education were critical to determining HIV serostatus for adolescent and adult women at the individual and societal levels. The lack of associations between HIV serostatus and age (adolescent versus adult) and location (urban versus rural) also contrasted the findings of authors who identified strong and significant associations between HIV serostatus and age, gender, and location [12,13]. Mee et al. [24] found that being in school not only increased students' awareness of HIV and the practice of preventive measures but also eventually contributed to diminishing the spread of HIV infection. Other researchers failed to find an association between education and the use of HIV services [24]. Bunyasi et al. [25] suggested a direct association between accomplishment in education and the reduction of HIV prevalence. The main reason for the association between a lower incidence of HIV and higher educational achievement may be the ability of educated people to implement safer sexual practices and abstain from sexual activity. Increased

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health literacy and academic progress could empower educated people to engage in informed decision-making and take responsibility for themselves and their communities.

Clinical Determinants of HIV Serostatus

The findings in this study also indicated a significant association between aggregate use of HIV services and HIV serostatus for women in both age groups. This result neither confirmed nor refuted the conclusions reported by authors of systematic reviews, who implied that it was essential to conduct further studies to maximize prevention using HIV medications [26,27]. However, in the current study, no significant associations were observed between HIV serostatus and the use of government services, clinic services, and NGO services considered individually. This finding agreed with the results of Mustapha et al. [28] regarding the use of HIV services by women in Uganda, a Sub-Saharan country with substandard HIV services for women. Yet Mustapha et al. [28] also reported that women who knew their HIV status were motivated to use services but women who did not know their HIV serostatus and faced discrimination, and economic constraints were demotivated to use HIV services. The authors of systematic studies described the benefits of team-based HIV service access to improve HIV prevention in Sub-Saharan African countries. Reviewers of quantitative and qualitative studies explicitly described associations between HIV serostatus and the use of team-based services versus institutionalized HIV services (i.e., from governments, clinics, and NGOs) [29]. In HIV-prone Sub-Saharan African countries, the availability of HIV services could be positive indicator of the containment of HIV spread and the deterrence of new infections. The use of HIV services in communities has the same level of importance. Along with HIV services, the implementation of precise HIV diagnostic tests to minimize false test outcomes is critical in Sub-Saharan African countries [30].

Demographic, Behavioral, and Clinical Determinants of HIV Serostatus

Multivariate tests indicated no significant association between the synergistic association of demographic, behavioral, and clinical determinants with HIV serostatus for Zambian women aged 18–24. The finding regarding the synergistic association between behavioral, demographic, and clinical determinants with HIV serostatus did not address the recommendation by Kharsany et al. [14] for a study of behavioral determinants and the HIV literacy (education) gap concerning HIV serostatus cognizance at the community level. Synergistic association was observed for demographic, behavioral, and clinical determinants with HIV serostatus for Zambian women aged 25 to 49. The community strategy outlined by health professionals, policymakers, and other entities involved in HIV prevention should be a collective work to manage HIV epidemics.

Limitations of the Study

This study has certain limitations. The exclusion of those aged younger than 18 years and older than 49 years, prisoners, and military personnel was one of the limitations. Because resource constraints dictated that the ZDHS surveyed only two provinces, the other eight provinces were excluded from data collection. The complete absence of men could also be a significant limitation. Another limitation is that the study was cross-sectional rather than longitudinal. Therefore, the study lacked the benefits of conducting longitudinal research, including identifying temporal effects and associated changes in the dynamics of sexual behaviors, demographic shifts, and capacity and acceptability of HIV prevention services. The last limitation is the age of the data from the ZDHS. The lapse of 10 years since the data were collected means the data may not reflect the current situation. However, I could somewhat overcome this limitation by extrapolating the findings through the lens of other consistent HIV research findings in Sub-Saharan Africa. The generalization of the results beyond the specific setting to other similar settings thus appears reasonable.

Recommendations

The recommendations in this section apply to Zambian women and women living in similar settings throughout Sub-Saharan Africa. Notably, the on sequences and risks of HIV prevail in older women. Future researchers can improve the robustness of their findings by including older women. Including this age group in HIV prevention efforts will help to significantly diminish HIV in Sub-Saharan Africa. According to Maughan-Brown et al. [31], the high prevalence of HIV in South Africa has occurred due to risky sexual behaviors among older women. However, HIV is a public health threat in every county, so national and international collaborations are pivotal to lessening the spread of HIV globally. A unified approach to HIV prevention and control would have collateral health benefits when supported by measurable goals and comprehensive strategies [32,33].

Implications

The dynamics of sexual behaviors and their associations with HIV serostatus indicate their impacts on HIV prevalence, incidence, and epidemics in Sub-Saharan Africa. One of the foci regarding the lessoning of such impact was the paramount importance of the consolidation of leadership to mobilize communities for harmonized HIV responses [34]. In conjunction with the findings on the associations of behavioral, demographic, and clinical determinants with HIV serostatus for Zambian women aged 18-49, the

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inclusion of female participants younger than 18 years and older than 49 years would yield more holistic findings that could be applied to fighting HIV [20]. The findings regarding the associations of behavioral, demographic, and clinical determinants with HIV serostatus can be used to project risk, inform prevention efforts, and initiate longitudinal research. These findings suggest that self-perceived HIV risk, education, and type of HIV services are reliable indicators of HIV serostatus. Based on such findings, effective HIV prevention and control in Sub-Saharan countries should focus on developing awareness using educational advancement as a tool, recognizing HIV risks through health literacy, and addressing social determinants of HIV health. These findings ultimately complement the growing evidence indicating the benefits of collaborative HIV prevention efforts that involve HIV researchers and health professionals at both the local and international levels.

Conflict of interest

The authors declare no conflict of interests.

Author Summary

Zambia is a country in the Sub-Saharan region of Africa, which disproportionately faces the risk of an increase in HIV infection rate and the number of people impacted. For women aged 18-19 years old, the HIV exposure rate especially shows an extraordinary increase. The behavioral, demographic, and clinical determinants of HIV serostatus form an intricate web that snares adolescent and adult women, deteriorating their quality of life and their mental and emotional well-being.

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