

Explanatory Factors for the Variation in HIV Prevalence between Regions of Côte d'Ivoire: An Ecological Study

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Abstract

Introduction: No study has analyzed the reasons for the difference in HIV prevalence between Ivorian regions ranging from 1.3% in the central-western region to 4.1% in Abidjan among men. **Objective:** To analyze explanatory factors for the difference in HIV prevalence observed in men in Côte d'Ivoire's regions. **Methodology:** Assessment of the relationship between HIV prevalence per region and risk factors explored in the 2012 Côte d'Ivoire Demographic and Health Surveys (DHS). A multivariate analysis was conducted to assess the relationship between HIV prevalence and each variable. **Results:** The explanatory power of the variation of HIV prevalence between regions was 98%. There was a significant association between HIV prevalence and union ($r = -0.38$; $p = 0.008$; 95% CI $(-0.53$ to $-0.23)$), condom use ($r = -0.01$; $p = 0.19$; 95% CI $(-0.03$ to $-0.01)$), practice of Christian religion ($r = -0.1$; $p = 0.017$; 95% CI $(-0.16$ to $-0.05)$), and schooling ($r = -0.01$; $p = 0.25$; 95% CI $(-0.04$ to $0.02)$). There was a paradoxical association between HIV prevalence and mean age at first sexual intercourse ($r = -0.1$; $p = 0.017$; 95% CI $(-0.16$ to $-0.05)$) and sexual infections ($r = -0.48$; $p = 0.016$; 95% CI $(-0.75$ to $-0.22)$). **Conclusion:** The explanatory factors for the difference in HIV prevalence observed in men in the regions of the country were union, condom use, mean age at first sexual intercourse, sexual infection, sexual activity, and multiple sexual partnerships. However, only union and condom use were effective in reducing HIV prevalence by preventing new infections.

Keywords

VIH Prevalence, Explanatory Factors, Ecological Study, Region, Sub-Saharan Africa

1. Introduction

HIV infection remains a priority public health problem in the West African sub-region and in Côte d'Ivoire, where prevalence has dropped from 3.7% [1] to 2.5% among adults aged 15 to 49. Several national studies have incriminated key populations of men who have sex with men [2] [3] and transgender women [4] as well as the population of male [5] and female [6] [7] [8] sex workers, migrants, and armed forces [9] [10] as being at the root of the spread of the epidemic. Individual risk behaviors that have been shown in the local literature to be responsible include anal sex [2] [3] [6], sexually transmitted infections [11] [12], unprotected sex, multiple partnerships, risky casual sex, early sex and lack of circumcision [13].

However, disparities in prevalence exist between sexes, regions, ethnic groups, living environments, etc., like in all countries of the world. Disparities between Ivorian regions range from 2.2% to 5.5% in the general population, including 1.3% to 4.1% in the male subgroup [1]. These disparities within the same country have led to a reconsideration of the fight. Therefore, the emphasis is now put on community risk behaviors research with consequent means of control. Hence, the importance of ecological studies does not use an individual as the subject of research but units grouping individuals with identical characteristics. Thus, several ecological studies have focused on HIV by looking for explanatory factors for different disparities observed in HIV prevalence between countries [14] [15], ethnic groups or regions of the same country [16] [17] [18] [19] [20]. The explanatory factors addressed in these different studies revolve around gender inequalities, sexually transmitted infections (STIs), male circumcision, condom use, high-risk sexual behaviors (casual partners, multiple lifetime partners, concurrent partners, polygamy, early sexual intercourse, premarital sex), and internal and international migration.

In Côte d'Ivoire, in spite of the means of prevention through the popularization of the use of condoms and antiretroviral treatment, the disease continues to be a threat within the general population and among men in particular, especially those who have sexual relations with other men. All studies conducted at the local level have addressed individuals' explanatory factors that make HIV a major public health problem at the national level and place the country at the forefront of the West African region. No study has looked at regional disparities in HIV prevalence in Côte d'Ivoire to try to explain this difference in the spread of the pandemic between the country's geographic regions. This study uses an ecological analysis to explain the extent of the differential spread of HIV between regions of Côte d'Ivoire. It aims to analyze the explanatory factors for the

difference in HIV prevalence observed among men in the different regions of Côte d'Ivoire, using the 2012 Demographic and Health Surveys (DHS) database. The interest of this study is to contribute to improving HIV interventions through strategic reorientations at the regional level.

2. Methodology

2.1. Sampling

This is a secondary data study from the 2012 DHS, collected from individuals residing in ordinary households throughout the country through a cross-sectional study. A national sample of 10,413 households was selected by stratification in order to have an adequate representation of urban and rural areas and the eleven study areas, corresponding to the ten former administrative regions and the city of Abidjan. The sample was based on a two-stage stratified area sample.

In the first stage, 352 enumeration areas (Denomination Zones, DZs) from the 1998 General Census of Population and Housing were selected. These zones were updated during a mapping and household enumeration exercise with a double stratification according to the living environment and the 10 development poles of the country in addition to the city of Abidjan. 351 clusters were visited. The second stage selected 9873 households at the national level in the selected DZs, that's to say, 27 in urban areas and 32 in rural areas in each cluster counted by a systematic draw with equal probability. A total of 352 clusters were selected, of which one was inaccessible. 9873 occupied households were identified, of which 9686 were successfully surveyed, for a response rate of 98%. Of these households, 5135 men aged 15 - 59 were eligible for the individual survey.

2.2. Data Collection

Three questionnaires were used: the household questionnaire, the women's questionnaire and the men's one. The content of these documents was based on the model questionnaires developed by the MEASURE DHS program, to which were added certain modules developed by UNICEF in the framework of the Multiple Indicator Cluster Surveys (MICS).

The individual male questionnaire made it possible to collect information on the respondent's sociodemographic characteristics, reproduction, contraception, health and nutrition, marriage and sexual activity, fertility preference, characteristics of the respondent's spouse and work, HIV/AIDS, other health problems, female genital mutilation and cutting, relationships within the household and maternal mortality. Verification, coding, data entry and editing (correction of inconsistencies) of the data were carried out using CSPro software.

2.3. Ethical Considerations

Ethical approval for the survey was obtained from the Ivorian National Research and Ethics Committee, the Institutional Review Board of ICF International, and the Center for Disease Control. Detailed information on the study area, study

population, survey organization, survey design, questionnaires, data collection, data quality, data processing, and ethics are published in the 2012 Côte d'Ivoire Demographic and Health Survey report. Permission to download and use the survey data was provided to the lead author by MEASURE DHS/ICF International.

2.4. Data Analysis

All analyses were ecological in nature and conducted per region for the 5135 men in the sample. Variables were constructed from the men's data using EXCEL software. All analyses were performed using STATA version 16.0 (College Station, TX).

A univariate analysis initially measured the crude association between HIV prevalence, the independent variable, and selected covariates using simple logistic regression. Any variable with a degree of significance (p-value) of less than 20% was retained for the construction of the multilevel model. In addition, univariate analysis was used to calculate the frequency of the study variables. A bivariate analysis was used to identify factors associated with HIV prevalence per region. Multivariate analysis was performed using unadjusted linear regression and then adjusted for covariates.

The dependent variable was "HIV Prevalence", the independent variable was "Education", and the moderator variable was "Being in a union" (Table 1). The covariates were "Condom Use, Christian Religion, Age at First Sexual Intercourse, Sexual Activity, Sexual Infection, Multi-Sexual Partnership and Education" (Table 2).

Table 1. Dependent, independent and moderator variables.

HIV prevalence	Education	Being in union
According to the DHS 2012 report	Proportion of schooling men per region	Proportion of men in union per region

HIV prevalence: estimated prevalence per region from the 2012 DHS report; Education: percentage of males attending school per region among all males aged 15 - 59 residing in the regions; Union: percentage of men in union per region among men aged 15 - 59 residing in the regions.

Table 2. Covariates.

Mean age at 1 st sexual intercourse	Sexual infection	Sexually active
Mean age at first sexual intercourse per region	Mean number of sexual infections in the last 12 months per region	Mean number of sexually active men per region
Multiple sexual partnerships	Religion	Condom use
Mean number per region of the number of sexual partners past 12 months	Proportion of Christians per region	Proportion of men per region having used a condom in the past 12 months

Mean age at first sexual intercourse: average age at first sexual intercourse in men aged 15 - 59 per region; Sexual Infection: mean number per region of sexual infections in men aged 15 - 59 per region who report having had sexual infections in the past 12 months; Sexually active: mean number per region of sexual partners in men aged 15 - 59 per region who have been sexually active in the past 12 months; Multiple sexual partnerships: mean number per region of sexual partners in men aged 15 - 59 per region who have had sex in the past 12 months; Religion: percentage of Christians per region in all men aged 15 - 59 residing in the regions; Condom use: percentage of men who used a condom during sex in the last 12 months in all men aged 15 - 59 per region reporting sexual activity in the last 12 months.

3. Results

3.1. Dispersion of HIV Prevalence among Men (15 - 59 Years) Stratified by Region According to the 2012 DHS of Cote d'Ivoire

In the spatial distribution of HIV prevalence in Côte d'Ivoire, the Centre-West (1.3%) and the North (1.5%) regions had the lowest HIV prevalence, while the city of Abidjan had the highest one (4.1%). The estimated national prevalence was 3.7% (Figure 1).

3.2. Spatial Distribution of Average Male Data per Geographic Location According to the 2012 DHS of Cote d'Ivoire

All average data for males aged 15 - 59 years by geographic location are reported in Table 3. Condom use was also low in the country's regions. The lowest rate of use was recorded in the Northwest (17.25%), while the highest rate was observed

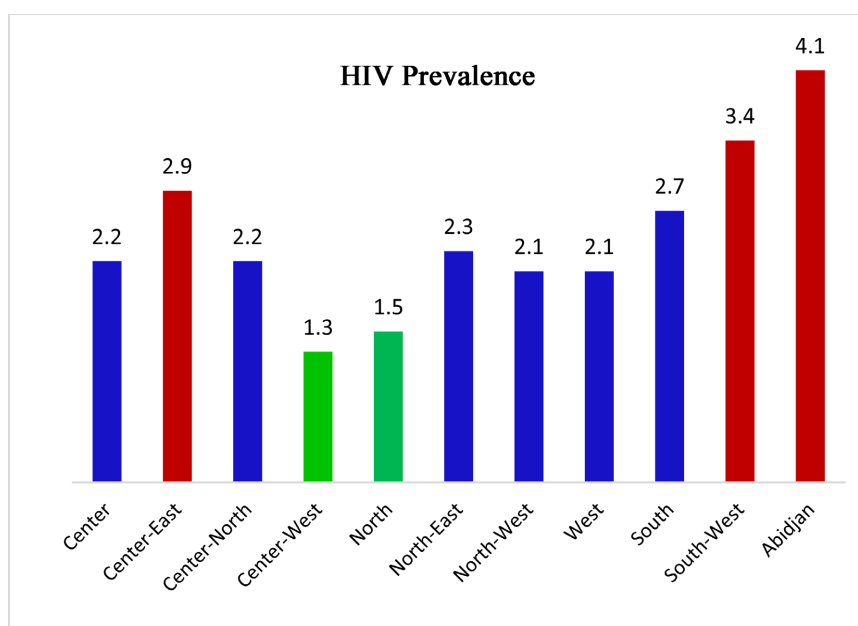
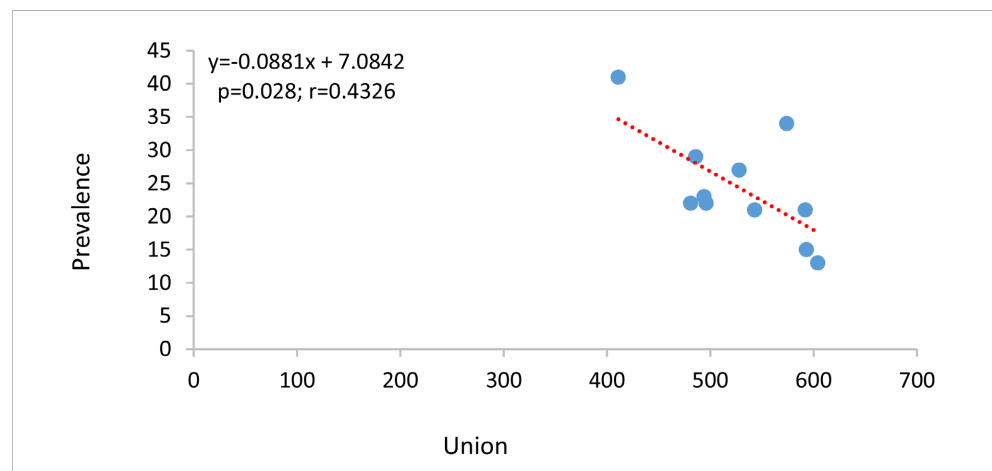


Figure 1. HIV prevalence in men per region.

Table 3. Spatial distribution of average male data.

Regions	HIV Prevalence	Condom use	Christian religion	Educated	Average age	In couple	Sexually active	Sexual infection	Average partners
Center	2.2	20.33	42.49	59.2	14.8	49.57	46.87	4.5	0.86
Center-East	2.9	33.24	42.74	61.89	15.45	48.58	52.53	7.1	1.27
Center-North	2.2	32.11	27.21	62.65	14.9	48.1	49.68	7.2	1.28
Center-West	1.3	22.72	35.6	63.29	15.36	60.43	56.92	4.8	1.3
North	1.5	29.07	18.11	43	15.48	59.28	59.28	5.3	1.21
North-East	2.3	33.11	39.38	57.54	14.8	49.36	49.1	4.3	1.11
North-West	2.1	17.25	6.42	39.19	15.27	59.15	52.2	4.2	1.18
West	2.1	21.6	40.28	67	15.5	54.25	61.46	12.9	1.73
South	2.7	26.62	49.35	69.32	15.69	52.83	52.31	5.9	1.24
South-West	3.4	24.54	40.04	57.64	16.03	57.42	58.42	5.1	1.35
Abidjan	4.1	41.3	40.72	78.31	15.35	41.13	50.65	7.9	1.29

**Figure 2.** Bivariate analysis of association between HIV prevalence and union.

in Abidjan (41.3%). Areas with more educated men (the southern and southwestern regions and the city of Abidjan) were the most affected by HIV.

3.3. Factors Associated with HIV Prevalence between Regions

The p values for the variables: condom use, union, religion and schooling were statistically significant (<20%) (Figures 2-5). However, since the “union” variable was more significant (Figure 2), this variable was considered as a protective factor, while the variables “mean age at first sexual intercourse”, “sexual activity”, “sexual infection” and “mean number of sexual partners” had a non-significant “p” (>20%) and were risk factors (Figures 6-9).

3.4. Explanatory Factors of Difference in HIV Prevalence between Côte d’Ivoire’s Regions

The unadjusted linear regression between HIV prevalence, union and schooling

showed that HIV prevalence in the regions of the country was not significantly associated with schooling and union (Table 4). However, HIV prevalence moved in the same direction as education and in the opposite direction to that of “union” variable. Thus, this analysis paradoxically revealed that as the mean

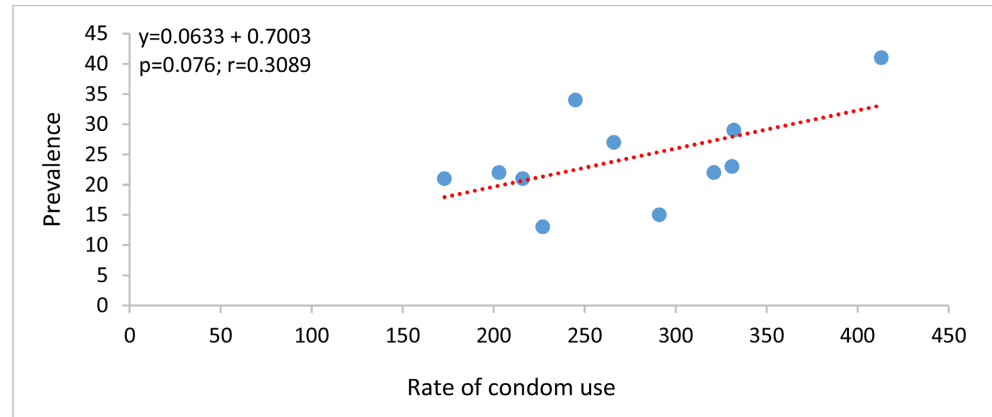


Figure 3. Bivariate analysis of association between HIV prevalence and condom use.

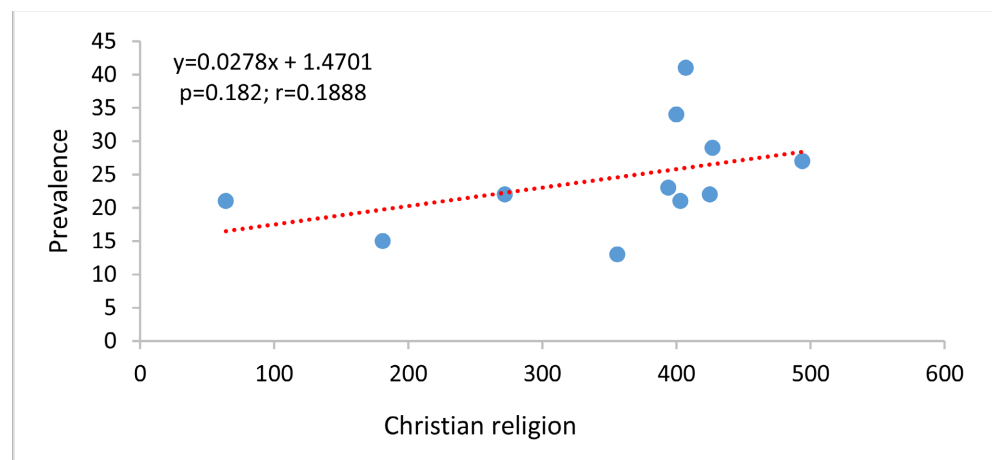


Figure 4. Bivariate analysis of association between HIV prevalence and Christian religion.

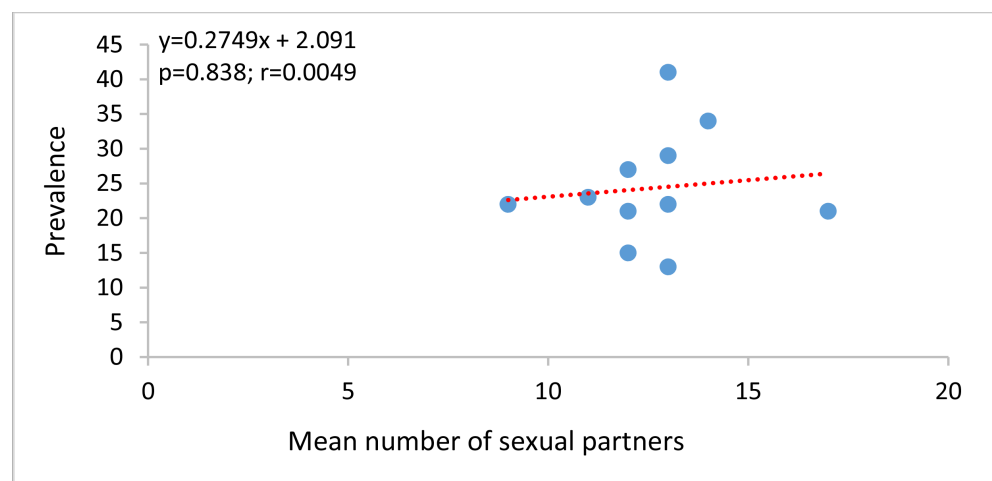


Figure 5. Bivariate analysis of association between HIV prevalence and education.

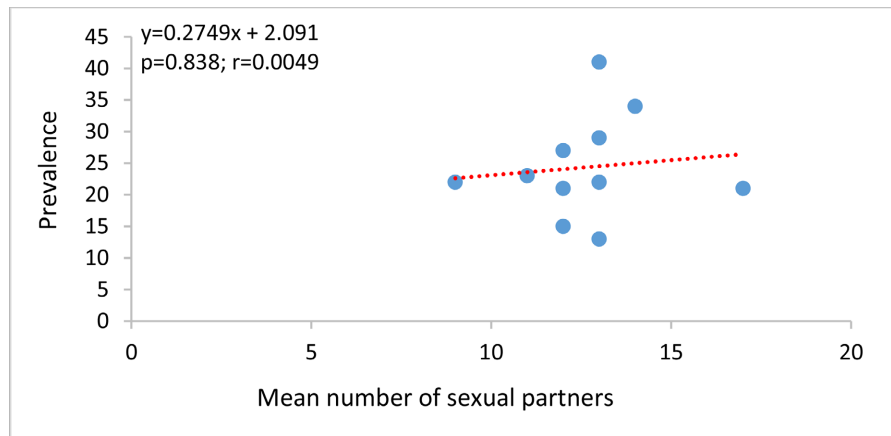


Figure 6. Bivariate analysis of association between HIV prevalence and number of sexual partners.

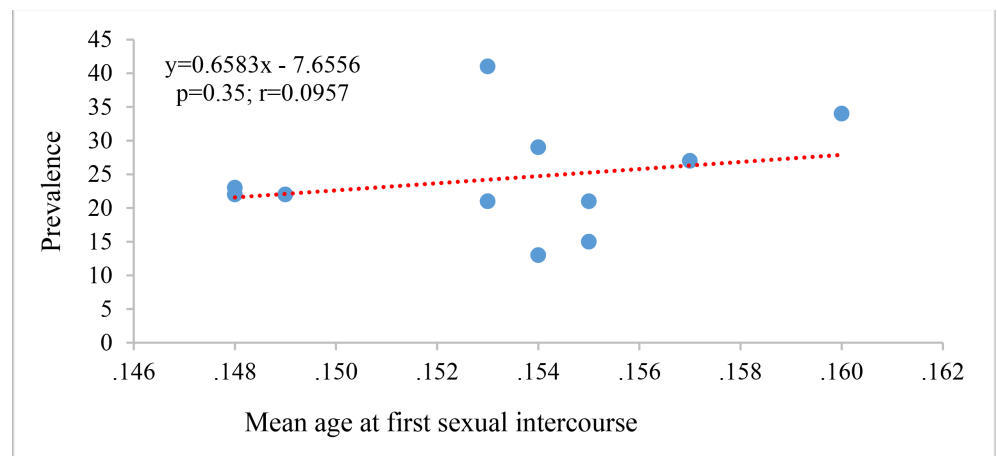


Figure 7. Bivariate analysis of association between HIV prevalence and age at first sex

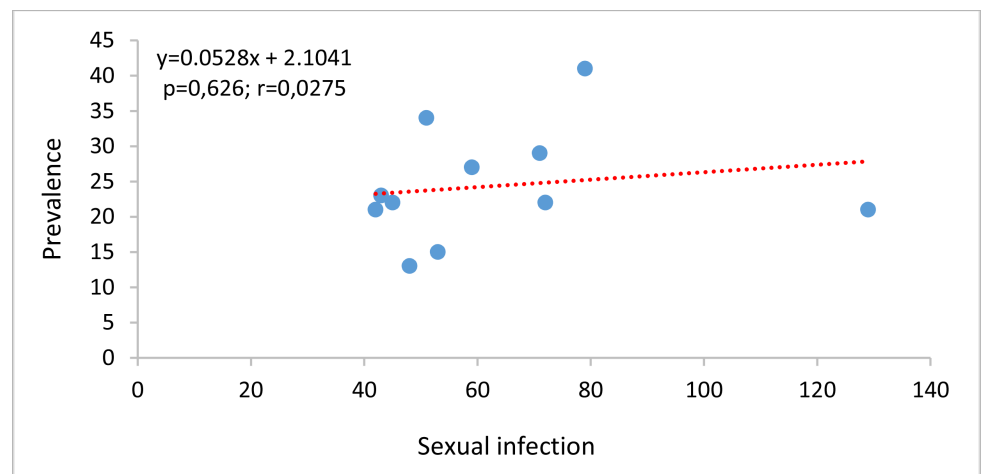


Figure 8. Bivariate analysis of association between HIV prevalence and sexual infection.

number of men attending school in the regions increased, so did the HIV prevalence. But, as the number of men entering unions in the regions increased, the HIV prevalence decreased. The “Union” variable was thus a protective factor,

while “education” was a risk factor.

Multivariate analysis showed that all variables had good explanatory power (98%) for the variation in HIV prevalence between regions of Côte d’Ivoire. There was a significant association between HIV prevalence and union, condom use, mean age at first sex, sexual infection, sexual activity and multiple sexual partnerships ($p < 5\%$; **Table 5**). Thus, union, condom use, mean age at first sexual intercourse, sexual infection, sexual activity and multiple sexual partnerships, explained the difference in HIV prevalence in the country’s regions (significantly). This disparity was moderated by Christian religion and education (p

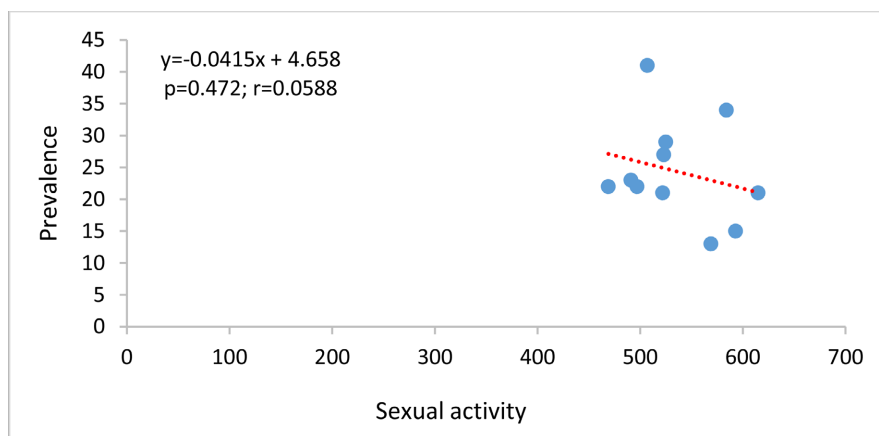


Figure 9. Bivariate analysis of association between HIV prevalence and sexual activity.

Table 4. Multivariate analysis using unadjusted linear regression, Côte d’Ivoire, 2012.

Non-adjusted linear regression			
HIV prevalence	r	p	IC 95%
Union	-0.01	0.607	-0.04 to 0.07
Education	-0.07	0.164	-0.18 to 0.024

Table 5. Multivariate analysis using adjusted linear regression with covariates, Côte d’Ivoire, 2012.

Adjusted linear regression with covariates			
HIV prevalence	r	p	IC 95%
Union	-0.38	0.008	-0.53 to -0.24
Condom use rate	-0.11	0.017	-0.16 to -0.05
Christian religion	-0.01	0.191	-0.03 to -0.01
Mean age at first sex	1.31	0.015	0.61 to 2.01
Sexual activity	0.15	0.048	0.00 to 0.29
Sexual Infections	-0.48	0.016	-0.75 to -0.22
Mean number of sexual partners	-0.38	0.008	-0.53 to -0.24
Education	-0.11	0.017	-0.16 to -0.05

= 0.191 and $p = 0.253$).

This analysis also showed that HIV prevalence in the regions changed inversely with union, condom use, the practice of Christian religion and education (Table 5). However, only union and condom use had an impact on HIV prevalence in a sense of reducing it by preventing new infections. Paradoxically, this analysis revealed that the average age of the first sex evolved in the same direction as HIV prevalence, while sexual infection moved in the opposite direction to HIV prevalence (Table 5). In other words, delaying first intercourse increased the risk of HIV infection and frequent sexual infection, reflecting a lack of condom use, reducing the risk of HIV infection in the regions.

4. Discussion

This study analyzed explanatory factors of the differential spread of HIV observed in men aged 15 - 59 years at the Ivorian geographical regions level, using the 2012 DHS database.

Spatial distribution of average male data per geographic location showed low HIV prevalence in the central-western (1.3%) and northern (1.5%) regions, but a high prevalence in the city of Abidjan (4.1%). This could be explained by socio-cultural and religious factors, since the central-western and northern regions were deeply rooted in the country's traditional religions of Islam and Catholicism, but also in tradition. As a result, morality, respect for social norms and the weight of the elderly were paramount in decision-making. This was not the case in the big city of Abidjan, which was also a crossroads for several peoples in continuous movement. It was in the city of Abidjan that high-risk sexual practices were found, key populations in which HIV infection was concentrated, gateway populations responsible for the spread of HIV in the general population, and rising drug use [2] [3] [4] [6] [7] [8] [12] [21] [22] [23] [24] [25].

These same factors could explain the low condom use in the North-West region (17.25%), while it is high in the city of Abidjan (41.3%). Indeed, cultural and religious norms ran counter to the use of contraceptive barriers. Because condoms were seen as a contraceptive method, their use remained low in the predominantly Muslim north of the country that is in favor of large families [26].

Areas with more schooled men (the south, south-west regions and the city of Abidjan) were the most affected by HIV. These results could be explained by the fact that educated people had access to true HIV information through health professionals, mass media, internet and social networks. They would then be screened for antiretroviral treatment unlike other illiterate men, who would immerse themselves in denial and prejudices of all kinds. This finding was in line with Bouba's finding that HIV prevalence increased with educational attainment, in line with the general population in Cameroon [27].

Several previous studies have identified condom use and stable living together as factors that reduce HIV prevalence by reducing new infections at the individ-

ual level. Specifically, these factors would prevent HIV spread from key populations that are pockets of infection to the general population [28]-[33]. Therefore, it seems quite urgent to emphasize the proper use of condoms to better protect the individual against HIV infection. It is necessary to adapt awareness and information messages to the context and real needs of the people and especially to use new communication technologies (internet, all social networks, telephones) for their dissemination in the different communities [34]. Above all, it is necessary to target all the social networks used by young people and adults, the various associations to which they belong, the communities of people, etc. to communicate and meet.

In contrast, our results paradoxically indicated that mean age at first sexual intercourse was a risk factor, while frequent sexual infections reduced the risk of HIV infection.

In contrast, our results paradoxically revealed that the average age at first sexual intercourse was a risk factor and frequent sexual infections reduced the risk of HIV infection. Indeed, late age at first sexual intercourse (after 15 years) was the most important protective factor among positive sexual behaviors of men and women in Sub-Saharan Africa [35]. Early sexual intercourse before 15 years was a risk factor for HIV infection in HIV-positive sex workers in Bangui, Central African Republic [31]. In addition, sexually transmitted infections (STIs) have always been proven to be the bed of HIV infection. At the national level, a high prevalence of HIV has been found associated with STIs in key populations of male professionals [36], in HIV-positive women [11], and in users of three sexually transmitted disease clinics [12]. STIs have been identified as high-risk factors for the high prevalence of HIV infection in Banjul, Central Africa [31], Meyomessala Health District, Cameroon [28], between ethnic groups in Uganda [16] and sex workers enrolled in behavioral intervention in Battambang, Cambodia [37]. Inadequate treatment of STIs appeared to be at the root of the higher prevalence of HIV among African populations. For example, effective large-scale STI treatment capacity was recommended for effective HIV control in Africa [14] [18].

However, our contradictory results at the individual level may well open new horizons to explain differences in HIV prevalence at the population level, between areas and regions, and between groups of individuals with identical characteristics of the same country. The persistence of HIV transmission after more than four decades of relentless struggle has not yet been sufficiently exploited. Moreover, HIV infection has not yet finished revealing its secrets, according to the results of some ecological studies. Indeed, the sub-Saharan Africa region, with more than 80% of men circumcised, recorded the highest prevalence of HIV in the world.

This paradoxical relationship between circumcision and HIV prevalence worldwide, found in black ethnic groups in South Africa, was explained by the existence of another factor whose effect would be mitigated by circumcision.

Inadequate treatment of STIs has been the underlying factor in the literature with little evidence. At that time, the diverse sexual behaviors of individuals were examined more closely and revealed a differential spread of STIs through networks of sexual partnerships. The connectivity of the sexual network is determined by the number of sexual partners over life and the simultaneity of sexual partners that have been found in higher numbers in black communities with high HIV prevalence in the United States and South Africa [14] [16].

The spread of HIV is determined by a complex interaction of social, behavioral, economic and biological factors operating at multiple levels. As a result, further ecological studies were needed to explore in-depth the contradictory results of this study.

5. Limitations of Our Study

In addition to all the limitations of ecological studies known in the literature, it is known that any ecological analysis is sensitive to ecological inference error, so inferences cannot be drawn at an individual level. DHS surveys are also not optimal for determining sensitive sexual information. In addition, while response rates for participation in the HIV survey and testing were high, they varied considerably across regions [20]. As a result, the data are subject to many biases such as social desirability, recall, and non-response biases. We cannot rule out the possibility that respondents in regions where low-risk sexual behavior has been reported may be subject to a greater social desirability bias, which could invalidate our findings. However, available data suggest that only minor differences in sexual behavior exist between those who respond and those who do not respond to sexual behavior questionnaires [20]. The possibility that relationships between sexual behavior, region and HIV prevalence may be confounded by other unmeasured variables is not excluded.

Data were aggregated in eleven regions of Côte d'Ivoire and not on individuals. Data on condom use were limited to the last sexual partner, which did not inform us about condom use in pre-data sex which is regular condom use. The lack of data on individuals limits the ability to identify periods and new HIV infections (of individuals) in the regions. Finally, there were programmatic limitations to the study results. Despite these shortcomings, our study opens up prospects for operational research on the determinants of HIV prevalence and condom use between Ivorian regions, even though conclusions cannot be drawn about individuals.

6. Conclusions

The study found that factors that accounted for the difference in HIV prevalence among men in the country's regions were union, condom use, the average age at first sexual intercourse, sexual infection, sexual activity, and multi-sexual partnership. However, only union and condom use were effective in reducing HIV prevalence through the elimination of new infections. The disparity in preva-

lence was mitigated by Christian religion and schooling. Mean age at first sexual intercourse was a risk factor while paradoxically frequent sexual infections reduced the risk of HIV infection.

This study confirms the critical role of sexual behavior and certain socio-demographic characteristics in the differential spread of HIV in communities. Despite good results after several years of fighting the pandemic, infection remains highly concentrated in certain groups or communities. For a long time, this struggle has been focused on the individual. It would be appropriate to go beyond the individual level to fight a much more community-based fight like Uganda, Thailand, Zambia and the gay community of the United States did with better results in the early stages of the fight against HIV/AIDS [38]. Uganda has successfully used social networks to disseminate community intervention strategies that promote behavior change among the population. These proven good practices need to be adopted by pandemic programs or adapted to the Ivorian context to enable the fight against HIV to take another turn for greater effectiveness [38] [39].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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