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Full Length Research Paper

Individual and area-based socioeconomic influences on HIV seroprevalence in Cameroon

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HIV infection prevalence shows strong regional variations in Cameroon, with the North West and the East as the most affected regions. Studies which have attempted to investigate the variation in HIV prevalence in Sub-Saharan countries found that the geographical heterogeneity in Human immunodeficiency virus (HIV) prevalence between high and low prevalence areas still existed after considering the different distribution of unsafe sexual behaviours. Individual and area level socio-economic-positions are both related to HIV transmission but the only study carried out in Cameroon that investigated HIV seroprevalence and socio-economic factors used only individual-based measures. We carried out this study to investigate the full extent of socio-economic influences on HIV sero-prevalence. We analysed data from 4,672 men and 5,227 women, aged 15 to 49, who participated in the Cameroon Demographic and Health survey (CDHS). Among men, HIV risk increased with household wealth at the individual level and there was a positive association between HIV seropositivity and variation in wealth within a region. Among women, there was no evidence of association between living in a relatively disadvantaged region (regional wealth index) and being HIV positive, but HIV seropositivity was associated with variation in wealth within a region. The main direct link between income inequality and HIV is likely to be through transactional sex. High income inequality would stimulate risky sexual behaviours and the diffusion of illicit sexual relationships, especially for wealthy men. Public-health interventions should be carried out, paying particular care in raising the awareness of wealthy men towards less risky sexual behaviours. Policy makers should define intervention strategies to reduce the socio-economic differences within regions.

Key words: Multilevel modelling, socio-economic, development country, human immunodeficiency virus (HIV).

INTRODUCTION

Geographical differences in HIV seropositivity have been documented consistently in various African regions (Orroth et al., 2007; Yaoundé: National Institute of Statistics: Ministry of Planning dlpddedldtYC. Demographic and Health Survey: Cameroon, 2004. Calverton, Md., 2005; Mishra et al., 2007). Four cities' study found that the geographical heterogeneity of Human Immunodeficiency Virus (HIV) prevalence in Sub- Saharan countries was partly explained by differences in the age at which women married, age at first sexual experience, variations in the prevalence of sexual transmitted infections (STIs), and variations in the prevalence of circumcision between cities with relatively low and high prevalences of HIV (Orroth et al., 2007; Buve et al., 2001a; Buve et al., 2001b; Weiss et al., 2001; Buve et al., 2001c; Auvert et al., 2001).

It is well established that individual and area socio-economic factors can both exert an effect on health conditions (Duncan et al., 1993; Jones and Duncan, 1995; Shouls et al., 1996; Sloggett and Joshi, 1998; Congdon

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et al., 1997; Macintyre et al., 1992; Pickett and Pearl, 2001; Davey et al., 1998). Studies carried out in Western countries suggested that other factors such as individual and area socio-economic-position might be related to increased HIV prevalence (Mari-Dell'olmo et al., 2007; Marshall, 2008). However, in Africa, studies which have specifically examined the relationship between the prevalence of HIV infection and aspects of the wider setting, as well as individual risk factors, are sparse and have not taken socio-economic factors into account (Orroth et al., 2007; Buve et al., 2001a; Buve et al., 2001b; Weiss et al., 2001; Buve et al., 2001c; Auvert et al., 2001; Morison et al., 2001). The only study carried out in Cameroon (Cameroon Demographic and Health survey (CDHS) which investigated HIV seroprevalence and socio-economic factors, used individual-based measures of socio-economic-position (Mishra et al., 2007).

This study found higher prevalences of HIV in wealthier men than their relatively disadvantaged counterparts, whereas these findings were not statistically significant in women. In addition, evidence from Tanzania Demographic and Health Survey (DHS), Kenya DHS, Uganda AIDS Indicator Survey (AIS), Malawi DHS, Lesotho DHS, Burkina Faso DHS and Ghana DHS suggests a positive wealth gradient in HIV infection (Mishra et al., 2007). After controlling for an array of covariates, the positive wealth gradient remained statistically significant only in Cameroon and Malawi for men and in Tanzania for women, though some of the covariates included in the models (for example, age at first sexual intercourse) could potentially mediate the effects of household wealth on HIV prevalence.

Individual and area level measures of socio-economic-position are used to find out the pathways by which social inequalities translate into inequalities in timing and risk of infection. At the individual level, low literacy, poverty and unemployment can promote risky sexual behaviour and HIV infection. At the area level, inadequate educational facilities, inadequate and ineffective health services for treating STIs, including HIV, and limited access to HIV/AIDS and other STIs prevention programmes have been identified as increasing risk for HIV infection. Individual and area socio-economic factors are associated with HIV risk, partly through their influence on individual behaviours. However, some of them are independently associated with risk of HIV infection even when adjusting for the effect of individual unprotected sex behaviours (Adimora et al., 2006).

The associations between HIV risk and the different socio-economic indicators may have different implications and causes. For example, at the individual level, people of lower income, may not have access to protective measures and healthcare (Davey et al., 1998; Davey et al., 2002); people with higher education may have increased knowledge related to health promotion and increased compliance to prevention; people with higher income may be at higher risk of engagement into sexual risky behaviours for HIV (Kongnyuy et al., 2006; Shelton et al., 2005; Fenton, 2004). At the area level, living near a market place may be associated with increased HIV risk for young women (Gabrysch et al., 2008); living near roads connecting villages to cities increase the likelihood of migration from presumably conservative villages to more sexually permissive cities (Greig and Koopman, 2003; Tanser et al., 2000); and living in rural areas may be associated with poor health care including HIV testing and treatment.

In our opinion, individual and area level measures of socio-economic-position may also influence the rates of progression of HIV in infected subjects and their risk of death. At the individual level, higher income could ensure longer survival because of the level of care subjects can receive, including food security and quality; while higher education could influence access and adherence to treatment (poor adherence to treatment leads to treatment failure and the emergence of drug-resistant strains of HIV). At the area level, the hygiene and sanitation conditions of the environment may influence the likelihood that they contract opportunistic infections; inadequate health services could influence access to treatment while patient willingness to undergo treatment can be influenced by social and cultural factors existing at the community level (stigma, religious believes, community support).

It is important to establish whether the effect of socio-economic-position varies for different types of individuals. For example, sexual risk for HIV may be greater among those most vulnerable to certain risky social or environmental factors. Women may be more vulnerable to social or environmental factors than men because they are in a subordinate position in relation to them. Their vulnerability may be also modulated by their marital status. Those of lower socio-economic-position may be more likely to engage in commercial sex and to have non regular sexual partners if widowed or divorced (Masanjala, 2007) whereas those of higher socio-economic-position may be at lower risk before marriage (because of their later sexual debut (Hallett et al., 2007), but at higher risk after marriage because of their husband's extramarital affairs (Carpenter et al., 1999)). In addition, concomitant mucosal lesions due to STIs may also increase their vulnerability to HIV infection in relation to men. The rate of progression of HIV may be higher for individuals affected by other debilitating diseases (including non-AIDS-defining illnesses such as debilitating renal, vascular, and pulmonary diseases) for older subjects (Pezzotti et al., 1992) and for those with a long duration of infection. Unfortunately, information about co-morbidity, CD4 counts and the date of sero-conversion were not available in this study.

Our study takes into account the effects of both individual and area-based measures of social inequalities in order to provide insight on the influences of socio-economic-position on HIV sero-prevalence in Cameroon.

Table 1. Sample characteristics of the participants per unit of analysis.

Parameter	Number of respondents (individuals) by PSU		
	Minimum	Average	Maximum
Men (N = 4502)			
PSUs (N = 466)	1	9.7	28
Women (N = 5125)			
PSUs (N = 464)	1	11.0	31

PSU: Primary sampling unit.

MATERIALS AND METHODS

Data sources

This study is a cross-sectional, population based survey that uses data from the 2004 CDHS. The CDHS was carried out with a study design based on a two-stage clustered sample (Demographic and Health Surveys, 1996). The sample frame was a list of all census enumeration areas [primary sample unit (PSU)] established by the General Census of Population and Housing Bureau Central des Recensements des Etudes de la Population (BUCREP) in 2003. Overall, 466 primary sampling units (PSU) were selected in the first stage and 11,556 households in the second stage. All women aged, 15 to 49 years, in all households, and men aged 15 to 49, in every other households, were asked to participate in the interview. Fifty percent of the households selected in the second stage were eligible for voluntary HIV testing and 90% of men and 92% of women consented to be tested. The HIV testing was conducted on dried blood spot samples and test results were anonymously linked to the individual and household questionnaires. The CDHS protocol was approved by the Cameroon Ministry of Health and the Macro Institutional Review Board (IRB) (National Institute of Statistics, 2004). More detail on this survey can be found elsewhere (Measure DHS - Demographic and Health survey. http://www measuredhs com/What-We-Do/Survey-Types/DHS cfm 2012).

The household questionnaire included questions about the total number of household members (men, women, children), kind of facilities in the house (a bed-net for sleeping, a place for hand washing and toilet facilities), questions on the location of water sources and travel time to get to water sources, type of cooking fuel used, and ownership of means of transportation. In addition also, question on the region of residence and characteristics of the region of residence (whether it was rural or urban and whether it was near to a truckers' route) were asked. The individual questionnaire included questions about age, sex, education level, employment status (whether the respondent was currently working), marital status/co-residence, number of children, number of co-wives, ethnic group, religion, intensity of sexual activity in the past year, sexually transmitted infections in past 12 months (women only STIs), whether the respondent used a condom the last time he/she had sexual intercourse.

We measured individual/household socio-economic position using three indicators: (1) educational attainment; (2) employment in the past 12 months and; (3) household wealth. Educational attainment was recorded as the highest educational level achieved and coded as 0 "no education", 1 "primary school", 2 "secondary school" and 3 "higher education". Employment status was recorded as any work done in the past 12 months (coded as 1), or unemployment in the time period (coded as 0). Household ownership of consumer durables were used by MEASURE DHS (weight for each assets was obtained through principal component analysis) to allocate households into poverty quintiles with the lowest quintile representing the poorest 20% and the highest quintile representing the wealthiest 20% of the households (household wealth index) (Rutstein and Kiersten, 2004; Filmer and Pritchett, 2001).

The same household wealth quintile was assigned to all individuals in the same household. From these individual/household measures, we computed three region level measures of socio-economic circumstances: the median regional wealth index (to measure overall wealth at the region level), the regional wealth index inter-quartile range (to measure variation in wealth at the region level) (Ben-Shlomo et al., 1996) and the regional percentage of young people (Pickett and Pearl, 2001; Davey et al., 1998; Mari-Dell'olmo et al., 2007; Marshall, 2008; Morison et al., 2001) who did not attend primary school. The median wealth index, the inter-quartile range and the percentage of young people who did not attend primary school were standardized. The same region level socio-economic measures were assigned to all individuals in the same region.

Data analysis

The starting point for the statistical analysis was the conceptual framework presented in Figure 1. Descriptive statistics and preliminary analyses were performed using individual sampling weights for tabulations involving information gathered from the individual questionnaire, and HIV sampling weights for tabulations including HIV status. Sampling weights were used throughout the analyses to correct the unequal probability of selection due to the multilevel sample design and to ensure the representativeness of the results.

Multilevel logistic regression models were used to investigate whether demographic and medical information of participants to the CDHS and information on area characteristics could help explain differences in HIV regional prevalence. To account for the multi stage sampling design of the study, a multilevel model with a random effect at the Primary sampling unit (PSU) level was used (Table 1). The unit of analysis was the individual. Tests for linear trend across strata of relevant independent variables were carried out by treating the ordinal scores as a continuous variable.

Seven models were constructed separately for men and women. The first model was a one level random effect model without explanatory variables. This include: (i) the fixed intercept term and one random term associated with the intercept, which reflected the variation at the PSU level. In this model, the individual level variance represents differences within PSUs; (ii) further models contained age, marital status, number of children, education, occupation, religion; (iii) household wealth index; (iv) rural, proximity of the household to the truckers route; (v) median regional wealth index, regional wealth index inter-quartile range, regional proportion of illiterate young people; (vi) interaction term between household wealth index and median regional wealth index or; (vii) interaction term between household wealth index and marital status. The

significance of the random components was tested by checking if the estimates were greater than twice the standard error. A random term was only included for the intercept. The effects of age, marital status, number of children, education, occupation, religion, household wealth index, rural, proximity of the household to the truckers' route, median regional wealth index and regional wealth index inter-quartile range were modelled as fixed effects within units. In all models, records with missing data for any of the variables included in the model were excluded. There was no reversal of the relationship between any independent variable and outcome variable when other covariates were included in the model, which suggest stability of model estimates (Tu et al., 2005). We presented results separately by gender because there are biological and social differences between men and women's risk of HIV transmission at the individual and community levels. For this study, our institution did not require ethical approval because it was a secondary analysis of aggregated data from which it was impossible to trace back single individuals.

Results from this study are based on 4,672 men and 5,227 women aged 15 to 49 (there were 19 missing data for education in men and 23 in women, 113 missing data for occupation in men and 99 in women, 54 missing data for marital status in men and 99 in women).

RESULTS

HIV infection shows strong regional variations. The most affected regions were the North West, the South West, the East and Yaounde (Figures 2 to 4). The prevalence of being HIV positive was higher among women than men in all regions, apart from the North, where it was higher in men. In general, prevalence was higher in urban than in rural areas. In men, the crude Odds Ratio (OR) of being HIV positive increased from the age 15 to 19 to 35 to 39 years and then decreased afterwards. In women, it increased from the age 15 to 19 to 25 to 29 years and then decreased from 25 to 29 to 45 to 49. Overall, the sex specific crude OR (M:W) was 0.27 at age 15 to 24 and 0.68 at age 25 to 49. We observed a similar age distribution of the HIV positivity in all the strata of the household wealth index considered (men: $p = 0.169$; women: $p = 0.582$).

Table 2 represents findings from the multilevel logistic regression models. Results are reported at individual level for men and women separately and ORs were calculated using 5,125 observations for women and 4,502 for men.

Men

The OR of HIV initially increased with age but then decreased once a particular threshold age was reached. The risk of being HIV positive was highest for men aged 36. There was no evidence of an association between HIV seroprevalence, marital status and number of children. The odds of being HIV positive did not vary by employment status and educational attainment in the models which include or exclude household wealth index. The odds of being HIV positive showed an increasing linear trend across the quintiles of household socio-economic-position from the poorest to the richest, although confidence intervals were wide and overlapping. There was no evidence of interaction between household wealth index and marital status. Risk of being HIV positive increased for men living near a truckers' route and for men living in relatively disadvantaged regions (median regional wealth index). There was a positive association between HIV seropositivity and the extent of variability of the wealth index within a region. HIV risk was not related to area level educational attainment. There was no evidence of interaction between regional wealth index and household wealth index in predicting HIV positivity.

Women

The OR of HIV initially increased with age, but for women aged over 31 was somewhat lower and the lowest in the older age group. Results were similar to those found for men with regard to the association between HIV seroprevalence and employment status. Women with a primary education were more likely to be HIV positive than those with no education. Highly educated women had a similar risk than those with no education. The OR of being HIV positive was higher in widowed or divorced than in those who were single (most of all, in small city/town and in the countryside than in the capital), and it decreased by 0.80 times for increases of 1 unit in the number of children. Having a religious belief different from Christian or Muslim showed a negative association with the risk of HIV infection. The odds of being HIV positive did not vary by household wealth index. There was no evidence of interaction between marital status and wealth index. As also seen in men, the OR of being HIV positive was similar in rural and urban areas. Living near a truckers' route was not associated with HIV status. There was no evidence of association between living in a relatively disadvantaged region (median regional wealth index) and being HIV positive. There was a positive association between HIV seropositivity and the extent of variability of the wealth index within a region. HIV risk was not related to area level educational attainment. There was no evidence of interaction between household wealth index and median regional wealth index in predicting HIV positivity.

DISCUSSION

We have observed regional variations in HIV prevalence, with the North West being the most affected region and the East the second most affected region. Living in a relatively disadvantaged region increased the risk of HIV in men (median regional wealth index) independently from individual conditions, such as their socio-economic-

Table 2. Multilevel logistic regression (results from model - IV): predictors of HIV positivity in men and women aged 15 to 49.

Fixed effect parameter	Men (N = 4,502)		Women (N = 5,125)	
	OR	(95% CI)	OR	(95% CI)
Age				
15-19	1		1	
20-24	2.98	(1.26;7.04)	3.72	(2.27;6.07)
25-29	7.14	(2.99;17.06)	5.80	(3.46;9.73)
30-34	11.55	(4.71;28.34)	4.45	(2.56;7.71)
35-39	13.21	(5.23;33.34)	3.26	(1.81;5.85)
40-44	9.30	(3.56;24.28)	2.83	(1.51;5.30)
45-49	5.96	(2.15;16.57)	1.91	(0.95;3.84)
Educational attainment				
None	1		1	
Prim	1.62	(0.82;3.22)	1.55	(1.00;2.40)
Sec	1.15	(0.56;2.36)	1.39	(0.85;2.26)
High	0.67	(0.25;1.78)	0.74	(0.27;1.99)
Employment status				
Unemployed	1		1	
Employed	1.66	(0.88;3.15)	1.00	(0.76;1.31)
Marital status				
Single	1		1	
Married	0.83	(0.52;1.33)	1.22	(0.80;1.86)
Divorced/widowed	1.23	(0.72;2.11)	3.92	(2.41;6.36)
Child number	0.88	(0.76;1.02)	0.80	(0.72;0.90)
Religion				
Christian	1		1	
Muslim	1.11	(0.69;1.77)	0.82	(0.55;1.24)
Others	0.74	(0.43;1.28)	0.51	(0.29;0.88)
Household wealth index				
Poorest	1		1	
Poorer	1.34	(0.61;2.93)	0.78	(0.47;1.28)
Middle	2.62	(1.26;5.45)	1.40	(0.88;2.22)
Richer	3.14	(1.45;6.82)	1.44	(0.86;2.42)
Richest	3.58	(1.54;8.31)	1.25	(0.69;2.24)
Household near trucker routs	1.66	(1.09;2.54)	1.38	(0.95;2.01)
Household in rural or urban location				
Urban	1		1	
Rural	0.86	(0.56;1.31)	0.87	(0.61;1.23)
Regional Wealth index				
interquartile range	1.33	(1.07;1.66)	1.30	(1.08;1.55)
median	0.64	(0.45;0.92)	0.88	(0.65;1.20)
Regional proportion of illiterate among young people (15-19)	1.14	(0.80;1.62)	0.92	(0.69;1.22)
Random effect parameter				
PSU-level variance [± (SE)]	0.45 (0.18)		0.61 (0.11)	

PSU: Primary sampling unit.

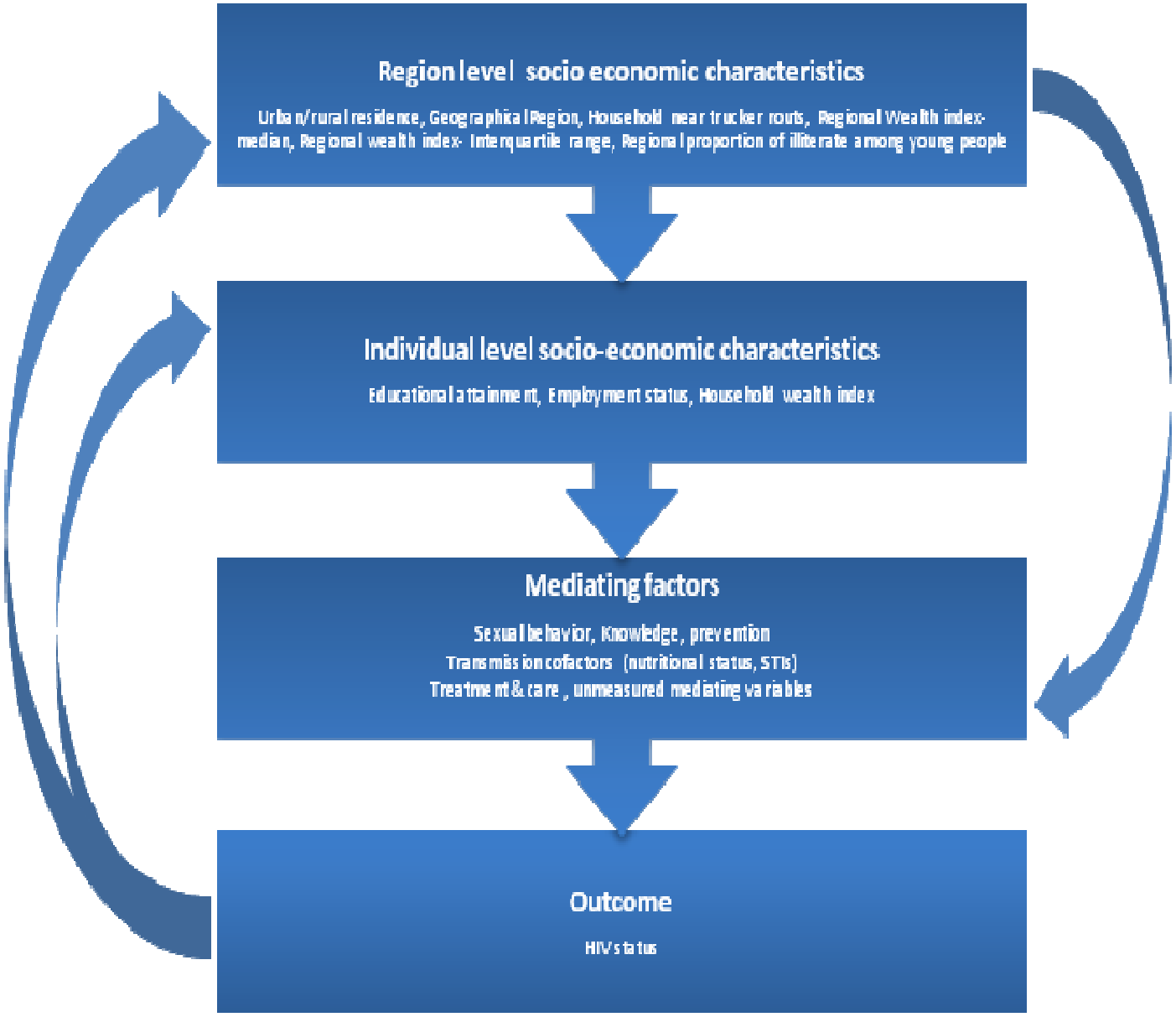

Figure 1. Schematic representation of the pathways linking individual and regional level socio-economic circumstances to HIV risk.

position, household wealth, and age. Area level educational attainment was not related to HIV infection for men and women. We observed an association between HIV risk and the variability of the wealth index within a region (inter-quartile range of wealth index). At the individual level, the odds of being HIV positive seem to increase monotonically from the poorest to the richest quintile of household wealth in men, although confidence intervals were wide and overlapping but did not vary with household wealth in women in the fully adjusted model. Other factors like employment status and educational attainment did not affect the risk of infection in men but exerted some effect in women (in particular, the level of education).

A study carried out in Sub-Saharan countries showed evidence of a direct correlation between HIV prevalence and household wealth index at the individual level in Cameroonian men (Mishra et al., 2007). Whereas, in Cameroonian women, the same and other studies found that the risk of being HIV positive was higher in the middle and fourth quintile if adjusted for social and behavioural covariates (education, occupation, media exposure, marital status, duration in union, number of years in current place of residence, alcohol use at last sex, knowledge of prevention methods and of HIV status), but was no longer associated with household wealth index

Figure 2. Cameroon administrative regions.

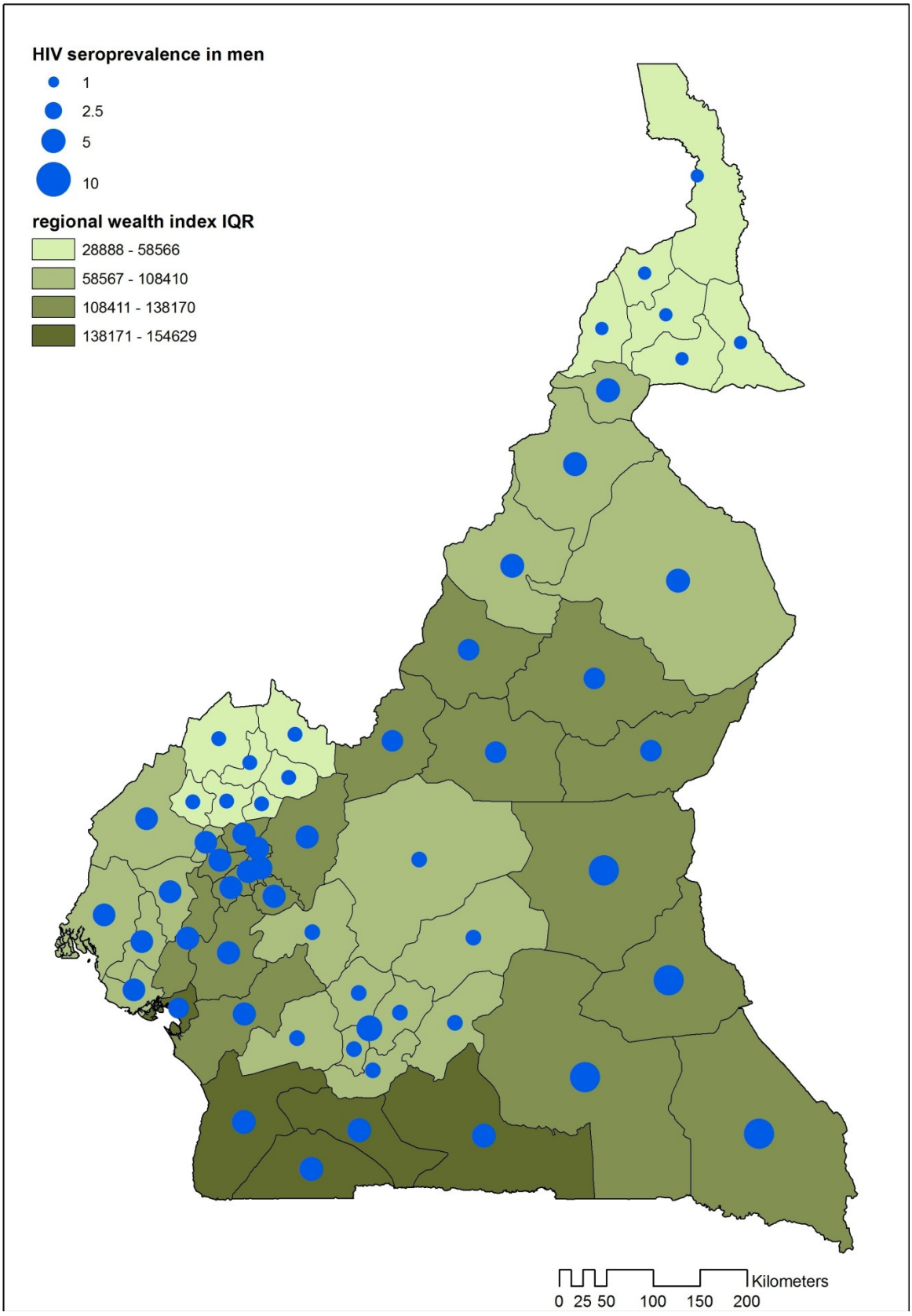

Figure 3. Seroprevalence of HIV (cases/100 000) in men aged 15-49 by regional level socio-economic circumstances [Wealth score Inter-quartile Range (IQR)].

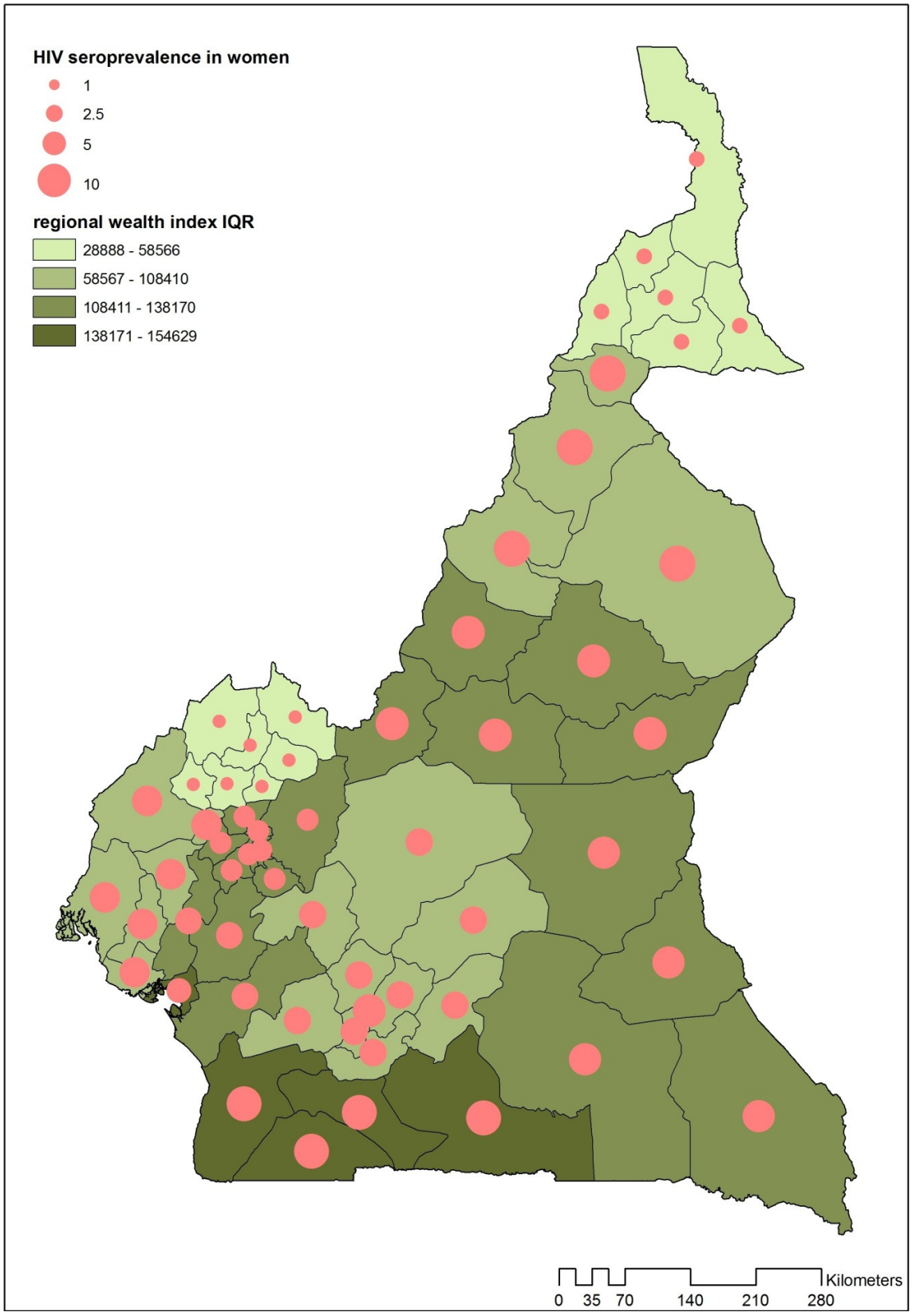

Figure 4. Seroprevalence of HIV (cases/100 000) in women aged 15-49 by regional level socio-economic circumstances [Wealth score Inter-quartile Range (IQR)].

after adjustment for the wealth index of the cluster (primary sample unit within the DHS) (Mishra et al., 2007; Demographic and Health Surveys, 1996). Other studies carried out in Tanzania, Kenya and Zambia found instead that, the positive relation between HIV and wealth was stronger in women than in men (Tanzania Commission for AIDS(TACAIDS), 2005; National Bureau of Statistics (NBS), 2005; ORC Macro. Tanzania HIV/AIDS Indicator Survey 2003-04, 2005; Central Bureau of Statistics (BCS), Ministry of Health (MOH), ORC Macro. Kenya demographic and health survey 2003. Claverton, Maryland; 2004) and that young women living in low socio-economic-position neighbourhoods had higher HIV prevalence than those living in higher socio-economic-position neighbourhoods (Gabrysch et al., 2008).

The only study which has investigated the effect of socioeconomic factors at the individual and community levels in African countries found communities with lower educational attainment and greater wealth at higher risk of HIV (Ishida et al., 2012). However, educational attainment at the community level was measured as the percentage of all members of the households in each community who obtained incomplete secondary school education or higher, but this measure does not take into account the age and sex structure of the households (for example, percentages are probably higher in younger people and in men).

Studies carried out in Western countries found that HIV seropositivity was related to HIV risk at the individual and area levels, being the poor areas, and the poor people in them being the worst affected (Mari-Dell'olmo et al., 2007; Diaz et al., 1994; Wallace and Wallace, 1995; Zierler et al., 2009; Zierler and Krieger, 1997; Simon et al., 1995; Poundstone et al., 2004; Peterman et al., 2005; Zierler et al., 2000). Conversely, the few studies on individual factors related to the risk of HIV carried out in African countries suggest that men of higher socio-economic position may be at higher risk of HIV. Higher socio-economic position adults, especially men, are more likely to engage in sex with non regular partners and underestimate their own risk for contracting HIV in spite of having concurrent sexual partners. Also high socio-economic position men and women may live longer with HIV due to easier access to anti-retroviral drugs and adequate level of nutrition.

Concerning the area level of HIV risk, it could be influenced by the change in social and cultural factors that can occur in the context of increasing population in urban areas (poverty, increased human density, lack of hygiene and health care facilities). Changes in these factors are related to economic development and do not occur homogeneously among social strata and geographical areas.

In general, people living in disadvantaged areas may be more vulnerable to factors that increase HIV risk, such as violence, high criminal rate, inadequate health services for treating sexually transmitted infections and limited laccess to HIV/AIDS prevention, care and treatment facilities. In addition, disadvantaged areas may have higher prevalence of HIV and STIs. For this reason, people living in disadvantaged areas may have heightened risk of HIV beyond their individual risk factors.

It is possible that individual and area level measures of socio-economic-position may influence the rates of progression of HIV in infected subjects and their risk of death (Ishida et al., 2012). Because we do not have data about time since sero-conversion, we cannot distinguish between effects of socio-economic-position on survival and effects on risk of infection. Hence, it is possible that poor people have a higher risk of infection and a lower chance for survival. The cross sectional design of the study should have heightened the probability to observe more often, wealthy men and women among the HIV positive than their un-wealthy counterparts, even though the incidence of HIV infection may be higher in the latter category. This hypothesis could be indirectly tested, considering the age of the infected people in the two groups; infected wealthy men and women should be older but in our study, we have found a similar age distribution in the two groups.

On the whole, the risk of HIV did not vary between rural and urban areas, however urban and rural areas may show internal variability with regard to living conditions. For example, disadvantaged rural areas near truck routes or bordering other countries, may have high risks of HIV transmission as a result of the increased travel and economic activity of the subjects living in those areas (Somi et al., 2006) which may be more likely to move to the more infected urban areas, contract HIV (Coffee et al., 2007; Mundandi et al., 2006) and transmit the virus to family when they come back home (MacDonald, 1996). Whereas, disadvantaged villages in remote rural areas may have lower risks of HIV transmission because of the relative isolation they have (Bloom et al., 2002). A study carried out in Tanzania found that people living in a small trading center had higher risk of HIV infection than those in nearby rural areas (Bloom et al., 2002). Hence, rural areas may be highly heterogeneous in terms of social and economic conditions.

We have found higher rates of HIV in women than in men, and especially, young women had higher rates, as already found elsewhere (Magadi and Desta, 2011). Mathematical models show that reducing cross-generational mixing (young women, sometimes as early as 9 or 10 years of age, forming sexual partnership with older men) will decrease the prevalence of HIV among women (Hallett et al., 2007). Cross generational mixing increases the prevalence of HIV because most of the partners of infected old males will probably be young non infected females (Hallett et al., 2007; Gregson et al., 2002). Older men are also less likely to use condoms than younger ones (Hallett et al., 2007). Women show a higher prevalence of ulcerative STIs than men and this makes them more susceptible to infection once exposed (Glynn et al.,

2001) and may be at higher risk of infection by non sexual transmission mechanisms than men, such as those related to the pregnancy and delivery practices. In addition, women may be more likely to receive HIV testing than men (that is, women may receive HIV testing during pregnancy), or may live longer with HIV than men. Information on AIDS-attributable mortality is essential to assess the impact of the epidemic in men and women, but vital registration systems have extremely limited coverage in sub Saharan Africa.

Our findings show that the heterogeneous distribution of wealth within a region (described through the inter-quartile range) could explain part of the risk of HIV infection at individual level, and this association is retained when other explanatory variables are considered, as observed for mortality and deprivation in England and Wales by Ben-Shlomo et al. (1996). Lynch at al. (1998) found that metropolitan areas with high income inequality and low per capita income within the US had higher mortality compared to areas with low income inequality. Holtgrave and Crosby (2003) also found that the more income inequality in the US, the higher the AIDS case rate. Results from our study indicate that inequality in wealth may be more important than absolute wealth in explaining higher rates of infection.

The main direct link between inequality in wealth and HIV is likely to be through transactional sex. High inequality would stimulate risky sexual behaviours and the diffusion of illicit sexual relationships, especially for wealthy men because of the high tolerance for male promiscuity. These findings deserve further investigations with particular attention for social heterogeneity and social conditions because these topics have never been considered before in this setting.

LIMITATIONS

Before drawing conclusions, some limits and possible biases of the study should be mentioned.

First, the wealth index may not be appropriate for rural areas (for example, household characteristics, household size and type of water sources may vary in rural and urban areas) and for women (for example, it may also be important to study what influences resource allocation in the household, and whether women take part in decision making concerning household resources and control over money). Perhaps educational attainment might be a better indicator of socio-economic-position than household wealth and occupation in women. Also, the 2004 CDHS is a large cross-sectional population based survey. Our analyses are based on 4,672 men and 5,227 women.

Second, there is a time lag between exposure and detection of HIV infection, therefore the use of indicators which refer to the same period for which the outcome is collected may not inform on exposures which could have occurred in earlier years. Hence, current socio-economic-position as indexed by occupation and household wealth may not be aetiologically relevant. Low education may be a marker for socioeconomic or environmental influences in early young hood (Galobardes et al., 2006), which may trigger unhealthy life trajectories and put people at higher risk of HIV infection.

Third, because of the long incubation period of HIV, prevalence may be affected by varying mortality and treatment. The probability to be tested for HIV may also vary with time, socio-economic circumstances and also between women and men, being the former, most often subjected to HIV testing. Longitudinal studies on incidence are therefore necessary to understand the contemporary epidemiology. It is also possible that any trend in the association between relative wealth and risk of infection vary with time (Parkhurst, 2010).

Fourth, possible selection bias because of the higher refusal rate for HIV testing module among the wealthier and more educated may attenuate the relationship between wealth and HIV infection (Mishra et al., 2006). Another study also found that HIV-positive status was negatively correlated with consent to test in men, but not in women (Baernighausen et al., 2011).

Fifth, education and occupation may mediate the association between household wealth and HIV infection. The relationship between household wealth and HIV infection may be attenuated in the model, including education and occupation.

Sixth, we cannot rule out reverse causality (for example, AIDS-related illness limits people's ability to work, thus decreasing household wealth).

PUBLIC HEALTH IMPLICATIONS

A better understanding of the interplay between socio-economic circumstances, cultural factors and sexual behaviour is required. Health promotion should take both individual and area characteristics into account (Gupta et al., 2008). Our findings indicate that public health interventions for HIV prevention in this context should consider the socio-economic factors and their variation. Policies towards HIV should take into account the diversity of settings, and that a combination of successful approaches in one place might not be transferable to another (Gupta et al., 2008). Planning and applying intervention measures could have different outcomes in areas with a high degree of internal variability with regard to socio-economic-position. Defining criteria for the selection of homogeneous areas to be addressed with intervention strategies should help public health decision makers and increase the effectiveness of the intervention.

Findings from our study also suggest that special prevention programmes should target wealthy men in working environments, areas for leisure time activities, and other areas mainly attended by them, thus increasing

their awareness on the risk of HIV and the importance to reduce risky sexual behaviours (for example, concurrent sexual relationships (Uchudi et al., 2012; Wilson and Halperin, 2008)). Changes in transmission require that large numbers of people change their behaviours substantially and maintain these changes for a long time (Coates et al., 1923). We suggest working with social units rather than with individuals in isolation, to increase potential of success (Coates et al., 1923; Auerbach et al., 2011).

The transformation of developing countries into market economies generates a social risk environment. The risk environment cannot be modified by simply changing individual behaviours. Overall economic development must be encouraged in developing countries, but must point to inequality reducing rather than to inequality-inducing, in order to minimize the social dislocations that increase risk for HIV.

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REFERENCES

Adimora AA, Schoenbach VJ, Martinson FE, Coyne-Beasley T, Doherty I, Stancil TR, Fullilove RE (2006). Heterosexually transmitted HIV infection among African Americans in North Carolina 6. J. Acquir. Immune Defic. Syndr. 15;41(5):616-23.

Auerbach JD, Parkhurst JO, Caceres CF (2011). Addressing social drivers of HIV/AIDS for the long-term response: Conceptual and methodological considerations. Global Public Health 6:S293-S309.

Auvert B, Buve A, Lagarde E, Kahindo M, Chege J, Rutenberg N, Musonda R, Laourou M, Akam E, Weiss HA; Study Group on the Heterogeneity of HIV Epidemics in African Cities (2001). Male circumcision and HIV infection in four cities in Sub-Saharan Africa. AIDS Suppl 4:S31-S40.

Baernighausen T, Bor J, Wandira-Kazibwe S, Canning D (2011). Correcting HIV Prevalence Estimates for Survey Nonparticipation Using Heckman-type Selection Models. Epidemiology 22(1):27-35.

Ben-Shlomo Y, White IR, Marmot M (1996). Does the variation in the socioeconomic characteristics of an area affect mortality? BMJ 312(7037):1013-4.

Bloom SS, Urassa M, Isingo R, Ng'weshemi J, Boerma JT (2002). Community effects on the risk of HIV infection in rural Tanzania 3. Sex Transm. Infect. 78(4):261-6.

Buve A, Carael M, Hayes RJ (2001a). The multicentre study on factors determining the differential spread of HIV in four African cities: summary and conclusions. AIDS 15 Suppl 4:S127-S131.

Buve A, Weiss HA, Laga M, (2001b). The epidemiology of gonorrhoea, chlamydial infection and syphilis in four African cities. AIDS 15 Suppl 4:S79-S88.

Buve A, Weiss HA, Laga M, (2001c). The epidemiology of trichomoniasis in women in four African cities 36. AIDS 15 Suppl 4:S89-S96.

Carpenter LM, Kamali A, Ruberantwari A, Malamba SS, Whitworth JA (1999). Rates of HIV-1 transmission within marriage in rural Uganda in relation to the HIV sero-status of the partners 7. AIDS 13(9):1083-9.

Central Bureau of Statistics (BCS), Ministry of Health (MOH), ORC Macro. Kenya demographic and halth survey 2003. Claverton, Maryland 2004.

Coates TJ, Richter L, Caceres C (1923). Behavioural strategies to reduce HIV transmission: how to make them work better. Lancet 372(9639):669-84.

Coffee M, Lurie MN, Garnett GP (2007). Modelling the impact of migration on the HIV epidemic in South Africa 2. AIDS 21(3):343-50.

Congdon P, Shouls S, Curtis SE (1997). A Multi-Level Perspective on Small-Area Health and Mortality: A Case Study of England and Wales. Int. J. Popul. Geogr. 3:243-63.

Davey SG, Gunnel D, Ben-Shlomo Y (2002). Poverty inequalities and health. Life-course approach. p. 88-123.

Davey SG, Hart C, Watt G, Hole D, Hawthorne V (1998). Individual social class, area-based deprivation cardiovascular disease risk factors, and mortality: the Renfrew and Paisley study. J. Epidemiol. Community Health 52:399-405.

Demographic and Health Surveys - Phase III. Sampling Manual. DHS-III Basic Documentation. Claverton, Maryland; 1996. Report No.: 6.

Diaz T, Chu SY, Buehler JW (1994). Socioeconomic differences among people with AIDS: results from a Multistate Surveillance Project 13. Am. J. Prev. Med. 10(4):217-22.

Duncan C, Jones K, Moon G (1993). Do places matter? A multi-level analysis of regional variations in health-related behaviour in Britain. Soc. Sci. Med. 37(6):725-33.

Fenton L (2004). Preventing HIV/AIDS through poverty reduction: the only sustainable solution? Lancet 364(9440):1186-7.

Filmer D, Pritchett LH (2001). Estimating wealth effects without expenditure data--or tears: an application to educational enrollments in states of India. Demography 38(1):115-32.

Gabrysch S, Edwards T, Glynn JR (2008). The role of context: neighbourhood characteristics strongly influence HIV risk in young women in Ndola, Zambia. Trop. Med. Int. Health 13(2):162-70.

Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey SG (2006). Indicators of socioeconomic position (part 1). J Epidemiol Community Health 60(1):7-12.

Glynn JR, Carael M, Auvert B, Kahindo M, Chege J, Musonda R, Kaona F, Buvé A; Study Group on the Heterogeneity of HIV Epidemics in African Cities (2001). Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia. AIDS 15 Suppl 4:S51-S60.

Gregson S, Nyamukapa CA, Garnett GP, Mason PR, Zhuwau T, Caraël M, Chandiwana SK, Anderson RM (2002). Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe. Lancet 1;359(9321):1896-903.

Greig FE, Koopman C (2003). Multilevel analysis of women's empowerment and HIV prevention: quantitative survey Results from a preliminary study in Botswana. AIDS Behav. 7(2):195-208.

Gupta GR, Parkhurst JO, Ogden JA, Aggleton P, Mahal A (2008). HIV prevention 4 - Structural approaches to HIV prevention. Lancet 372(9640):764-75.

Hallett TB, Gregson S, Lewis JJ, Lopman BA, Garnett GP (2007). Behaviour change in generalised HIV epidemics: impact of reducing cross-generational sex and delaying age at sexual debut. Sex Transm. Infect. 83 Suppl 1:i50-i54.

Holtgrave DR, Crosby RA (2003). Social capital, poverty, and income inequality as predictors of gonorrhoea, syphilis, chlamydia and AIDS case rates in the United States. Sex Transm. Infect. 79(1):62-4.

Ishida K, Arnold M, Stupp P, Kizito P, Ichwara J (2012). Exploring the connections between HIV serostatus and individual, household, and community socioeconomic resources: evidence from two population-based surveys in Kenya. Soc. Sci. Med. 74(2):185-95.

Jones K, Duncan C (1995). Individuals and their ecologies: analysing the geography of chronic illness within a multilevel modelling framework. Health Place 1:27-40.

Kongnyuy EJ, Wiysonge CS, Mbu RE, Nana P, Kouam L (2006). Wealth and sexual behaviour among men in Cameroon. BMC. Int. Health Hum. Rights 6:11-8.

Lynch JW, Kaplan GA, Pamuk ER, Cohen RD, Heck KE, Balfour JL, Yen IH (1998). Income inequality and mortality in metropolitan areas of the United States. Am. J. Pub. Health 88(7):1074-80.

MacDonald DS (1996). Notes on the socio-economic and cultural factors influencing the transmission of HIV in Botswana 2. Soc. Sci. Med. 42(9):1325-33.

Macintyre S, Maciver S, Sooman A (1992). Area, Class and Health: Should we be Focusing on Place or People? J. Soc. Policy 22:213-34.

Magadi M, Desta M (2011). A multilevel analysis of the determinants and cross-national variations of HIV seropositivity in sub-Saharan Africa: Evidence from the DHS. Health Place 17(5):1067-83.

Mari-Dell'olmo M, Rodriguez-Sanz M, Garcia-Olalla P (2007). Individual and community-level effects in the socioeconomic inequalities of AIDS-related mortality in an urban area of southern Europe. J. Epidemiol. Community Health 61(3):232-40.

Marshall BD (2008). The contextual determinants of sexually transmissible infections among street-involved youth in North America. Cult. Health Sex 10(8):787-99.

Masanjala W (2007). The poverty-HIV/AIDS nexus in Africa: a livelihood approach. Soc. Sci. Med. 64(5):1032-41.

Measure DHS. Demographic and Health survey. http://www measuredhs com/What-We-Do/Survey-Types/DHS cfm 2012.

Mishra V, Assche SB-V, Greener R, Vaessen M, Hong R, Ghys PD, Boerma JT, Van Assche A, Khan S, Rutstein S (2007). HIV infection does not disproportionately affect the poorer in sub-Saharan Africa. AIDS 21.

Mishra V, Vaessen M, Boerma JT, Arnold F, Way A, Barrere B, Cross A, Hong R, Sangha J (2006). HIV testing in national population-based surveys: experience from the Demographic and Health Surveys. Bull. World Health Organ. 84(7):537-45.

Morison L, Buve A, Zekeng L (2001). HIV-1 subtypes and the HIV epidemics in four cities in sub-Saharan Africa55. AIDS 15 Suppl 4:S109-S116.

Mundandi C, Vissers D, Voeten H, Habbema D, Gregson S (2006). No difference in HIV incidence and sexual behaviour between out-migrants and residents in rural Manicaland, Zimbabwe. Trop. Med. Int. Health 11(5):705-11.

National Institute of Statistics, ORC Macro. Cameroon Demographic and Health Survey. Claverton, Maryland, USA; 2004.

Orroth KK, Freeman EE, Bakker R, Buvé A, Glynn JR, Boily MC, White RG, Habbema JD, Hayes RJ (2007). Understanding the differences between contrasting HIV epidemics in east and west Africa: results from a simulation model of the Four Cities Study. Sex Transm. Infect. 83 Suppl 1:i5-16.

Parkhurst JO (2010). Understanding the correlations between wealth, poverty and human immunodeficiency virus infection in African countries. Bull. World Health Organ. 88(7):519-26.

Peterman TA, Lindsey CA, Selik RM (2005). This place is killing me: a comparison of counties where the incidence rates of AIDS increased the most and the least. J. Infect. Dis. 191 Suppl 1:S123-S126.

Pezzotti P, Rezza G, Lazzarin A, Angarano G, Sinicco A, Aiuti F, Zerboni (1992). Influence of gender, age, and transmission category on the progression from HIV seroconversion to AIDS. J. Acquir. Immune Defic. Syndr. 5(7):745-7.

Pickett KE, Pearl M (2001). Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. J. Epidemiol. Community Health 55:111-22.

Poundstone KE, Strathdee SA, Celentano DD (2004). The social epidemiology of human immunodeficiency virus/acquired immunodeficiency syndrome. Epidemiol. Rev. 26(1):22-35.

Rutstein SO, Kiersten J (2004). The DHS Wealth Index. Calverton, Maryland. Report No. 6.

Shelton JD, Cassell MM, Adetunji J (2005). Is poverty or wealth at the root of HIV? Lancet 366(9491):1057-8.

Shouls S, Congdon P, Curtis SE (1996). Modelling inequality in reported long term illness in the UK: combining individual and area characteristics 737. J. Epidemiol. Community Health 50:366-76.

Simon PA, Hu DJ, Diaz T, Kerndt PR (1995). Income and AIDS rates in Los Angeles County. AIDS 9(3):281-4.

Sloggett A, Joshi H (1998). Deprivation indicators as predictors of life events 1981-1992 based on the UK ONS longitudinal study. J. Epidemiol. Community Health 52:228-33.

Somi GR, Matee MI, Swai RO, Lyamuya EF, Killewo J, Kwesigabo G, Tulli T, Kabalimu TK, Ng'ang'a L, Isingo R, Ndayongeje J (2006). Estimating and projecting HIV prevalence and AIDS deaths in Tanzania using antenatal surveillance data. BMC. Public Health 6:120.

Tanser F, Lesueur D, Solarsh G, Wilkinson D (2000). HIV heterogeneity and proximity of homestead to roads in rural South Africa: an exploration using a geographical information system. Trop. Med. Int. Health 5(1):40-6.

Tanzania Commission for AIDS(TACAIDS), National Bureau of Statistics (NBS), ORC Macro. Tanzania HIV/AIDS Indicator Survey 2003-04. Claverton, Maryland; 2005.

Tu YK, Kellett M, Clerehugh V, Gilthorpe MS (2005). Problems of correlations between explanatory variables in multiple regression analyses in the dental literature. Br. Dent. J. 199(7):457-61.

Uchudi J, Magadi M, Mostazir M (2012). A Multilevel Analysis of the Determinants of High-Risk Sexual Behaviour in Sub-Saharan Africa. J. Biosoc. Sci. 44(3):289-311.

Wallace R, Wallace D (1995). U.S. apartheid and the spread of AIDS to the suburbs: a multi-city analysis of the political economy of spatial epidemic threshold . Soc. Sci. Med. 41(3):333-45.

Weiss HA, Buve A, Robinson NJ, Van Dyck E, Kahindo M, Anagonou S, Musonda R, Zekeng L, Morison L, Caraël M, Laga M, Hayes RJ, Study Group on Heterogeneity of HIV Epidemics in African Cities. (2001). The epidemiology of HSV-2 infection and its association with HIV infection in four urban African populations. AIDS 15 Suppl 4:S97-108.

Wilson D, Halperin DT (2008). Know your epidemic, know your response": a useful approach, if we get it right. Lancet 372(9637):423-6.

Yaoundé : Institut national de la statistique: Ministère de la planification dlpddedldtYC. Enquête démographique et de santé : Cameroun, 2004. Calverton, Md.; 2005.

Zierler S, Krieger N (1997). Reframing women's risk: social inequalities and HIV infection. Annu. Rev. Pub. Health18:401-36.

Zierler S, Krieger N, Tang J (2009). Economic Deprivation and AIDS Incidence in Massachusetts. Am. J. Public. Health 90(7):1064-73.

Zierler S, Krieger N, Tang Y, Coady W, Siegfried E, DeMaria A, Auerbach J (2000). Economic deprivation and AIDS incidence in Massachusetts. Am. J. Pub. Health 90(7):1064-73.