ORIGINAL ARTICLE

Association of HIV prevalence and concurrency of sexual partnerships in South Africa's language groups: An ecological analysis

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Background. There is considerable variation in HIV prevalence between different language groups in South Africa (SA). Sexual partner concurrency has been linked to the spread of HIV, but its effect on differential HIV transmission within SA's language groups has not been investigated quantitatively.
Objective. This ecological analysis was intended to explore the degree to which the variation in HIV prevalence according to language group can be explained by differential concurrency rates.
Method. Linear regression was used to assess the association between each language group's HIV prevalence and four risk factors: the prevalence of concurrency, multiple sexual partners in the preceding year, circumcision, and condom utilisation.
Results. In multivariate analysis, only the point prevalence of concurrency remained associated with HIV prevalence.
Conclusion. There is evidence of a high prevalence of point concurrency in sexual partnerships in SA's most HIV-affected language groups. Together with evidence that relatively small decreases in concurrency can lead to large declines in HIV incidence, this provides impetus for interventions to promote having only one sexual partner at a time.

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Although adult HIV incidence in South Africa (SA) has fallen somewhat, it remains alarmingly high – between 1% and 2%.[1] It is of great importance to ascertain what is driving this high incidence. One approach that has received little attention is to compare the potential risk factors for HIV in SA's various language groups. Since HIV prevalence varies widely among these groups, this offers an opportunity to determine which population-level factors co-vary most closely with this prevalence. The objective of this analysis was to determine the manner in which HIV prevalence varies according to SA's 11 major self-defined language groups, and to examine the ecological association of four risk factors (prevalence of concurrency, multiple partners in the preceding year, circumcision, and condom utilisation) with HIV prevalence in these groups.

Methods

Two nationally representative surveys were used for this study, namely the South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey of 2008 (SABSSM III) and the National Communication Survey of 2009 (NCS 2009).[2,3] In both surveys, respondents were asked to verify which main language they spoke at home; responses were coded into 11 identical language options (Table 1). The HIV prevalence (dependent variable) and risk factors (independent variables: prevalence of concurrency, multiple sexual partners in the preceding year, circumcision, and condom utilisation) were calculated for each language group.

HIV prevalence

The HIV prevalence of each language group (among individuals aged 16 - 55 years) was obtained from the SABBSSM III survey.[2] This was the third and most recent of the SABSSM surveys, which are the only nationally representative HIV sero-surveys of South Africans of all ages. The survey used a multi-stage stratified sampling approach. When correctly weighted to account for the complex sampling design and HIV testing non-response, the sample was representative of the population in SA for the main reporting domains of sex, age, race and province.[2] Structured questionnaires were used to collect demographic, social and behavioural data. Dried blood-spot specimens were used for HIV testing using an algorithm that saw all samples initially being tested with an enzyme immuno-assay (Vironostika HIV Uni-Form II plus O, Biomerieux). Of 23 369 individuals, 20 826 (89.1%) completed the interviews and 15 031 (64.3%) agreed to provide blood for HIV testing. The mid-point of data collection was September 2008.

Risk factors

The four independent variables were derived from the NCS 2009[3] – a cross-sectional survey that utilised a multi-stage, stratified sampling approach (comprising three stages). Firstly,

Table 1. Prevalence of HIV[2] and various risk factors[3] per language group among South Africans aged 16 - 55 years

	SABSSM III[2]			NCS 2009[3]					
Language	*N*	Age median (IQR)	HIV prevalence % (95% CI)	*N*	Age median (IQR)	Concurrency % (95% CI)	Multiple partners per year % (95% CI)	Circumcision % (95% CI)	Condom utilisation % (95% CI)
IsiZulu	1 646	28 (21 - 40)	28.8 (24.3 - 31.8)	1 973	29 (23 - 38)	8.9 (7.3 - 10.9)	16.8 (14.4 - 19.7)	23.5 (20.0 - 27.3)	50.5 (46.2 - 54.7)
IsiXhosa	1 497	28 (20 - 40)	21.6 (17.6 - 24.6)	1 351	28 (22 - 39)	4.9 (3.5 - 6.9)	11.6 (9.4 - 14.2)	76.6 (72.3 - 80.4)	45.8 (42.1 - 54.7)
IsiNdebele	105	28 (21 - 41)	20.6 (9.4 - 38.5)	191	27 (22 - 36)	6.1 (3.0 - 12.0)	9.4 (5.0 - 17.0)	68.0 (52.9 - 80.1)	44.4 (33.7 - 55.5)
IsiSwati	251	28 (19 - 41)	23.9 (18.1 - 30.0)	365	25 (21 - 34)	5.3 (3.6 - 7.6)	7.7 (5.3 - 10.9)	32.9 (19.5 - 49.8)	51.7 (42.7 - 60.6)
English	1 847	32 (21 - 43)	1.5 (0.8 - 2.6)	370	36 (27 - 44)	1.4 (0.5 - 3.9)	3.1 (1.4 - 6.9)	31.9 (22.3 - 43.4)	22.8 (16.6 - 30.3)
Afrikaans	2 568	33 (21 - 44)	2.5 (1.8 - 3.3)	1 228	36 (26 - 44)	1.2 (0.6 - 2.4)	4.3 (2.8 - 6.6)	14.8 (10.3 - 21.0)	21.3 (17.0 - 26.3)
Sesotho	783	29 (21 - 40)	20 (16.6 - 22.9)	946	31 (23 - 40)	4.6 (3.0 - 7.0)	13.2 (9.9 - 17.5)	49.2 (42.5 - 56.1)	44.5 (39.6 - 49.5)
Sepedi	808	29 (20 - 42)	16.6 (11.4 - 21.6)	797	26 (21 - 35)	5.4 (5.0 - 7.5)	12.8 (9.1 - 17.8)	79.5 (72.5 - 85.0)	54.0 (44.9 - 62.9)
Setswana	852	29 (20 - 41)	18.4 (13.6 - 22.7)	699	31 (24 - 40)	4.6 (2.8 - 7.5)	11.0 (7.5 - 15.9)	31.6 (23.4 - 41.2)	49.2 (43.9 - 54.5)
Tshivenda	143	27 (20 - 41)	8.1 (3.2 - 17.8)	232	28 (22 - 36)	3.8 (1.5 - 9.5)	10.9 (6.5 - 17.5)	89.2 (77.4 - 95.2)	45.6 (38.1 - 53.2)
Xitsonga	331	28 (21 - 38)	17.6 (10.6 - 26.3)	374	27 (22 - 36)	5.4 (2.3 - 11.9)	11.8 (7.4 - 18.3)	70.1 (55.4 - 82.4)	39.5 (30.0 - 49.8)

SABSSM III = South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey of 2008; NCS 2009 = National Communication Survey of 2009; IQR = interquartile range; CI = confidence interval.

400 primary sampling units (PSUs) were sampled using principles of probability proportional to size. PSUs comprised small areas from the 2001 National Census. The second and third stages, respectively, involved the selection of secondary sampling units or households, and the selection of one individual per household (aged 15 - 55 years) from eligible household members. The final sample comprised 9 728 individuals aged 16 - 55 years, who were representative of South Africans in this age band. The overall response rate was 58%. Data were collected between June and August 2009. See Johnson *et al.*[3] for further details of the methodology and possible bias introduced by differential non-response. The four independent variables were defined as follows:

- *Point concurrency:* The point prevalence of concurrency (i.e. having two or more overlapping sexual relationships) at the time of the survey was used as the indicator of concurrency, as this has been shown to best capture the effect thereof in increasing a sexual network's connectivity and, hence, HIV transmissibility.[4,5] For each language group, the point concurrency was determined by the percentage of persons who reported having two or more partners at the time of the survey. This variable was derived from the question: 'How many sexual partners do you currently have?'
- *Multiple partners per year:* defined as the proportion of respondents in each language group who reported having two or more sexual partners in the preceding 12 months.
- *Condom utilisation:* defined as the proportion of respondents in each language group who reported using a condom the last time they had sexual intercourse.
- *Circumcision:* defined as the proportion of male respondents who reported being circumcised (each male respondent was asked whether or not he was circumcised).

Statistical analyses

The HIV prevalence and independent variables were calculated for each self-defined language group using Stata version 12.0 (College Station, Texas, USA) and by applying the survey methodology to account for the multi-stage sampling strategies and varying non-response rates. Uni- and multivariate linear regression models were used to assess the association between the independent and dependent variables. All analyses were limited to sexually experienced individuals aged 16 - 55 years. The data were not age-standardised, as the differences in the age structure of each language group were relatively small (Table 1).

Results

Table 1 shows the variation in HIV prevalence between language groups, ranging from 1.5% (95% CI 0.8 - 2.6) to 28.8% (95% CI 24.3 - 31.8). These variations remained considerable upon analysis of the nine black language groups alone; ranging from 8.1% (95% CI 3.2 - 17.8) in Tshivenda speakers to 28.8% (95% CI 24.3 - 31.8) in isiZulu speakers.

Three risk factors were strongly associated with increased HIV prevalence per language group upon univariate analysis: multiple partners per year, point concurrency (Fig. 1) and lower condom utilisation rates (Table 2). Circumcision prevalence rates were not associated with HIV prevalence; however, this may have been driven by the effect of the English- and Afrikaans-speaking groups who had low rates of circumcision and HIV prevalence (Fig. 2). When the analysis was restricted to the nine black language groups, increasing circumcision rates were correlated with lower HIV prevalence rates (R^2=0.48; p=0.04).

Table 2. Univariate and multivariate linear regression analysis of the relationship between HIV prevalence per language group and risk factors[2,3]

	Univariate			Multivariate	
Risk factor	**β co-efficient**	**R^2**	***p*-value**	**β co-efficient**	***p*-value**
Concurrency	3.79	0.84	0.0001	3.50	0.046
Multiple partners/year	2.04	0.55	0.0061	-0.23	0.949
Circumcision	0.04	0.02	0.8132	-0.02	0.427
Condom utilisation	0.61	0.58	0.0165	0.24	0.267

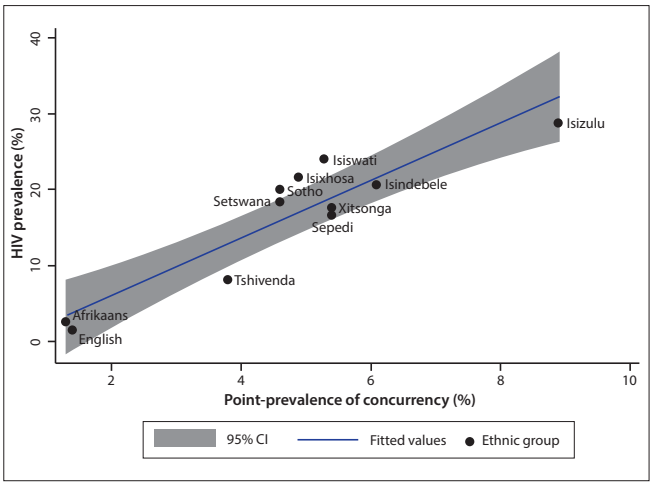

Fig. 1. Association between HIV prevalence (derived from SABSSM III) and the point prevalence of concurrency (derived from NCS 2009) for 11 language groups in South Africa (R^2=-0.84; p< 0.001).[2,3]

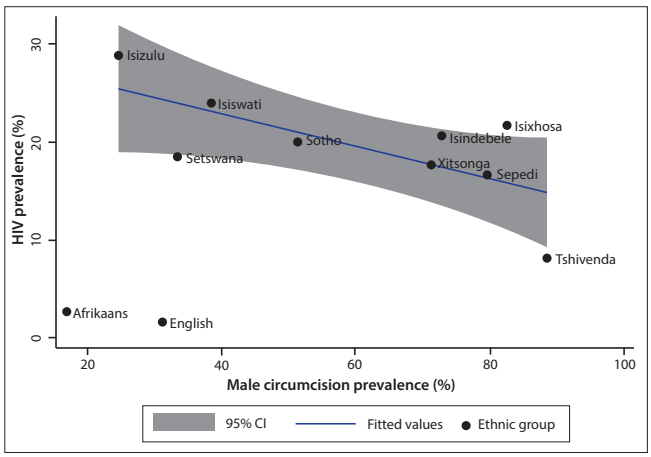

Fig. 2. Association between HIV prevalence (derived from SABSSM III) and the prevalence of male circumcision (derived from NCS 2009), for 11 language groups in South Africa (R^2=-0.02; p=0.70 for all 11 language groups and R^2=0.48; p=0.04 when analysis restricted to the nine black language groups).[2,3]

In multivariate analysis, only point concurrency remained associated with HIV prevalence (β co-efficient=3.5; *p*=0.03) (Table 2).

There was a high degree of overlap between language and self-reported ethnicity within the NCS 2009 sample. The proportion of coloureds, Indians and whites who spoke English or Afrikaans was 91.9%, 97.9% and 97.8%, respectively. The proportion of blacks who spoke English or Afrikaans as their home language was 1.6%. Omitting these individuals from the analyses made no difference to the results (data not shown). Moreover, it is possible that HIV prevalence may peak in different language groups at different times depending on the stage of the epidemic. To evaluate this, we repeated the analyses using the HIV prevalence rates from the 2002 and 2005 SABSSM surveys. The resultant difference to the results was negligible (data not shown).

Discussion

HIV prevalence is known to vary dramatically between South African language and racial groups.[2] This heterogeneity offers a useful opportunity to examine the reasons underpinning the country's generalised HIV epidemic. Great caution needs to exercised in the use of ethnic and racial categories in health research. This is especially the case in SA, where the uncritical use of racial categories in the apartheid era, combined with the concomitant lack of controlling for the effects of the widely divergent socio-economic conditions, served to exaggerate racial differentials in various health outcomes.[6-8] However, a wide range of evidence indicates that economic differences are not the predominant drivers of differential HIV spread according to racial group.[9] Furthermore, it is important to explain the considerable differences in HIV prevalence between language groups among black South Africans.

There is a high degree of homophilous partnering (like-with-like) among self-defined language groups in sub-Saharan Africa[10] and elsewhere.[11] Sexual networks would therefore be expected to cluster and segregate to a considerable degree along these lines, as has been demonstrated empirically.[10,11] These sexual networks may be, more or less, densely interconnected and these differences are believed by many,[4,12] but not all, epidemiologists[13] to be important in explaining differential HIV spread. Since network connectivity, as assessed by measures such as concurrency prevalence, is a network-level property, it is necessary and appropriate to investigate it at a network or ecological level.

A number of studies from SA, the USA and elsewhere have found that racial or ethnic variations in HIV prevalence are not explained by individual-level risk factors (e.g. multiple partners per year and lifetime number of sexual partners), but rather that network-level factors such as concurrency prevalence are important.[4,14,15] This is commensurate with global reviews of sexual behaviour which have shown that the average number of lifetime sexual partners is, if anything, lower in countries with generalised HIV epidemics than in countries with low HIV prevalence rates such as those in Western Europe.[16]

In the data described here, the relationship between circumcision and HIV prevalence is interesting, especially considering the significant association within the black language groups. Circumcision cannot, however, explain the low HIV prevalence rates in the English and Afrikaans groups, as they have the lowest circumcision rates. This is

mirrored globally. Eastern and Southern Africa have considerably higher circumcision rates than Latin America, and the non-Islamic countries in Asia and Europe, all of which have very low HIV prevalence rates.[17,18] Clearly, something else may be driving the higher HIV prevalence rates. The multivariate analyses presented here support findings from elsewhere which suggest that the degree of connectedness of the sexual network (here measured by point prevalence of concurrency) is playing a significant role in this regard.[4,14,15,19,20]

Study limitations

There are a number of weaknesses in this analysis, including the fact that the data for sexual behaviour and HIV prevalence were derived from different surveys. Both surveys were, however, conducted with nationally representative samples. The surveys were designed to provide representative data for the four racial groups in SA, but not for the eleven language groups. Ecological analyses, such as this one, assume a high degree of language group homophily as far as sexual partnering is concerned. This has been long been shown to be the case in the USA,[11] but only recently so in SA.[10] The data are derived from self-reported behaviour and circumcision statuses; however, these are prone to well-described biases.[11] In particular, self-described circumcision has been shown to over-estimate circumcision prevalence.[21] There is, however, no evidence to indicate that these biases vary between different language groups and, as such, they should not affect the validity of this study. Furthermore, ecological studies are susceptible to the ecological inference fallacy. This study, however, makes no inferences from the population to the individual level. Further work is necessary to evaluate whether partner concurrency is associated with an increased risk of HIV acquisition in prospective cohorts. Lastly, it is possible that the study's results may have been confounded by unmeasured variables.

Conclusion

In summary, evidence is presented here of a high prevalence of point concurrency in sexual partnerships in SA's most HIV-affected language groups. Other studies have found that these groups may be unaware of the dangers of concurrency.[22] These results combined with the evidence that relatively small decreases in concurrency can lead to large declines in HIV incidence provide further impetus for interventions to promote having only one partner at a time.[15,19,20]

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