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Concurrent Sexual Partnerships and HIV/AIDS among Youths in the Cape Metropolitan Area

Timothy Mah

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Timothy Mah is a Research Fellow with the AIDS Prevention Research Project at the Harvard Center for Population and Development Studies, and a ScD Candidate in the Department of Global Health and Population at the Harvard School of Public Health.
Email: timothy_mah@harvard.edu

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Abstract

Concurrent sexual partnerships are increasingly recognized as an important behavioural driver of HIV epidemics, particularly in southern Africa. The prevalence of HIV among young people in South Africa can be reduced by decreases in sexual risk behaviours, including engaging in concurrent partnerships. This analysis examines the frequency and correlates of concurrency in a representative multi-racial young adult (aged 16-26) population in the Cape Metropolitan Area, using multivariate logistic regression. Overall, approximately 13% of sexually active young adults reported concurrency during their last sexual partnership, though there was significant variability by sex and race, ranging from 33% of young Black men to 2% of young Coloured women reporting concurrency. Concurrency was associated with other high risk behaviours, including a higher number of lifetime sex partners and a lower age of sexual debut. Future prevention effects among young adults will need to address concurrency in order to minimize the risk of HIV infection.

Introduction

In recent years, a renewed emphasis has been placed on understanding the basic epidemiology of an HIV epidemic (e.g. risk groups, transmission factors, etc.) within a specific country in order to most effectively target prevention funding, policies, and programs (Wilson and Halperin, 2008, UNAIDS, 2008, Chin, 2007). This renewed emphasis has in part occurred to improve upon the successes of large amounts of funding, programs and policies aimed at reducing the spread and impact of the HIV/AIDS epidemics, particularly in the generalized epidemics of southern Africa. While the critical role of sexual behaviours on transmission has for long been recognized, the public health understanding of these behaviours and changes to such behaviours continues to require further research and understanding.

Since the first cases of HIV/AIDS were recognized in South Africa in 1983, responses to the epidemic have often been shaped by politics and a development and social agenda shaped by the consequences and aftermath of Apartheid, rather than by public health principles and epidemiology. The severity and heterogeneity of the HIV epidemic in South Africa is attributed to a variety of determinants, ranging from distal factors – poverty, wealth inequality, gender inequality, a history of migrant labour, etc. – to proximate factors – sexual practices and circumcision status, among others (Siegfried, Muller, Deeks, Volmink, Egger, Low, Walker and Williamson, 2005, Dunkle, Jewkes, Brown, Gray, McIntryre and Harlow, 2004, Abdool Karim, 2005). The best responses to the epidemic in South Africa will require a comprehensive approach that will address the myriad factors ranging from development and human rights issues to individual behaviour change. But given limited resources – particularly human capital – prioritizing of the responses to HIV should be guided by epidemiology and public health principles. Increasingly, calls are being made for a reorientation of HIV prevention interventions to primarily focus on sexual behaviour change (Potts, Halperin, Kirby, Swidler, Marseille, Klausner, Hearst, Wamai, Kahn and Walsh, 2008, Green, 2003, SADC HIV/AIDS Unit - SADC Secretariat, 2006, Mah and Halperin, 2008).

In South Africa, young adults remain at high risk for HIV infection. In 2005, 4.4% of young men and 16.9% of young women, aged 15-24 were infected with HIV (Shisana, Rehle, Simbayi, Parker, Zuma, Bhana, Connolly, Jooste and Pillay, 2005). A population-based survey among young people in 2003 found similar prevalence; 4.8% of young men and 15.5% of young women were infected (Pettifor, Rees, Kleinschmidt, Steffenson, MacPhail, Hlongwa-

Madikizela, Vermaak and Padian, 2005). Between 2002 and 2005, sexual risk behaviours among South African men worsened. In 2002, 23% of young men, age 15-24 reported more than one partner in the past twelve months. In 2005, this had increased to 27% (Shisana, 2002, Shisana et al., 2005). During this same period the number of young women reporting more than one partner declined from 9% to 6%. Among adults aged 15 or older who believed they would probably be infected with HIV during their lifetime, less than 8% thought it would happen as a result of having multiple, though not necessarily concurrent, partners. More than 45% believed it would be the result of cuts or an accident (Shisana et al., 2005).

Based on these data, it is evident that HIV prevention interventions have not yet reached their full potential in effecting sexual behaviour changes that will slow the transmission of HIV in South Africa at the population level. Various large- and small-scale interventions in South Africa have targeted young people such as the loveLife, Soul City, and various programs by government and non-governmental organizations, some more successfully than others (Parker, 2003, Green, 2004). In order to improve behaviour change messages and interventions, better knowledge about the sexual practices of these young adults is needed to inform these interventions.

This study therefore seeks to describe the frequency and correlates of concurrency among the young adult population in the Cape Metropolitan Area of Western Cape Province. Specifically, data on sexual partnerships are examined to estimate the frequency of concurrency and to better characterize young people who participate in concurrency. This analysis of sexual history data collected as part of the Cape Area Panel Survey (CAPS) in 2005 provides evidence to suggest that concurrent sexual partnerships are common in certain sub-populations and that prevention interventions should begin to address this high risk behaviour among young people.

Concurrent Partnerships

Concurrency is increasingly being noted as an element of sexual partnerships that plays a critical role in HIV transmission dynamics (SADC HIV/AIDS Unit - SADC Secretariat, 2006, Shelton, 2007, Halperin and Epstein, 2007, Hankins, 1998, Epstein, 2004, UNAIDS, 2006, Mah and Halperin, 2008). Concurrency or concurrent partnerships have been variably defined and measured in the literature. In general, concurrent partnerships are sexual relationships, whereby

an index partner has overlapping relations with two or more partners. This is contrasted with sequential or serial monogamy, whereby an individual engages in a sexual relationship with only one partner at a time, with no overlap with subsequent sexual partners.

Variability in viremia over the course of HIV infection, and in particular high viral loads during acute infection, the biological foundation for the role that concurrency plays in HIV transmission dynamics. During acute infection, defined approximately as the first three weeks to two months following viral acquisition, viral replication is relatively unchecked resulting in high viral loads and increased efficiency in HIV transmission (Wawer, Gray, Sewankambo, Serwadda, Xianbin, Laeyendecker, Kiwanuka, Kigozi, Kiddugavu, Lutalo, Nalugoda, Wabwire-Mangen, Meehan and Quinn, 2005, Pinkerton, 2007, Pilcher, Tien, Eron, Vernazza, Leu, Stewart, Goh and Cohen, 2004).

Concurrent partnerships increase the probability that uninfected partners will have sexual intercourse with and potentially be exposed to a partner during acute infection. This is because in regular, as opposed to casual partnerships, there may be a higher number of coital acts along with less condom use (Van Rossem, Meekers and Akinyemi, 2001). Additionally, given the time overlap in partnerships, earlier partners with whom an individual is still sexually active, are still at risk for HIV infection via current and future overlapping partners. This transmission network effect cannot occur in serial partnerships. During serial partnerships, given the potential time gaps between sexual relationships, few and possibly no uninfected partners will be exposed to an infected partner during the acute infection stages. This will result in a lower per act risk of transmission and put fewer individuals at risk.

A 1995 survey in rural KwaZulu Natal, South Africa found that 40% of sexually active men report more than one partner during the past three months, though it is not known if those relationships were serial or concurrent (Colvin, Abdool Karim, Connolly, Hoosen and Ntuli, 1998). The authors of the study state that such high reporting of multiple partners is most likely indicative of concurrency rather than serial partnerships in this population. In Eastern Cape Province, a 2005 study of young men, aged 15-26, found that 55% of the study population reported having one or more concurrent partners (Jewkes, Dunkle, Mduna, Levin, Jama, Khuzwayo, Koss, Puren and Duvvury, 2006). A 2006 study in Swaziland found that 70% of males and 62% of females reported having 2 or more partners in the last three months (James and Matikanya, 2006). Though the overlap between relationships was not measured, the high frequency of two or

three partners suggests that a large proportion of the population in Swaziland are engaged in concurrent partnerships.

Design & Methods

Data

The data used in this analysis were collected as part of the Cape Area Panel Study (CAPS), which was conducted by the Centre for Social Science Research at the University of Cape Town, in collaboration with the Population Studies Center at the University of Michigan[1]. The study collected data on approximately 4 800 young people, aged 14-22 in 2002 living in the Cape Metropolitan Area of Western Cape Province and focused on issues affecting young people during their transition from adolescence to adulthood (Lam, Seekings and Sparks, 2006). In 2003 and 2004, a two-part second wave was conducted, interviewing about 3 900 of the young people from Wave 1. In 2005, the third wave successfully interviewed over 3 500 young people who were initially contacted during the first Wave.

According to the principal investigators, "[t]he CAPS project was designed to provide rich detail on the transitions made by young South Africans as they move through school, enter the labour force, begin sexual activity, move into their own households, and start their own families" (Lam et al., 2006). The study occurred in the period following political changes resulting from the end of the apartheid, social and economic uncertainty and the worsening HIV/AIDS epidemic. The study is therefore able to look at the transition between adolescence and adulthood in the context of these societal shifts occurring in South Africa.

The CAPS cohort consists of a random sample of households in the Cape Metropolitan Area (CMA) in Western Cape. The sampling was done using a

[1] Subsequent collaborators included the South African Labour and Development Research Unit at the University of Cape Town and the Research Program in Development Studies at Princeton University. Major funding for the Cape Area Panel Study was provided by the National Institute of Child Health and Human Development, the Office of AIDS Research and the John E. Fogarty International Center of the U.S. National Institutes of Health and the Andrew W. Mellon Foundation. More information about the CAPS Project can be found at www.caps.uct.ac.za.

two-stage cluster sampling methodology. The CMA has 4 759 enumerator areas (EA), according to the 1996 Population Census, which was the most recent available census at the time of the study design. In 1996, the population of the CMA was approximately 2.6 million (Lam et al., 2006). The first stage sampling utilized selected EA from the 1996 Census with a Probability Proportional to Size (PPS) methodology, while the second stage randomly selected households within each cluster. The EA were stratified based on the predominant population group living in the area. Up to and including three young adults, aged 14-22 (in 2002) per household were entered into the CAPS cohort. During the first stage selection, Black and White clusters were oversampled to allow for statistically meaningful conclusions to be made about each group. Overall, the sampling design aimed to produce a young adult sample of 4 500 – 5 000 individuals that would be representative of the non-institutionalized population aged 14-22 in the CMA. (For a more detailed discussion of the sample design, see Lam, Seekings *et al*. 2006).

A majority of the data used in this analysis were collected during Wave 3 in 2005, unless otherwise noted below. During this Wave, a module on Health, Reproductive Health and Sexual Activity collected sexual histories including information on up to ten sexual partners, beginning with sexual debut, if the respondent had begun sexual activity. Interviews were conducted in three languages: English (29%), Xhosa (35%), and Afrikaans (36%).

Because of the sampling methodology, various types of response rates are presented for wave 1. The response rate for households with young adults was 75%; the response rate for young adults, conditional on response at the household level was 90%; the composite young adult response rate (combining the above two rates) was 68% for Wave 1. A previously published multivariate probit attrition analysis found that non-respondents were more likely to be older, male, working and non-African (Lam et al., 2006). The target sample for Wave 3 was the entire set of young adults interviewed during Wave 1. Only individuals who were deceased or mentally ill at the time of Wave 2 were excluded. Participation in Wave 3 was therefore not conditional on participation in Wave 2. 3 536 young adults completed Wave 3; a response rate of 74%. A multivariate probit regression analysis found that non-respondents were more likely to be older, not in school or working in 2002, not born in Cape Town and non-Coloured.

In order to adjust for the sample design, including the two-stage cluster sampling and oversampling of Black and White households and individual non-

response in Waves 1 and 3, sample weights were designed. The weighted distribution of the sample is representative of the population groups in the CMA in 1996. A full analysis of attrition and the creation of sample weights has been previously published in Lam, Seekings *et al*. 2006.

Study Participants

3 536 young adults completed surveys during Wave 3 in 2005, all of whom lived in the CMA at the time of the interview. The CMA consists of Cape Town City and the eight surrounding sub-districts. Among those interviewed, 2 486 young people had ever had sexual intercourse[2]. Only individuals who had ever been sexually active by the time of the survey in 2005 were included in this analysis. The following characteristics describe those individuals. All percentages and/or proportions are weighted and therefore are representative of young adults (age 16-26) in the CMA in 2005; counts presented are unweighted.

The young adults were nearly evenly divided by sex: 48% young men and 52% young women. Three racial groups, categorized by the former Apartheid definitions, were represented: Black – 37%, Coloured – 49%, and White – 14%. Three individuals (<1%) identified themselves as Indians. However, given their small number, these individuals were re-assigned to the "Coloured" group. It should be noted that the racial make-up of the CMA and of Western Cape is unique in South Africa, since Coloureds and not Blacks represent the largest racial group there. However, this demographic composition allows for meaningful comparisons between the Coloured and Black sub-populations.

The ages of the respondents ranged from 16 to 26 years, with a majority in the 20-24 year age range (66%), and a mean age of 21.2 years. A minority were still in school; 13% were still in primary or secondary school and 12% were enrolled in post-matriculation schools (e.g. university or other professional schools). 37% were no longer in school, having completed grade 12. 39% were no longer in school, but had not completed grade 12. Possibly due to the young age of the population and general high rates of unemployment, 53% reported having no personal income from any job; 47% reported having some personal income. Among those reporting income, the mean amount was R 890 per month, but the range was large (up to R 30 000 per month) and a standard deviation of R 1 700

[2] Sexual intercourse was defined as "full penetration," though distinctions between anal, vaginal or oral penetration were not made on the survey.

per month. Approximately 91% were unmarried at the time of the survey in 2005. Additional characteristics of the sample can be found in Appendix B, Table 1.

The age of sexual debut ranged from 7 to 24 years old, with a (weighted) mean of 16.7 years. This is similar to the median age of sexual debut (17 years) among 15-24 year olds from the 2005 National HIV and Behavioral Survey (Shisana et al., 2005). The number of lifetime sexual partners ranged from 1 to 32 partners, with a (weighted) mean of 2.2 lifetime partners.[3]

Biological markers for HIV prevalence were not collected among this cohort. However, the 2006 national ante-natal HIV survey found that in Western Cape, HIV was highest among 25-29 year olds (21%). Among 20-24 year olds, the prevalence was 15% and in under-20 year olds, the prevalence was 6% (Western Cape Provincial Department of Health, 2006).

Measures

Dependent Variable

In constructing the dependent variable, several definitions and measures of concurrency were considered. Four different "definitions" of concurrency were evaluated: concurrency at the time of the first sexual relationship (partner at sexual debut), concurrency during the relationship with a current partner, concurrency during a relationship with any partner, and concurrency during the most recently reported relationship. This last definition was ultimately used for several reasons.

By selecting the most recent partnership, recall bias was minimized compared to other previous relationships, including the first (sexual debut) partnership. The first partnership may also not be representative of other relationships, given the unique nature of an individual's first sexual experience. Concurrency with the most recent partner was excluded because by its definition, individuals who were not currently in a sexual relationship were excluded, resulting in a loss of potentially useful data. Concurrency during any previous reported partnership was not used because a known bias would be introduced into the analysis.

[3] The mean number of partners in the *past twelve months* was 1.2, with a range of 1 to 10 partners.

Specifically, if an individual reported concurrency during any partnership, characteristics from that partnership were used in defining the independent variables. For individuals reporting concurrency in multiple relationships, the most recent partnership during which concurrency was reported could be used. However, for individuals who did not report concurrency during any relationship, there was not a specific relationship from which characteristics could be drawn from for the independent variables. If a relationship were randomly chosen, relationships of a higher order would be selected at a higher rate for those with more partnerships, thereby introducing a bias. All four definitions yielded varying frequencies of concurrency among the sample, with concurrency in the most recent partnership falling in the middle.

The dependent variable was therefore defined as reporting of concurrency during the most recent partnership, among sexually active individuals. The variable was based on one question in the sexual history section of the 2005 survey (E.33_1-10): *Did you have any other sexual partners during the time that you and [partner] were having a sexual relationship?* Three possible responses were recorded: *"Definitely Yes," "Not Sure," "Definitely No."* Individuals who refused to answer the question (n=129) were dropped from the analysis. The variable was dichotomously defined; those responding "*Definitely Yes*" and those who responded "*Definitely No*" or "*Not sure*". Coding individuals who responded "*Not sure*" with those who responded "*Definitely No*" may result in an underestimation of concurrency, particularly if a social desirability bias was present.

Independent Variables

Two categories of independent variables are used for the regression analysis – individual-level and partnership-level. The partnership-level variables are constructed from information collected about the respondent's most recent sexual partnership. Therefore, variables such as the age gap with a partner refers to the age gap between the respondent and his/her most recent partner. The following variables were used: sex, age group, marital status, racial classification, education, individual monthly income, religious identification, self-perception of HIV risk, age of sexual debut, exposure time since sexual debut, and lifetime number of sexual partners. Several partnership-level variables were also used: age gap with the most recent partner, knowledge of partner's concurrency, co-residence with a partner, and condom use. A full description of the independent variables used in this analysis can be found in Appendix A.

Analysis

Descriptive statistics were used to describe the background characteristics and distribution of variables among the sample population. All statistics were weighted to account for the sampling methodology and non-response in the various waves of the survey.

Univariate logistic regression was used to examine associations between reported concurrency and the independent variables, using the survey (svy) methodology in Stata (UCLA: Academic Technology Services, 2006, StataCorp LP, 2007). Unadjusted odds ratios and their 95% confidence intervals are presented and were tested for significance using the Wald Test. The univariate results are presented in Appendix B, Table 2.

Multivariate logistic regression, also using the survey (svy) methodology, was then used to assess the relationships between concurrency, the independent variables, and possible interactions between relevant independent variables. Weighting was used to account for survey design and non-response. Model 1 of the multivariate models is a full main effects model with all variables included, regardless of their significance in the univariate analyses. Model 2 is a reduced model that includes all variables that were significant at the $p \leq 0.10$ level in Model 1. Model 3 is a reduced model that includes all variables that were significant at the $p \leq 0.05$ level in Model 2. Interactions between all significant variables in Model 3 that were theoretically plausible were tested. Several interactions were present between race and other variables. For this reason, additional models were built, stratified by racial group. No other significant or meaningful interactions were present. These models can be found in Appendix B, Table 4.

Models 4 and 5 examine the correlates of concurrency among Black respondents, while Models 6 and 7 examine correlates among Coloured respondents. Since there were few instances of concurrency among White respondents, a separate model to examine the correlates of concurrency among this population could not be fitted. Models 5 and 7 contain variables that were significant at the $p \leq 0.05$ level in the previous race-stratified model, Models 4 and 6, respectively. The results from these models can be found in Appendix B, Tables 5 and 6.

Colinearity was first assessed by examining changes in the standard errors. Additionally, measures of tolerance and variance inflation factors (VIF) were

examined. Hosmer-Lemeshow goodness-of-fit tests were conducted for all of the models. The area under the receiver operator characteristic (ROC) curve was calculated to determine each model's ability to discriminate between individuals who reported concurrency and those who did not (Hosmer and Lemeshow, 2000).

Unweighted models are presented alongside weighted models. Due to limitations in Stata, post-estimation statistics, such as the Hosmer-Lemeshow goodness-of-fit and the area under the ROC curve could not be calculated with the svy command methodology. However, as can be seen, the unweighted models are very similar to the weighted models. Therefore, to judge the strength of the weighted models, post-estimation statistics from the unweighted models are considered.

Ethical Considerations

Each wave of the Cape Area Panel Survey received ethical approval from the Centre for Social Science Research Ethics Committee at the University of Cape Town and the University of Michigan. Informed written consent was sought from each respondent and written parental consent was sought for participants under the age of 18 at the initiation of each survey round. The study presented in this chapter was exempted from Institutional Review by the Harvard School of Public Health's Human Subject's Committee (Protocol # 16035).

Results

Overall, 13% of young adults in the Cape Metropolitan Area engaged in concurrency during their last sexual partnership. This however masks a significant difference in reporting between young men and women, with 20% of young men and 6% of young women reporting concurrency. This difference between men and women was significant in the univariate model (OR=0.26, 95% CI: 0.20-0.33). No significant differences were of note between the various age groups. Black respondents were significantly more likely than Coloureds or Whites to report concurrency – 22% versus 9% and 3% respectively. The differential between young men and women exists within Blacks and Coloureds. 33% of Black young men and 13% of Black young women reported

concurrency. Among Coloureds, 15% of young men and 2% of young women reported concurrency.

In the univariate model, individuals who were enrolled in post-matriculation schools were 60% less likely to report concurrency compared to individuals who were out of school and had not completed grade 12 (OR=0.35, 95% CI: 0.20-0.60). Individuals who were in primary or secondary school or who were out of school, having completed grade 12, were not significantly more likely to report concurrency than individuals who were out of school. Individuals who were married, individuals who had a personal income, and individuals who reported belonging to a religious denomination, were all less likely to report concurrency in the univariate models compared to the respective reference groups. Individuals who had their sexual debut after age 14, who had had sexual debut less than two years ago, had 1-3 lifetime sexual partners were significantly less likely to report concurrency in the univariate analyses compared to the respective reference groups. Compared to individuals who had a partner whose age was within four years, individuals who had partners five or more years older than him/herself were nearly three times as likely to report concurrency (OR=2.84, 95% CI: 1.52-5.32), whereas individuals with a partner who was five or more years younger were half as likely to report a concurrent partner (OR=0.48, 95% CI: 0.32-0.72). Individuals who knew that their partner had other concurrent partners, individuals who did not co-reside with their partner and individuals who consistently used condoms were all significantly more likely to report concurrency in the univariate analyses.

In the final reduced multivariate model (Model 3), young women were nearly seven times less likely to report concurrency, compared to young men (adj.OR=0.28, 95% CI: 0.15-0.30), after adjusting for other factors. Individuals aged 25 years and older and between the ages of 20-24 were less likely to report concurrency compared to those aged 15-19 (adj.OR=0.31, 95% CI: 0.16-0.60 and adj.OR=0.54, 95% CI: 0.35-0.83, respectively). Those who were most highly educated, i.e. were enrolled in a post-matriculation school, were 60% less likely to report concurrency compared to those who were not enrolled in school and had not completed grade 12 (adj.OR=0.41, 95% CI: 0.20-0.87).

In Model 1, personal income was not a significant correlate at either the $p \leq 0.10$ or the $p \leq 0.05$ levels and was therefore not included in subsequent models. In Model 1, Mainline Christians were marginally less likely to report concurrency, compared to those who did not identify with a religion. However, this did not reach the significance levels to warrant inclusion in Model 3. Individuals who

were married were significantly less likely than unmarried young people to report concurrency (adj.OR=0.19, 95% CI: 0.08-0.49), though very few individuals in this young adult population are married. Age of sexual debut, self-assessed HIV risk, and age gap, co-residence and condom use with the most recent partner did not achieve significance in either Model 1 or 2 to warrant inclusion in Model 3. Time since sexual debut, which was originally included to account for potential confounding related to age of sexual debut, was significant for individuals who were sexually active for 5-6 or 7+ years (adj.OR=2.11, 95% CI: 1.23-3.62; adj.OR=2.46, 95% CI: 1.37-4.41, respectively). Individuals who reported having five or more lifetime sexual partners were three times more likely to report concurrency compared to those with 1-3 lifetime sexual partners. The strongest positive correlate of concurrency, however, was knowledge that a partner had a concurrent partner (adj.OR=5.52, 95% CI: 3.95-7.71).

Model 3 included data from 2 127 respondents. The unweighted post-estimation statistics indicate that the model is a good fit to the data; the Hosmer-Lemeshow goodness-of-fit Test p=0.39. The model was able to discriminate very well between individuals reporting concurrency and those not reporting concurrency; the area under the ROC curve = 0.822. The likelihood ratio test, comparing the unweighted Model 3 to Model 1 was significant (p = 0.00). However, this significance may be the result of dropping seven variables between the two models. Colinearity in Model 3 was assessed in several ways. Standard errors for the coefficients were not very large or inflated, suggesting little or no colinearity between variables. The variance inflation factor for the variables ranged from 1.04-1.59 and the tolerance ranged from 0.63-0.97, further suggesting that there was little colinearity between the variables in this model.

The final unstratified model (Model 3) was:

$$
\begin{aligned}
Logit\left[P_{concurrency}/(1 - P_{concurrency}) \right] \\
&= \beta_0 + \beta_1(sex) + \beta_2(age) + \beta_3(race) + \beta_4(education) + \beta_5(marital\ status) \\
&+ \beta_6(time\ since\ sexual\ debut) + \beta_5(lifetime\ number\ of\ sex\ partners) \\
&+ \beta_6(partner's\ concurrency\ status)
\end{aligned}
$$

There were several differences between the final unstratified model (Model 3) and the two final race-stratified models (Model 5 – Blacks only and Model 7 – Coloureds only). In both Model 5 and 7, young women were significantly less likely to report concurrency than young men. This was stronger among Coloureds compared to Blacks (adj.OR=0.11, 95% CI: 0.05-0.25). Among Coloureds, but not Blacks, individuals over the age of 20 were significantly (60%) less likely to report concurrency compared to their peers aged 15-19.

Among Blacks, enrolment in higher education was strongly correlated with reporting less concurrency (adj.OR=0.37, 95% CI: 0.17-0.80), whereas among Coloureds, there was no significant relationship between education and concurrency. Among Coloureds, but not among Blacks, acknowledging some personal HIV risk was associated with a doubling of reported concurrency (adj.OR=2.08, 95% CI: 1.13-3.82). As in Model 3, income, religion and condom use, co-residence, and age gap with the most recent partner were not significant in any stratified model where the inclusion criteria was $p \leq 0.05$ in the previous model. Marital status among Blacks was not a significant correlate of concurrency. Among Coloureds, there were no cases (0/80) of concurrency among married individuals. It was therefore impossible to include the variable in Model 7.

Among Blacks and Coloureds, individuals who knew their partner had concurrent partners were five to six times more likely to report concurrency (adj.OR=6.02, 95% CI: 4.11-8.84; adj.OR=4.86, 95% CI: 2.30-10.27). Among Blacks, but not Coloureds, those who had their sexual debut between the ages of 20-24 were significantly less likely to report concurrency compared to those who had their sexual debut at or before age 14, even when the time since sexual debut was accounted for (adj.OR=0.23, 95% CI: 0.06-0.81). However, among Coloureds, individuals who had debuted sexually 5-6 or 7+ years ago were significantly more likely to report concurrency than those who had debuted 0-2 years ago (adj.OR=5.23; 95% CI: 2.12-12.93; adj.OR=5.92; 95% CI: 2.15-16.26, respectively). However, age of sexual debut was not significantly correlated with reporting concurrency. Among both Blacks and Coloureds, having five or more lifetime sexual partners was significantly correlated with reporting concurrency (adj.OR=2.97; 95% CI: 1.80-4.92 and adj.OR=2.39; 95% CI: 1.06-5.36). Among Coloureds, having four lifetime sexual partners was also significantly correlated with reporting concurrency (adj.OR=3.33, 95% CI: 1.29-8.59).

Both final race-stratified models – Models 5 and 7 – fit the data fit the data well. Model 5 included data from 1091 Black respondents. The unweighted post-estimation statistics indicate that the model is a good fit to the data; Hosmer-Lemeshow goodness-of-fit test $p = 0.21$. The model was able to discriminate between individuals reporting concurrency and those not reporting concurrency very well; area under the ROC curve = 0.779. There was no evidence of colinearity between the variables in this model.

The final race-stratified model for Blacks (Model 5) was:

$$Logit[\,P_{concurrency}/(1-P_{concurrency})] = \beta_0 + \beta_1(gender) + \beta_2(education) + \beta_3(age\ of\ sexual\ debut) + \beta_4(time\ since\ sexual\ debut) + \beta_5(lifetime\ number\ of\ sex\ partners) + \beta_6(partner's\ concurrency\ status)$$

Model 7 included data from 871 Coloured respondents. The unweighted post-estimation statistics indicate that the model is a good fit to the data; Hosmer-Lemeshow goodness-of-fit test p = 0.22. The model was able to discriminate between individuals reporting concurrency and those not reporting concurrency very well; Area under the ROC curve = 0.841. There was no evidence of colinearity between the variables in this model.

The final race-stratified model for Coloureds (Model 7) was:

$$Logit\left[\frac{P_{concurrency}}{(1-P_{concurrency})}\right] = \beta_0 + \beta_1(gender) + \beta_2(age) + \beta_3(HIV\ risk) + \beta_4(time\ since\ sexual\ debut) + \beta_5(lifetime\ number\ of\ sex\ partners) + \beta_6(partner's\ concurrency\ status)$$

Discussion

This study found varying levels of concurrency among different sub-populations of young adults in the Cape Metropolitan Area. Nearly one-third of young Black men reported concurrency, whereas less than 2% of young Coloured women reported concurrency. The levels reported among Black men are higher than many previously published estimates in the southern Africa region, including in South Africa (Steffenson, 2008, Carter, Kraft, Koppenhaver, Galavotti, Roels, Kilmarx and Fidzani, 2007). Such varying levels of concurrency among different sub-populations could be one factor resulting in the heterogeneous spread of HIV in the Cape Metropole Area and in South Africa.

Using the different measure of *concurrency during any previous partnership*, the reporting differences between the various groups becomes even more evident. The overall population frequency of concurrency increases to 18%, with 27% of young men and 9% of young women reporting concurrency. Over 41% and 18% of young Black men and women report concurrency during any previous partnership, while 23% and 3% of Coloured young men and women, and 5% of White young men and 5% of White young women report

concurrency. While it is likely that there are substantial differences in the occurrence of concurrency among racial groups in this study, the differences may partially be the result of a differential reporting bias. It is not known if one population in this study is more or less likely to report on sexual behaviours compared to other populations.

In both the unstratified and race-stratified Black and Coloured models, young men reported engaging in concurrency more than young women reported concurrency. This finding is in agreement with other studies examining concurrency, as well as with similar research that indicate that young men report more sexual risk behaviors compared to young women (Carter et al., 2007, Shisana et al., 2005). It is possible that this differential in reporting is an artefact of reporting bias differences between men and women. However, a reporting bias is unlikely to account for the entire differential. Despite the lower reporting of concurrency among young women, it is evident that a comparatively small, but significant number of women do have concurrent partners. This fact is critical for enabling the sustained transmission of HIV through sexual networks, which would be difficult if only men were engaged in concurrency in the context of a generalized epidemic. The reported levels of concurrency found here among young men and women are likely large enough to enable a large and robust sexual network, similar to that described by Helleringer and Kohler (2007) in Malawi, though further modelling would be necessary to determine this.

It is hypothesized that concurrency is a risk behaviour that will occur in parallel to other behaviours that are known to be high risk, such as having a large number of sexual partners. Individuals with higher risk behaviours, specifically, a lower age of sexual debut and a higher number of lifetime sexual partners, may be more likely to engage in and report concurrency than individuals with lower risk behaviours. The personal, social, or cultural drivers of such risk behaviours may be similar. For instance, notions of masculinity and social and peer acceptance among young men may promote multiple girlfriends, concurrency and an earlier age of sexual debut (Harrison, O'Sullivan, Hoffman, Dolezal and Morrell, 2006). However, a link between concurrency and other risk behaviours has not been made. Previous research has found that a lower age of sexual debut increases the risk of HIV infection, possibly due in part to a higher number of lifetime sexual partners (Hallett, Lewis, Lopman, Nyamukapa, Mushati, Wambe, Garnett and Gregson, 2007). Pettifor *et al.* (2005) found that for each additional lifetime partner, the odds of HIV infection among young South Africans increased by 1.03 times for men and 1.09 times for women. Part

of the increases in risk associated with higher number of partners may be a result of concurrency in that study population.

This research found that concurrency is correlated with larger numbers of lifetime sexual partners, among both Blacks and Coloureds. Part of this correlation can be explained by the inclusion of individuals who have ever had only one lifetime partner, which may exaggerate the effect of having larger numbers of partners. However, among Blacks, the correlation was evident only with five or more partners, indicating that the correlation would probably hold even if individuals with only one lifetime partner were excluded from the analysis. It may therefore be appropriate to assume that as this young population acquires sexual partners, many do so concurrently rather than serially. This is also supported by the fact that the number of individuals reporting concurrency during any partnerships is higher than those reporting concurrency just in the past partnership.

The correlation between concurrency, age of sexual debut and time since sexual debut is more complicated. In the unstratified Model 3 and in Model 7, age of sexual debut was not significant, while time since sexual debut was significant. However, in Model 5, age of sexual debut was significant, while time since sexual debut was not significant. The two independent variables measure factors that are closely related. Since the sample population is young and the variability in the age of sexual debut is large (7 to 24 years), the exposure time to possible concurrent partnerships is highly variable. In an adult population, an earlier age of sexual debut would result in a longer exposure time to possible concurrent partnerships. However, the proportional variability would be expected to be smaller. Overall, the results indicate that an earlier age of sexual debut and therefore a longer exposure time to possible concurrent partnerships is correlated with concurrency. In the various models, it is possible that this effect is only being picked up by one and not both of the related variables. Overall, based on the data presented here, concurrency does appear to occur alongside other higher risk sexual activities, namely an early age of sexual debut and higher numbers of lifetime sex partners.

In this study, there was no direct relationship between income and reported concurrency, with individuals with higher income levels not reporting more concurrency than lower income-level individuals. Previous research has indicated that there is a transactional nature to concurrent partnerships in South Africa (Leclerc-Madlala, Seneka and Zondo, 2007, Leclerc-Madlala, 2003). The lack of association in this study between income and concurrency could be that

income for young people may not be an appropriate proxy for measuring transactional elements of sexual partnerships and concurrency specifically. Alternatively, young people may have small incomes from their households that were not reported, which could be spent on concurrent partners. Further research using more refined notions of wealth and income may be required to better understand the relationship between income or wealth and concurrency. Additionally, further research will need to investigate how behaviour change can occur when material and financial exchange are such basic and critical elements of partnerships. Individuals in lower income quintiles may spend larger proportions of their income on relationships compared to individuals in higher income quintiles, which was found to occur in some populations in Kenya (Luke, 2008). A third possible explanation is that income does not have any role or plays only a small role in concurrency.

Another important finding of this study is the strong correlation between reporting concurrency and knowledge that a partner has another partner. This strong correlation has also been reported in other studies (Mah, 2008). Morris (2001) points out that concurrency is an individual risk factor based on a partner's behaviour, not one's own behaviour. The finding here that index concurrency is strongly correlated with knowledge of a partner's concurrency demonstrates that indirectly, index concurrency can often, though not always, pose a risk for the index case, just as it does for the partner. This study therefore confirms the links between index concurrency, partner's concurrency and risk of HIV infection. This may be particularly true in populations where a significant minority of both men and women engage in concurrent partnerships, such as in this one.

The association between knowledge about a partner's concurrency and engaging in concurrency could result in a "social snowball effect," whereby having a large proportion of individuals that have concurrent partners within a community will perpetuate more individuals to have concurrent partners. However, this snowball effect could have important prevention effects at the population-level, when working in reverse. If prevention interventions are able to slightly decrease the frequency of concurrent partnerships at first, the effect could subsequently be magnified. Achieving such a population-level snowball effect will likely require changes in social and cultural norms, which may be difficult. The social and cultural norms may include things such as shifts in the acceptability of and communal silence about extra-marital or multiple regular partners. However, this snowball effect would also only be valid if there is, in fact, a causal link between engaging in concurrency and knowledge of a partner's concurrency.

Based on the findings, it is evident that several high risk behaviours of young people occur in tandem with concurrent partnerships. A young age at sexual debut, a high number of sexual partners and concurrency all put young people at risk for HIV infection. Comprehensive sexual education needs to reach young people before the onset of sexual experience, which for some may occur even before the teenage years. The ability of young people to appropriately utilize such a comprehensive sexual education will be mediated not only by social and cultural factors, but also by their "life skills," such as decision-making, negotiation, and relationship skills. Relationship-building skills can include renewed emphasis on sexual exclusivity and the negative health and social consequences of concurrency.

Limitations & Strengths

There are several limitations to this analysis that should be considered. First, the definition of the dependent variable may underestimate the true occurrence of concurrency in this population. For instance, concurrency during any sexual partnership, overall, was 17%, with 27% of young men reporting and 9% of young women reporting concurrency. Since the study population is young adults, such a high prevalence among any previous partner, of which there are relatively few compared to adults, may indicate that prevalence in adults may also be high.

Another limitation is that all data were self-reported. This may account for some of the differential in reporting between young men and women and possibly between the different races. Since trends in reporting and/or social desirability bias are generally known, it is reasonable to assume that men may have overestimated their sexual activity and therefore concurrency, while women may have underestimated their sexual activity and concurrency. However, it is unknown if there is a differential reporting bias between races.

There are several strengths to this study as well. First, this is one of the few studies in South Africa to examine the frequency of concurrency in South Africa and one of the first studies to examine correlates of concurrency among a population in South Africa. This analysis provides a profile of young individuals engaged in concurrency in a high HIV prevalence community in South Africa and can be utilized to help design new prevention interventions in the region.

Conclusions

Concurrent sexual partnerships are a critical element of sexual risk behaviours associated with HIV transmission. Given the moderate frequency of these partnerships and social norms that support such behaviours in this population, HIV intervention efforts should begin to target them in order to best prevent transmission. Future research can begin the difficult task of understanding how to best modify this sexual behaviour and other high risk behaviours that will potentially require widespread changes in social norms.

The current understanding of concurrency is based primarily on variable HIV transmission probabilities and on the overlap of sexual partnerships. Future research will require a more refined understanding of such overlaps. Researchers have already begun to examine the notion of relationship gaps and its impact on the transmission of other STIs (Foxman, Newman, Percha, Holmes and Aral, 2006, Aral, 2008, Chen, Ghani and Edmunds, 2008). This research can be further expanded to examine how increased partnership gaps or the reduction in overlap of partnerships can be used as an additional HIV prevention tool.

There are numerous definitions of concurrency that have been used in the published literature and currently there is no consensus definition (Morris and Kretzschmar, 1997, Lagarde, Auvert, Caraël, Laourou, Ferry, Akam, Sukwa, Morison, Maury, Chege, N'Doye and Buvé, 2001, Le Pont, Pech, Boelle, Giraud, Gilloire, Halfen and de Colomby, 2003). Given the various possible methods of measurement, a single operational definition of concurrency is difficult to provide. One possible suggestion is that the definition of concurrency be the overlap of one or more sexual partnerships for a period of one month or longer. The one month time period accounts for the approximate time duration of acute HIV infection, which is an important element for transmission during concurrent partnerships. Such a simplified definition of concurrency will result in a loss of information that can be gained by utilizing a measure such as Morris' and Kretzschmar's κ-statistic. However, it can be useful in providing a simple and comparable indicator of concurrency that can be utilized for designing interventions targeting concurrency.

Measurement of concurrency should include aspects of the direct and calendar methods. Specifically, individuals should be asked directly if s/he has had additional partners during a specific partnership. The characteristics of that partnership should also be obtained, such as the length of overlap between the partners and the types of sexual partners. A more specific definition of

concurrency and improved methods of measurement will allow future research findings to be more comparable.

The research findings of this study of concurrency generally support the findings of similar research in southern Africa. As the evidence continues to demonstrate the important epidemiological role that concurrency plays in the transmission of HIV, future research will need to better understand how this deeply rooted social and cultural sexual behaviour can be modified to reduce the transmission of HIV. This knowledge will need to be coupled with a better understanding of behaviour change both at the individual level as well as on the social or community level, such as what motivates sexual behaviour change, what are the minimal programmatic elements necessary to effect behaviour change, and what social or cultural changes are needed to complement or enable changes at the individual level.

Appendix A

The following section describes in detail the definitions and questions that were used to create the variables in this analysis.

Sex is binary and has been coded as "0" for men and "1" for women. Age is defined categorically in three age groups: aged 15 to 19 years, aged 20 to 24 years, and aged 25 years and older. The age groups were selected to match the groupings used in national HIV prevalence surveys. Several other groupings of age did not change the results of the analysis in a statistically significant way. Age is defined categorically because there was no linear relationship between age and probability of reporting a concurrent partnership. Additionally, concurrency status is not expected to change with a one-year change in age. The age used for this analysis was the age of the respondent at the time of the survey in 2005. Current marital status was defined as a binary variable: unmarried or married.

Racial classification is based on the former Apartheid definitions utilized in the Census. Three categories were included in this analysis: Black, Coloured, and White. Data on racial classification was only collected during Wave 1 in 2002. However, it was assumed that racial classification would not change over different rounds of the survey. Racial classification was coded as follows: Black – "0," Coloured – "1," and White – "2".

Education is defined as a four-category variable. The reference group is defined as individuals who are not currently in school and who have not completed grade twelve. A second category contains all individuals who are not currently in school, but who have completed grade twelve. The third category includes individuals who are currently attending primary- or secondary-level school. The fourth category contains individuals who are currently in school and enrolled in a post-matriculation school, such as a university, technikon, or college.

Personal income was defined dichotomously. Data were collected on the previous seven jobs for all individuals. However, most only provided information on their previous two jobs or may have only had two previous jobs, given the young age of the sample. If individuals were working one or two jobs at the time of the survey, their monthly take-home income from each job was summed. The total monthly income was defined as no income (for individuals reporting no jobs or no income from their jobs) or some income. Coding

personal income with three- or four levels, as opposed to dichotomously, did not alter the findings of the analysis in a statistically significant way.

A five-category variable was used to define religious identification. Data for this variable were collected during Wave 1 of CAPS in 2002. An assumption was made that religious identification did not change during the three years between the different waves of the survey. Since data were not subsequently collected in either the 2004 or 2005 waves, this assumption cannot be verified. Seventeen (17) different religions were originally coded from the survey. Individuals were asked to specify their religion if they responded *"Other"*. Given the wide range of possible responses, four broad religious categories were defined and a fifth category was used to define those with no religious affiliation (coded as "0"). The broad religious categories were taken from the 1996 South African Census (Statistics South Africa, 2005). The first group includes Mainline Christian churches, such as Anglican, Protestant, Methodist, and Roman Catholic, and was coded as "1". The second group of religions includes the African Independent Churches (AIC), Zionists, and Ethiopian-type churches. The third group includes Muslims. The forth category, coded as "4," includes other religions that do not fall into the previous categories, including Jehovah Witnesses and Seventh Day Adventists.

On the 2005 survey, respondents were asked questions related to knowledge, experience with, and perceptions of HIV/AIDS. Individuals were asked about self-perceived risk of HIV: "*Do you think you have no risk, a small risk, a moderate risk or a great risk of getting the AIDS virus?*" A self-assessed HIV risk variable was created to attempt to differentiate individuals who perceived they were at no risk versus those who perceived they were at some level of increased risk. Individuals who responded "*No risk*" were coded as "0". Individuals who responded that they were at "*A small risk,*" "*A moderate risk,*" or "*A great risk*" were categorized as some risk and coded as "1". Individuals who were HIV+, refused to answer, or did not know were coded as "2".

Age of sexual debut was categorized into three groups: 14 years and younger, 15-19 years, and 20-24 years. The number of lifetime sexual partners was also categorized into three groups: 1-3 lifetime partners, 4 lifetime partners and 5 or more lifetime partners. By definition, all individuals who have only had one partner and therefore could not have engaged in concurrency were placed in the first category.

Since the study population is young adults, the exposure time since beginning sexual debut may play an important role, compared to an adult population, particularly in understanding the role of age of debut. Therefore, a variable of time since sexual debut was created. This variable utilized the age of the participants at the time of the survey and the age at debut. Four categories were created: 0-2 years, 3-4 years, 5-6 years and 7+ years since sexual debut. The range of years since sexual debut was 0 to 18 years with a mean time of 4.8 years since sexual debut.

The last category of independent variables relate to the most recent sexual partnership of the respondent. The first, age gap with the most recent partner, was separated into three categories: the age gap between the respondent and his/her partner is four years or less, coded as "0", the partner is five or more years older than the respondent, coded as "1", and the partner is five or more years younger than the respondent, coded as "2". The second variable, partner's concurrency, utilized the following question "*As far as you know, did [partner] have any other sexual partners during the time that you and he/she were having a sexual relationship?"* Respondents who responded "*Definitely yes*" were coded as "1". Respondents who replied "*Not sure*" or "*Definitely no*" were coded as "0". The third partnership-level variable is co-residence with the most recent partner. This dichotomous variable was based on the question, *"Did you ever live in the same house with [partner]?*" Individuals who responded that they did live with their partner were coded as "1" and those who did not live with their partner were coded as "0". The last partnership-level variable was condom use and was based on the question "*When you had sex with [partner], how often if ever did you use a condom?*" Respondents who never used condoms were coded as "0". Respondents who replied "*usually*" or "*sometimes*" were coded as inconsistent users, "1" and respondents who replied "*always*" were coded as consistent users, "2".

Appendix B

Table 1. Percentages distribution of sexually active respondents for selected characteristics

Variable Description	Total n[a]	n[a]	%[b]
Sex	2486		
Men		1145	47.9
Women		1341	52.1
Age	2486		
15-19 years		665	22.9
20-24 years		1575	66.0
≥25 years		246	11.1
Race	2486		
Black		1313	37.1
Coloured		1012	49.3
White		161	13.6
Education	2486		
Out of school		1012	39.1
In Primary/Secondary school		435	12.8
Out of school (completed grade 12)		812	36.4
In school (post-matric)		227	11.7
Personal Monthly Income	2486		
No income		1493	53.2
Some income		993	46.8
Religion	2462		
No religion		340	11.4
Mainline Christian		1127	49.6
AIC[c]/Zion/Independent		591	21.3
Muslim		199	9.1
Other Affiliations/Denominations		205	8.6
Current Marital Status	2481		
Unmarried		2287	90.8
Married		194	9.2
Self-Assessed HIV Risk	2476		
No risk		954	37.8
Some risk		1290	53.4
HIV+/Refused/Don't know		232	8.8

Table 1. continued

Variable Description	Total n[a]	n[a]	%[b]
Age of Sexual Debut	2435		
≤14 years		343	12.5
15-19 years		1908	77.8
20-24 years		184	9.7
Time Since Sexual Debut	2263		
0-2 years		546	24.4
3-4 years		666	28.6
5-6 years		613	27.2
7+ years		438	19.9
# Lifetime Sexual Partners	2386		
1-3		2041	85.19
4		152	6.50
5+		193	8.31
Age Gap w/ Most Recent Partner	2486		
Partner is 4 or less years older/younger		1918	77.8
Partner is 5 or more years older		51	1.9
Partner is 5 or more years younger		517	20.3
Most Recent Partner's Concurrency	2345		
Partner did not have concurrent partners		2002	87.8
Partner did have concurrent partners		343	12.2
Co-Residence with Most Recent Partner	2345		
Does co-reside		453	23.5
Does not co-reside		1892	76.5
Condom Use with Most Recent Partner	2358		
Never use		544	24.7
Consistently use		1071	43.1
Inconsistently use		743	32.2

a. Unweighted
b. Weighted
c. AIC - African Independent Churches

Table 2. Percentage of sexually active respondents reporting concurrency, odds ratios, 95% confidence intervals and p-values from weighted univariate analyses

	Univariate				
Variable Description	%	OR	(95% CI)		*p* value
Total	12.8	N/A	N/A		N/A
Sex					
Men	20.4	1.00			
Women	6.2	0.26	0.20	0.33	**<0.01**
Age					
15-19 years	14.0	1.00			
20-24 years	12.6	0.89	0.66	1.19	0.42
≥25 years	11.4	0.79	0.50	1.25	0.32
Race					
Black	21.8	1.00			
Coloured	8.6	0.33	0.25	0.44	**<0.01**
White	2.9	0.11	0.04	0.31	**<0.01**
Education					
Out of school	14.6	1.00			
In Primary/Secondary school	14.9	1.03	0.74	1.43	0.86
Out of school (completed grade 12)	12.4	0.83	0.62	1.11	0.21
In school (post-matric)	5.6	0.35	0.20	0.60	**<0.01**
Personal Monthly Income					
No income	14.3	1.00			
Some income	11.1	0.75	0.58	0.96	**0.02**
Religion					
No religion	21.2	1.00			
Mainline Christian	12.8	0.55	0.39	0.76	**<0.01**
AIC/Zion/Independent	12.7	0.54	0.37	0.78	**<0.01**
Muslim	6.6	0.26	0.14	0.50	**<0.01**
Other Affiliations/Denominations	8.7	0.35	0.20	0.63	**<0.01**
Current Marital Status					
Unmarried	14.0	1.00			
Married	2.3	0.14	0.07	0.30	**<0.01**
Self-Assessed HIV Risk					
No risk	11.8	1.00			
Some risk	13.8	1.20	0.92	1.56	0.17
HIV+/Refused/Don't know	11.5	0.97	0.61	1.53	0.89

Table 2. continued

	Univariate				
Variable Description	%	OR	(95% CI)		*p* value
Age of Sexual Debut					
≤14 years	22.3	1.00			
15-19 years	12.7	0.51	0.37	0.70	<**0.01**
20-24 years	2.2	0.08	0.03	0.19	<**0.01**
Time Since Sexual Debut					
0-2 years	6.9	1.00			
3-4 years	11.0	1.69	1.08	2.63	**0.02**
5-6 years	15.2	2.43	1.57	3.77	<**0.01**
7+ years	19.5	3.28	2.10	5.13	<**0.01**
# Lifetime Sexual Partners					
1-3	10.5	1.00			
4	18.8	1.98	1.26	3.12	<**0.01**
5+	32.4	4.10	2.89	5.83	<**0.01**
Age Gap w/ Primary Partner					
Partner is 4 or less years older/younger	13.5	1.00			
Partner is 5 or more years older	30.7	2.84	1.52	5.32	<**0.01**
Partner is 5 or more years younger	7.0	0.48	0.32	0.72	<**0.01**
Most Recent Partner's Concurrency Status					
Partner did not have concurrent partners	9.6	1.00			
Partner did have concurrent partners	35.7	5.23	3.94	6.94	<**0.01**
Co-Residence with Most Recent Partner					
Does co-reside	6.7	1.00			
Does not co-reside	14.6	2.37	1.64	3.43	<**0.01**
Condom Use with Most Recent Partner					
Never use	9.7	1.00			
Consistently use	15.6	1.71	1.23	2.37	<**0.01**
Inconsistently use	11.5	1.20	0.84	1.72	0.31

a. All *p*-values are based on the Wald statistic

b. N/A = not applicable

Table 3. Percentage of sexually active respondents reporting concurrency, odds ratios, 95% confidence intervals and p-values from race-stratified weighted univariate analyses

Variable Description	Univariate									
	Black Respondents					Coloured Respondents				
	%	OR	(95% CI)		*p* value	%	OR	(95% CI)		*p* value
Total	21.8	N/A	N/A		N/A	8.6	N/A	N/A		N/A
Sex										
Men	32.9	1.00				15.3	1.00			
Women	13.0	0.30	0.23	0.41	**<0.01**	1.8	0.10	0.05	0.21	**<0.01**
Age										
15-19 years	21.1	1.00				9.6	1.00			
20-24 years	22.4	1.08	0.78	1.49	0.64	9.0	0.93	0.54	1.59	0.79
≥25 years	20.6	0.97	0.59	1.58	0.90	3.6	0.36	0.10	1.24	0.11
Education										
Out of school	26.0	1.00				8.5	1.00			
In Primary/Secondary school	18.9	0.67	0.47	0.95	**0.03**	4.5	0.51	0.15	1.72	0.28
Out of school (completed grade 12)	20.6	0.74	0.53	1.04	0.08	9.8	1.17	0.71	1.94	0.53
In school (post-matric)	15.8	0.53	0.29	0.99	**0.05**	5.3	0.61	0.17	2.22	0.45
Personal Monthly Income										
No income	20.8	1.00				8.0	1.00			
Some income	24.5	1.22	0.91	1.68	0.17	9.0	1.13	0.70	1.83	0.62
Religion										
No religion	28.6	1.00				6.8	1.00			
Mainline Christian	22.2	0.71	0.50	1.01	0.06	10.8	1.67	0.48	5.81	0.42
AIC/Zion/Independent	19.2	0.59	0.40	0.87	**0.01**	7.1	1.05	0.28	3.91	0.94
Muslim	9.7	0.27	0.06	1.19	0.08	6.3	0.93	0.24	3.62	0.92
Other Affiliations/Denominations	14.0	0.40	0.20	0.83	**0.01**	6.5	0.96	0.23	4.04	0.95
Current Marital Status										
Unmarried	22.5	1.00				10.1				
Married	11.0	0.43	0.19	0.93	**0.03**	0.0	*			
Self-Assessed HIV Risk										
No risk	23.4	1.00				5.2	1.00			
Some risk	21.6	0.90	0.67	1.21	0.50	11.7	2.40	1.37	4.21	**<0.01**
HIV+/Refused/Don't know	18.5	0.74	0.44	1.25	0.26	5.1	0.97	0.34	2.72	0.95
Age of Sexual Debut										
≤14 years	27.3	1.00				16.9	1.00			
15-19 years	21.5	0.73	0.51	1.04	0.08	8.7	0.47	0.25	0.87	**0.02**
20-24 years	6.2	0.18	0.05	0.60	**0.01**	1.8	0.09	0.02	0.33	**<0.01**

Table 3. continued

Variable Description	Univariate									
	Black Respondents					Coloured Respondents				
	%	OR	(95% CI)		*p* value	%	OR	(95% CI)		*p* value
Time Since Sexual Debut										
0-2 years	15.7	1.00				3.7	1.00			
3-4 years	20.3	1.37	0.85	2.20	0.20	7.2	1.99	0.89	4.44	0.09
5-6 years	21.3	1.45	0.90	2.33	0.13	13.1	3.87	1.78	8.42	**<0.01**
7+ years	28.4	2.13	1.32	3.43	**<0.01**	12.3	3.61	1.51	8.59	**<0.01**
# Lifetime Sexual Partners										
1-3	19.1	1.00				6.5	1.00			
4	19.9	1.05	0.63	1.76	0.84	24.1	4.60	2.06	10.30	**<0.01**
5+	47.9	3.90	2.56	5.94	**<0.01**	24.4	4.74	2.47	9.09	**<0.01**
Age Gap w/ Primary Partner										
Partner is 4 or less years older/younger	23.0	1.00				9.7	1.00			
Partner is 5 or more years older	41.7	2.40	1.24	4.82	**0.01**	10.6	1.10	0.14	8.80	0.93
Partner is 5 or more years younger	13.4	0.52	0.34	0.79	**<0.01**	1.8	0.17	0.05	0.58	**0.01**
Most Recent Partner's Concurrency Status										
Partner did not have concurrent partners	15.3	1.00				7.8	1.00			
Partner did have concurrent partners	46.3	4.68	3.50	6.50	**<0.01**	17.8	2.56	1.27	5.17	**0.01**
Co-Residence with Most Recent Partner										
Does co-reside	18.1	1.00				4.8	1.00			
Does not co-reside	22.3	1.30	0.83	2.03	0.26	10.2	2.25	1.19	4.23	**0.01**
Condom Use with Most Recent Partner										
Never use	21.4	1.00				6.1	1.00			
Consistently use	23.1	1.11	0.75	1.62	0.61	10.9	1.87	1.02	3.44	**0.05**
Inconsistently use	20.0	0.92	0.60	1.40	0.69	8.4	1.41	0.74	2.68	0.29

a. All *p*-values are based on the Wald statistic

b. N/A = not applicable

*: There were 0 cases of concurrency among married respondents.

Table 4. Adjusted odds ratios, 95% confidence intervals and p-values from weighted multivariate analyses

Variable Description	Multivariate											
	Model 1				Model 2				Model 3			
	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value
Sex												
Men	1.00				1.00				1.00			
Women	0.22	0.15	0.32	**<0.01**	0.21	0.15	0.30	**<0.01**	0.21	0.15	0.30	**<0.01**
Age												
15-19 years	1.00				1.00				1.00			
20-24 years	0.55	0.34	0.89	**0.01**	0.55	0.34	0.88	**0.01**	0.54	0.35	0.83	**0.01**
≥25 years	0.36	0.16	0.80	**0.01**	0.35	0.16	0.76	**0.01**	0.31	0.16	0.60	**<0.01**
Race												
Black	1.00				1.00				1.00			
Coloured	0.44	0.30	0.65	**<0.01**	0.43	0.29	0.62	**<0.01**	0.41	0.29	0.58	**<0.01**
White	0.17	0.05	0.59	**0.01**	0.17	0.05	0.54	**<0.01**	0.18	0.06	0.58	**<0.01**
Education												
Out of school	1.00				1.00				1.00			
In Primary/Secondary school	0.72	0.43	1.21	0.22	0.71	0.44	1.16	0.17	0.68	0.42	1.10	0.12
Out of school (completed grade 12)	0.96	0.66	1.40	0.84	0.97	0.68	1.39	0.87	0.98	0.70	1.39	0.93
In school (post-matric)	0.37	0.16	0.83	**0.02**	0.39	0.18	0.85	**0.02**	0.41	0.20	0.87	**0.02**
Personal Monthly Income												
No income	1.00											
Some income	0.94	0.64	1.38	0.76								
Religion												
No religion	1.00				1.00							
Mainline Christian	0.69	0.47	1.00	**0.05**	0.71	0.49	1.03	0.07				
AIC/Zion/Independent	0.63	0.29	1.37	0.24	0.62	0.29	1.34	0.22				
Muslim	0.58	0.32	1.08	0.09	0.58	0.32	1.08	0.08				
Other Affiliations/Denominations	0.87	0.59	1.26	0.45	0.85	0.59	1.24	0.41				
Current Marital Status												
Unmarried	1.00				1.00				1.00			
Married	0.26	0.09	0.72	**0.01**	0.22	0.09	0.56	**<0.01**	0.19	0.08	0.49	**<0.01**
Self-Assessed HIV Risk												
No risk	1.00											
Some risk	1.25	0.90	1.73	0.18								
HIV+/Refused/Don't know	0.91	0.53	1.56	0.73								
Age of Sexual Debut												
≤14 years	1.00				1.00							
15-19 years	1.14	0.70	1.86	0.59	1.13	0.70	1.83	0.61				
20-24 years	0.40	0.13	1.18	0.10	0.40	0.13	1.16	0.09				
Time Since Sexual Debut												
0-2 years	1.00				1.00				1.00			
3-4 years	1.35	0.80	2.28	0.26	1.31	0.78	2.21	0.31	1.32	0.80	2.18	0.27
5-6 years	2.07	1.13	3.78	**0.02**	2.00	1.09	3.66	**0.03**	2.11	1.23	3.62	**0.01**
7+ years	2.41	1.12	5.18	**0.02**	2.33	1.10	4.93	**0.03**	2.46	1.37	4.41	**<0.01**
# Lifetime Sexual Partners												
1-3	1.00				1.00				1.00			
4	1.63	0.88	3.02	0.12	1.71	0.92	3.15	0.09	1.77	0.98	3.21	0.06
5+	2.77	1.79	4.30	**<0.01**	2.84	1.84	4.37	**<0.01**	2.94	1.93	4.48	**<0.01**

Table 4. continued

Variable Description	Multivariate											
	Model 1				Model 2				Model 3			
	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value
Age Gap w/ Most Recent Partner												
Partner is 4 or less years older/younger	1.00											
Partner is 5 or more years older	1.39	0.67	2.89	0.38								
Partner is 5 or more years younger	0.72	0.45	1.15	0.17								
Most Recent Partner's Concurrency Status												
Partner did not have concurrent partners	1.00				1.00				1.00			
Partner did have concurrent partners	5.49	3.91	7.71	**<0.01**	5.26	3.75	7.38	**<0.01**	5.52	3.95	7.71	**<0.01**
Co-Residence with Most Recent Partner												
Does co-reside	1.00											
Does not co-reside	1.10	0.65	1.85	0.72								
Condom Use with Most Recent Partner												
Never use	1.00											
Consistently use	1.07	0.70	1.65	0.74								
Inconsistently use	1.07	0.67	1.69	0.78								
N	2054				2069				2131			
log likelihood	-682.6				-693.9				-714.2			
Likelihood Ratio Test (*p*-value)	N/A				0.004				0.000			
Area under the ROC Curve	0.828				0.825				0.822			
Hosmer-Lemeshow Goodness-of-fit test (*p*-value)	0.83				0.81				0.39			

a. N/A = Not applicable
b. All p-values are based on the Wald statistic
c. Likelihood Ratio Test - comparing Model 1 to respective model
d. Model 1: Full Main Effects Model - All individual- and partner-level variables
e. Model 2: Reduced Model using Model 1 variables that were significant at the $p \leq 0.1$ level
f. Model 3: Reduced Model using Model 2 variables that were significant at the $p \leq 0.05$ level
g. Post-estimation statistics are based on the unweighted models.

Table 5. Adjusted odds ratios, 95% confidence intervals and p-values from weighted multivariate analyses, with only Black respondents

Variable Description	Multivariate							
	Model 4				Model 5			
	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value
Sex								
Men	1.00				1.00			
Women	0.25	0.16	0.37	**<0.01**	0.23	0.16	0.33	**<0.01**
Age								
15-19 years	1.00							
20-24 years	0.83	0.46	1.48	0.53				
≥25 years	0.56	0.23	1.40	0.22				
Education								
Out of school	1.00				1.00			
In Primary/Secondary school	0.77	0.46	1.28	0.31	0.71	0.44	1.15	0.17
Out of school (completed grade 12)	0.71	0.46	1.09	0.12	0.71	0.47	1.08	0.11
In school (post-matric)	0.37	0.17	0.84	**0.02**	0.37	0.17	0.80	**0.01**
Personal Monthly Income								
No income	1.00							
Some income	1.11	0.73	1.68	0.64				
Religion								
No religion	1.00							
Mainline Christian	0.74	0.48	1.15	0.18				
AIC/Zion/Independent	0.36	0.06	2.14	0.26				
Muslim	0.62	0.28	1.37	0.24				
Other Affiliations/Denominations	1.06	0.69	1.63	0.79				
Current Marital Status								
Unmarried	1.00							
Married	0.81	0.27	2.42	0.71				
Self-Assessed HIV Risk								
No risk	1.00							
Some risk	1.01	0.69	1.48	0.97				
HIV+/Refused/Don't know	0.94	0.52	1.72	0.85				
Age of Sexual Debut								
≤14 years	1.00				1.00			
15-19 years	1.20	0.73	1.98	0.47	1.01	0.65	1.57	0.97
20-24 years	0.30	0.07	1.25	0.10	0.23	0.06	0.81	**0.02**

Table 5. continued

Variable Description	Multivariate							
	Model 4				Model 5			
	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value
Time Since Sexual Debut								
0-2 years	1.00				1.00			
3-4 years	1.27	0.66	2.45	0.48	1.21	0.67	2.20	0.53
5-6 years	1.17	0.53	2.56	0.70	1.04	0.55	1.97	0.91
7+ years	1.49	0.58	3.85	0.41	1.10	0.55	2.22	0.79
# Lifetime Sexual Partners								
1-3	1.00				1.00			
4	0.92	0.50	1.69	0.80	0.97	0.54	1.74	0.92
5+	2.94	1.74	4.95	**<0.01**	2.97	1.80	4.92	**<0.01**
Age Gap w/ Most Recent Partner								
Partner is 4 or less years older/younger	1.00							
Partner is 5 or more years older	2.06	0.93	4.59	0.08				
Partner is 5 or more years younger	0.86	0.51	1.45	0.57				
Most Recent Partner's Concurrency Status								
Partner did not have concurrent partners	1.00				1.00			
Partner did have concurrent partners	6.63	4.48	9.82	**<0.01**	6.02	4.11	8.84	**<0.01**
Co-Residence with Most Recent Partner								
Does co-reside	1.00							
Does not co-reside	1.04	0.51	2.13	0.91				
Condom Use with Most Recent Partner								
Never use	1.00							
Consistently use	0.97	0.60	1.58	0.92				
Inconsistently use	0.97	0.56	1.67	0.91				
N				1070			1094	
Log likelihood				-464.0			-480.7	
Area under the ROC Curve				0.791			0.779	
Hosmer-Lemeshow Goodness-of-fit test (*p*-value)				0.89			0.21	

a. All *p*-values are based on the Wald statistic

b. Model 4: Main Effects Model - with Black respondents only

c. Model 5: Main Effects Model - includes all variables that were significant at p≤0.05 level in Model 4

d, Post-estimation statistics are based on the unweighted models.

Table 6. Adjusted odds ratios, 95% confidence intervals and p-values from weighted multivariate analyses, with only Coloured respondents

Variable Description	Multivariate							
	Model 6				Model 7			
	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value
Sex								
Men	1.00				1.00			
Women	0.12	0.04	0.32	**<0.01**	0.11	0.05	0.25	**<0.01**
Age								
15-19 years	1.00				1.00			
20-24 years	0.34	0.15	0.77	**0.01**	0.41	0.21	0.79	**0.01**
≥25 years	0.11	0.02	0.59	**0.01**	0.11	0.03	0.39	**<0.01**
Education								
Out of school	1.00							
In Primary/Secondary school	0.41	0.09	1.85	0.25				
Out of school (completed grade 12)	1.31	0.67	2.53	0.43				
In school (post-matric)	0.72	0.19	2.72	0.63				
Personal Monthly Income								
No income	1.00							
Some income	0.84	0.45	1.57	0.58				
Religion								
No religion	1.00							
Mainline Christian	0.66	0.31	1.41	0.28				
AIC/Zion/Independent	0.66	0.26	1.65	0.37				
Muslim	0.53	0.20	1.40	0.20				
Other Affiliations/Denominations	0.51	0.16	1.64	0.26				
Current Marital Status								
Unmarried								
Married								
Self-Assessed HIV Risk								
No risk	1.00				1.00			
Some risk	1.84	0.96	3.53	0.07	2.08	1.13	3.82	**0.02**
HIV+/Refused/Don't know	0.56	0.16	1.99	0.38	0.63	0.18	2.19	0.47
Age of Sexual Debut								
≤14 years	1.00							
15-19 years	1.16	0.45	2.99	0.76				
20-24 years	0.63	0.10	3.81	0.61				

Table 6. continued

Variable Description	Multivariate							
	Model 6				Model 7			
	OR	(95% CI)		*p* value	OR	(95% CI)		*p* value
Time Since Sexual Debut								
0-2 years	1.00				1.00			
3-4 years	1.84	0.74	4.56	0.19	1.86	0.77	4.49	0.17
5-6 years	5.20	1.92	14.10	**<0.01**	5.23	2.12	12.93	**<0.01**
7+ years	6.66	1.67	26.51	**0.01**	5.92	2.15	16.26	**<0.01**
# Lifetime Sexual Partners								
1-3	1.00				1.00			
4	3.51	1.24	9.96	**0.02**	3.33	1.29	8.59	**0.01**
5+	2.34	0.98	5.59	0.06	2.39	1.06	5.36	**0.04**
Age Gap w/ Most Recent Partner								
Partner is 4 or less years older/younger	1.00							
Partner is 5 or more years older	*							
Partner is 5 or more years younger	0.46	0.08	2.52	0.37				
Most Recent Partner's Concurrency								
Partner did not have concurrent partners	1.00				1.00			
Partner did have concurrent partners	3.95	1.80	8.66	**<0.01**	4.86	2.30	10.27	**<0.01**
Co-Residence with Most Recent Partner								
Does co-reside	1.00							
Does not co-reside	1.57	0.73	3.39	0.25				
Condom Use with Most Recent Partner								
Never use	1.00							
Consistently use	0.95	0.42	2.15	0.90				
Inconsistently use	1.21	0.53	2.75	0.65				
N				838				872
log likelihood				-182.1				-195.6
Area under the ROC Curve				0.863				0.841
Hosmer-Lemeshow Goodness-of-fit test (*p*-value)				0.42				0.22

a. All *p*-values are based on the Wald statistic

b. Model 6: Main Effects Model - with Coloured respondents only

c. Model 7: Main Effects Model - includes all variables where p≤0.05 in Model 6

d. Post-estimation statistics are based on the unweighted models.

* 0 cases of concurrency were reported among respondents whose partner was 5 or more years older

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