



Sexual Risk Behavior: a Multi-System Model of Risk and Protective Factors in South African Adolescents

Kaymarlin Govender¹ · Richard G. Cowden² · Kwaku Opong Asante³ · Gavin George¹ · Candice Reardon¹

Published online: 30 April 2019
© Society for Prevention Research 2019

Abstract

Adolescent sexual risk behavior has typically been studied within singular, isolated systems. Using a multi-system approach, this study examined a combination of individual, proximal, and distal factors in relation to sexual risk behavior among adolescents. A large cross-sectional sample of 2561 adolescent ($M_{\text{age}} = 14.92$, $SD_{\text{age}} = 1.70$) males ($n = 1282$) and females in Grades 8 ($n = 1225$) and 10 completed a range of self-report measures. Hierarchical ordinal logistic regression results supported a multi-system perspective of adolescent sexual risk behavior. Although individual and peer levels were identified as the primary contributors to the final model, a range of factors at varying levels of proximity to the individual were associated with sexual risk behavior. Specifically, being male, black, attaining increased age, greater alcohol use (individual level), parent risk behavior (family/home level), and peer risk behavior, feeling more pressure from peers to have sex (peer level), and lower social cohesion (community level) were associated with increased sexual risk behavior. These findings suggest multiple individual, proximal, and distal factors are salient to understanding sexual risk behavior among adolescents. Implications of the findings for interventions targeting the prevention of adolescent sexual risk behavior are discussed.

Keywords Adolescents · Ecological · Multi-system · Protective factors · Risk factors · Sexual risk behavior · Youth

Adolescence is a critical developmental period characterized by marked changes in a person's internal attributes (e.g., physiological, psychological) and external environment (e.g., social, cultural). During this phase, individuals formulate sexual,

gender, and self-identities (Schlüter-Müller et al. 2015). They also interrogate the assumptions and people (i.e., parents) that governed their past thoughts and actions. As adolescents develop their sense of autonomy (Labouvie-Vief 2015), they often experience a shift in the circle of individuals that influence them (i.e., away from parents towards peers) and begin to participate in experimental behaviors and activities (Liao et al. 2013; van de Bongardt et al. 2014). Often underprepared for the typically abrupt transformations that occur, adolescents must apply their developing decision-making abilities to potentially risky situations (Leijenhorst et al. 2010) in which they may be conflicted by a combination of individual (e.g., sensation-seeking tendencies) and socio-contextual (e.g., peers) influences (Casey 2011). As reward-seeking processes tend to develop earlier in adolescence than self-regulatory processes (Steinberg 2008), decisions can favor risk behaviors that may have detrimental health consequences (Reyna et al. 2015).

Although a variety of health risk behaviors (e.g., alcohol use, physical inactivity) emerge during adolescence (Houck et al. 2016; Sawyer et al. 2012), susceptibility to adverse health consequences is pronounced for adolescents growing up in countries that carry the global burden of infectious diseases (Patton et al. 2016). In South Africa, where HIV prevalence (up to 7.1%) and incidence (up to 1.5%) rates among

✉ Kaymarlin Govender
Govenderk2@ukzn.ac.za

Richard G. Cowden
richardgregorycowden@gmail.com

Kwaku Opong Asante
kwappong@gmail.com

Gavin George
georgeg@ukzn.ac.za

Candice Reardon
candiceannereardon@gmail.com

¹ Health Economics and HIV and AIDS Research Division, University of KwaZulu-Natal, Westville Campus, Private Bag X54001, Durban 4000, South Africa

² Department of Psychology, University of the Free State, 205 Nelson Mandela Drive, Bloemfontein, Free State 9301, South Africa

³ Department of Psychology, University of Ghana, Legon Boundary, Accra, Ghana

individuals between 15 and 24 years of age (Shisana et al. 2014; Zuma et al. 2016) are among the highest globally (Piot et al. 2015), adolescents are especially vulnerable to experiencing undesirable health consequences of high-risk sexual behavior (Govender et al. 2013).

In light of this apparent vulnerability, an abundance of research has focused on identifying factors that affect the likelihood of South African adolescents' engaging in sexually risky behaviors, but most studies have isolated selected risk or protective factors (e.g., Harrison et al. 2012; Kaufman et al. 2014). A recent review found that across Sub-Saharan Africa, few studies have examined factors beyond the individual or family level, and studies involving a combination of factors across a range of distal (e.g., community) and proximal (e.g., individual) levels have been rare (Mmari and Sabherwal 2013). With the success of adolescent sexual risk intervention programs depending on the appropriate targeting of specific, adaptable areas at multiple systemic levels (Patton et al. 2016), comprehensive approaches to studying sexual risk are required in order for evidence-based, context-specific interventions to be developed. In this study, a multi-system approach is used to examine individual, proximal, and distal factors associated with sexual risk behavior in a sample of South African school-going adolescents residing in KwaZulu-Natal, a high HIV burdened region in South Africa.

Method

Participants

The sample ($N = 2561$) characteristics are presented in Table 1. Participants ($M_{\text{age}} = 14.92$, $SD_{\text{age}} = 1.70$) were drawn from 12 secondary schools located in the Bergville Education ($N = 7$) and Central Durban Education ($N = 5$) circuits within the province of KwaZulu-Natal, South Africa. For state funding allocations, the schools are categorized into poverty quintiles,¹ with the Bergville circuit comprising rural, lower income black families (poverty quintiles 1 to 3). The Central Durban circuit has greater racial diversity and families of higher socioeconomic status (poverty quintiles 4 and 5). The majority of the participants were male (50.08%), in Grade 10 (52.17%), and black (85.55%) students.

Materials

Participants completed the following measures. Response options for all single-item measures, along with the number of

items, scoring ranges, and internal consistency estimates for all scale measurements, are reported in Table 1.

Sexual Risk Behavior Given the complexities of measuring sexual risk behavior (Wilkinson et al. 2017), we used several items commonly applied in the measurement of sexual risk behavior (for reviews, see Ssewanyana et al. 2018; Toska et al. 2017). Participants who first indicated that they had experienced sexual intercourse were presented with six additional items assessing a variety of sexual risk behaviors, including age of sexual debut, condom use at last sex, number of sexual partners, any partner > 5 years older, prior pregnancy, and transactional sex. Responses to each item were dichotomized into categories representing low and high levels of sexual risk behavior (first category for each item represents sexual practices characterized by low risk): sexual debut (≥ 15 years, < 15 years), condom use at last sex (yes, no), multiple sexual partners (no, yes), any partner > 5 years older (no, yes), prior pregnancy (no, yes), and transactional sex (no, yes). Our approach to grading participants' sexual risk behavior is detailed in the Fig. 1.

Substance Use Substance use (not including alcohol use) was measured using an aggregated score of three items that inquired about the frequency with which participants had used tobacco, marijuana, and other illegal drugs (e.g., heroin, cocaine, ecstasy) in the last 30 days, respectively. Responses were provided using a three-point rating scale (1 = none; 3 = more than two times).

Alcohol Use We administered five items that were combined for a total index of alcohol use. Items measured the frequency of general alcohol use, typical quantity of alcoholic beverages when consuming alcohol, frequency of binge drinking occurrences, involvement in alcohol-related incidents, and whether others have expressed concern about participants' drinking patterns. Sample items include "how often do you have a drink containing alcohol?" (1 = never; 5 = four or more times a week) and "how many drinks containing alcohol do you have on a typical day when drinking?" (1 = I do not drink alcohol; 6 = ten or more drinks).

Leisure Opportunities A nine-item scale was constructed to measure adolescents' perceptions about leisure time, the leisure time activities they partake in, and the activities available in the community for them to engage in during their free time. All items were rated using a five-point response scale (1 = strongly disagree; 5 = strongly agree) and aggregated for a total score. Sample items include "I know of places in the community where there are lots of things to do" and "for me, free time just drags on and on" (reverse scored).

¹ All South African public schools are classified into one of five quintiles based on socioeconomic indicators of the communities that surround each school (Murray 2016).

Table 1 Summary statistics and bivariate associations (ordinal logistic regression) with sexual risk behavior

Systemic level	Variable	<i>n</i> (%)	Items	Item/scale range	<i>M</i> (<i>SD</i>)	ω	DV = sexual risk behavior (none = 0, low = 1, high = 2)
Individual	Age	2559			14.92 (1.70)		<i>OR</i> = 1.56***, 95% CI [1.47, 1.67]
	Gender	2560					
	Female (ref)	1278 (49.92)					
	Male	1282 (50.08)					<i>OR</i> = 3.30***, 95% CI [2.65, 4.11]
	Race	2546					
	Other (ref)	368 (14.45)					
	Black	2178 (85.55)					<i>OR</i> = 2.65***, 95% CI [1.83, 3.82]
	School grade	2561					
	Grade 8 (ref)	1225 (47.83)					
	Grade 10	1336 (52.17)					<i>OR</i> = 3.26***, 95% CI [2.60, 4.08]
	Leisure opportunities	2261	9	9 to 45	21.79 (5.54)	.73	<i>OR</i> = 1.00, 95% CI [1.98, 1.02]
	Substance use	2513	3	3 to 9	3.31 (.89)	.71	<i>OR</i> = 1.96***, 95% CI [1.75, 2.19]
	Alcohol use	2212	5	5 to 22	6.18 (2.45)	.82	<i>OR</i> = 1.34***, 95% CI [1.29, 1.40]
	Family/home	Household resident with HIV	2489				
No (ref)		1532 (61.55)					
I do not know		856 (34.39)					<i>OR</i> = 1.07, 95% CI [1.86, 1.33]
Yes		101 (4.06)					<i>OR</i> = 2.00**, 95% CI [1.28, 3.12]
Parental status		2448					
Both parents living (ref)		1623 (66.30)					
Father deceased		492 (20.10)					<i>OR</i> = 1.54***, 95% CI [1.20, 1.98]
Mother deceased		141 (5.76)					<i>OR</i> = 1.47, 95% CI [1.96, 2.23]
Both parents deceased		192 (7.84)					<i>OR</i> = 1.99***, 95% CI [1.41, 2.82]
Parental monitoring		2396	6	6 to 30	22.45 (5.84)	.85	<i>OR</i> = .94***, 95% CI [1.92, .96]
Communication about sex		2026	16	16 to 80	43.27 (12.42)	.89	<i>OR</i> = 1.02**, 95% CI [1.01, 1.02]
Sibling risk behavior		2410	5	5 to 20	7.78 (4.05)	.92	<i>OR</i> = 1.01, 95% CI [1.99, 1.04]
Parental/caregiver support		2522	3	3 to 6	5.45 (.80)	.51	<i>OR</i> = .71***, 95% CI [1.64, .80]
Violence at home		1997	12	12 to 60	14.75 (3.55)	.74	<i>OR</i> = 1.05***, 95% CI [1.01, 1.08]
Parent risk behavior	2496	4	4 to 8	4.53 (.86)	.62	<i>OR</i> = 1.29***, 95% CI [1.16, 1.44]	

Table 1 (continued)

Systemic level	Variable	<i>n</i> (%)	Items	Item/scale range	<i>M</i> (<i>SD</i>)	ω	DV = sexual risk behavior (none = 0, low = 1, high = 2)	
Peer	Pressure to have sex	2531						
	No (ref)	1687 (66.65)					<i>OR</i> = 2.67***, 95% CI [1.96, 3.63]	
	I am not sure	293 (11.58)					<i>OR</i> = 4.80***, 95% CI [3.50, 6.57]	
	A little bit	222 (8.77)					<i>OR</i> = 7.39***, 95% CI [5.60, 9.75]	
	Yes	329 (13.00)					<i>OR</i> = 83***, 95% CI [78, .89]	
	Prosocial peers	2496	2	2 to 8	6.21 (1.50)	.60		
	Peer support	2465	3	3 to 12	9.01 (2.70)	.77		
	Peer risk behavior	2507	4	4 to 12	5.38 (1.84)	.80	<i>OR</i> = .98, 95% CI [.94, 1.01] <i>OR</i> = 1.56***, 95% CI [1.48, 1.65]	
	School	Frequency of lessons about HIV/AIDS	2540					
		Not often (ref)	854 (33.62)					
		Often	1109 (43.66)					<i>OR</i> = .84, 95% CI [.67, 1.06]
		Very often	577 (22.72)					<i>OR</i> = .87, 95% CI [.67, 1.15]
		Frequency of lessons about sex	2526					
		Not often (ref)	824 (32.62)					
		Often	1136 (44.97)					<i>OR</i> = 1.18, 95% CI [.93, 1.49]
Very often		566 (22.41)					<i>OR</i> = 1.32, 95% CI [1.00, 1.74]	
Information about HIV/AIDS helpful		2537						
No (ref)		323 (12.73)						
Yes		2214 (87.27)					<i>OR</i> = .89, 95% CI [.66, 1.20]	
Information about sex helpful		2528						
No (ref)		409 (16.18)						
Yes		2119 (83.82)					<i>OR</i> = .99, 95% CI [.75, 1.31]	
School provides information about organizations to get help		2515						
No (ref)	970 (38.57)							
Yes	1545 (61.43)					<i>OR</i> = .96, 95% CI [.78, 1.18]		
Community	School	2561						
	A (quintile 5) (ref)	419 (16.36)						
	B (quintile 4)	237 (9.25)					<i>OR</i> = 1.15, 95% CI [.77, 1.71]	
	C (quintile 5)	242 (9.45)					<i>OR</i> = .39***, 95% CI [.23, .64]	
	D (quintile 3)	151 (5.90)					<i>OR</i> = 1.15, 95% CI [.73, 1.82]	
	E (quintile 2)	113 (4.41)					<i>OR</i> = 1.26, 95% CI [.78, 2.04]	
	F and G ^a (quintile 1)	187 (7.30)					<i>OR</i> = .85, 95% CI [.54, 1.33]	
	H (quintile 3)	113 (4.41)					<i>OR</i> = .93, 95% CI [.53, 1.62]	
	I (quintile 5)	301 (11.75)					<i>OR</i> = .51** 95% CI [.33, .77]	
	J (quintile 3)	260 (10.15)					<i>OR</i> = 1.12, 95% CI [.76, 1.65]	
	K (quintile 5)	287 (11.21)					<i>OR</i> = .78, 95% CI [.53, 1.16]	
	L (quintile 2)	251 (9.80)					<i>OR</i> = 1.31, 95% CI [.90, 1.91]	
	Violence at school	1986	12	12 to 60	15.54 (3.68)	.74	<i>OR</i> = 1.06***, 95% CI [1.03, 1.09]	
	Ease of learner engagement in risk behaviors at school	2437	4	4 to 16	7.88 (3.17)	.81	<i>OR</i> = 1.07***, 95% CI [1.04, 1.11]	
	School connectedness	1997	18	18 to 90	55.60 (9.65)	.83	<i>OR</i> = .99, 95% CI [.98, 1.00]	
Community support	2534							
No (ref)	1052 (41.52)							
Yes	1482 (58.48)					<i>OR</i> = .94, 95% CI [.77, 1.15]		
Violence in community	2141	12	12 to 60	19.49 (6.00)	.82	<i>OR</i> = 1.07***, 95% CI [1.05, 1.09]		

Table 1 (continued)

Systemic level	Variable	<i>n</i> (%)	Items	Item/scale range	<i>M</i> (<i>SD</i>)	ω	DV = sexual risk behavior (none = 0, low = 1, high = 2)
	Social cohesion	2297	4	4 to 20	13.10 (2.79)	.55	<i>OR</i> = .91***, 95% <i>CI</i> [.88, .95]

OR odds ratio, 95% *CI* 95% confidence intervals for odds ratio

The initial analysis for school could not be estimated, likely due to the comparably smaller sample size in school F ($n = 37$, 1.44%) relative to the other schools. We combined participants in school F with those in school G ($n = 150$, 5.86%), as both schools are located in the Bergville Education district and are classified as Quintile 1 schools. Neither school was associated with a higher odds of sexual risk behavior ($p = .793$)

** $p < .05$, *** $p < .01$, **** $p < .001$

Parental Vital Status and HIV Status of Household Residents Participants completed two single items to determine if their biological parents (none, one, or both) were alive and whether a household resident is living with HIV.

Parent Risk Behaviors Four items were administered to assess whether participants' parents/caregivers had smoked cigarettes, been visibly intoxicated in front of them, used illegal substances, and been in trouble with the police in the last 6 months. These items were rated using a two-point scale (1 = *no*; 2 = *yes*) and combined for a total measure of parent risk behavior.

Parental Support Three items were developed to measure supportive parent/caregiver behaviors. Participants were prompted to respond to each item (e.g., "I talk to my parents/caregiver about my homework assignments and projects") by selecting one of two dichotomous options (1 = *no*; 2 = *yes*). The items were aggregated for an index of family support.

Parental Monitoring Six items were selected from the Parental Monitoring Scale (Small and Kerns 1993) to measure the extent to which participants were monitored by their parents/caregivers. A five-point response format (1 = *never*; 5 = *very often*) was used to rate the items, which were summed for a total parental monitoring score.

Parent-Child Communication About Sex Participants responded to 16 items measuring quality of communication about sexual topics with their parents/primary caregivers (Jaccard et al. 2000). Items were rated on a five-point scale (1 = *strongly disagree*; 5 = *strongly agree*) and combined for a total score.

Sibling Risk Behaviors Five items were developed to assess whether participants' siblings had used tobacco, been intoxicated, used illegal substances, engaged in sexual activity, and been in trouble with the police during the last 6 months. Participants rated each item using a four-point response scale (1 = *I do not have siblings*; 4 = *yes*), which were combined for an index of sibling risk behavior.

Peer Risk Behavior Four items assessed peer involvement in problem behaviors and sexual activity (Brook et al. 2006). Items were rated on a three-point response scale (1 = *none*; 3 = *most*) and combined for a total score.

Prosocial Peers Prosocial peer behavior was assessed using two items (e.g., "my friends try to do what is right"). Both items were rated on four-point scale (1 = *not at all true*; 4 = *very much true*) and summed for a total measure of peer prosociality.

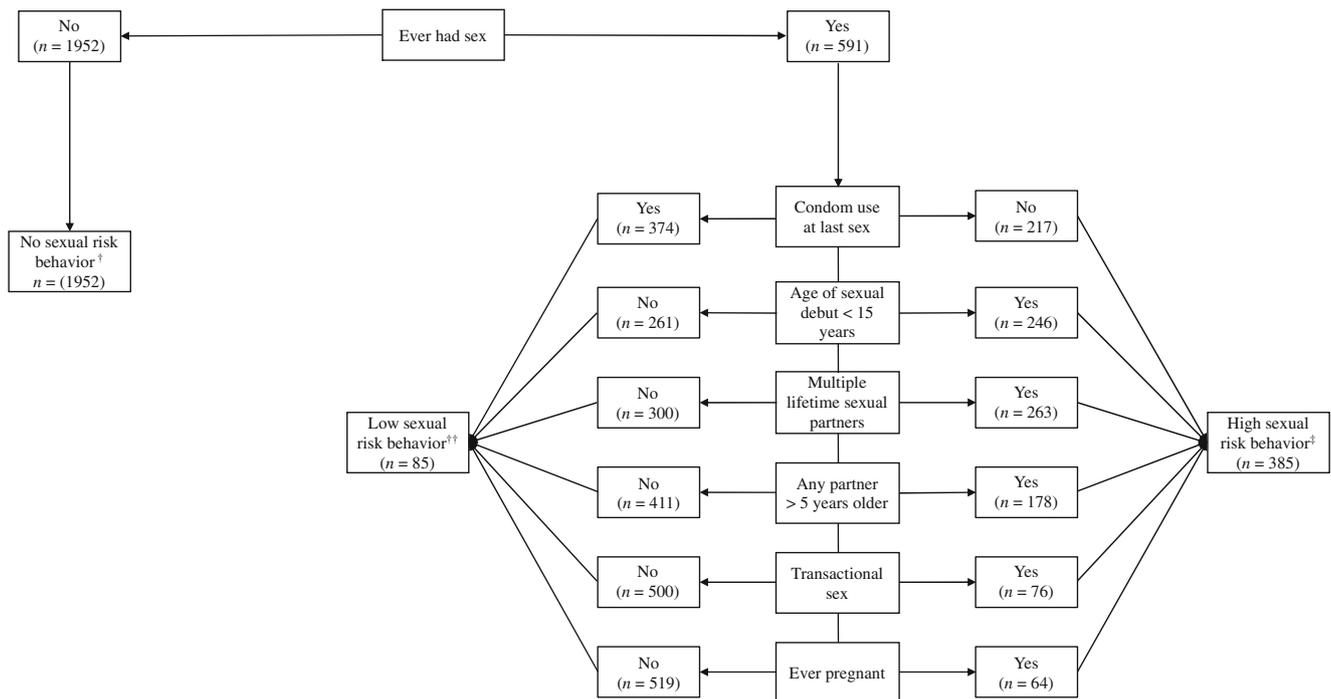


Fig. 1 Gradation of sexual risk behavior. †Participants have not experienced sexual intercourse; ††Participants have experienced sexual intercourse and endorsed low sexual risk-taking behavior on all subsequent items. ‡Participants have experienced sexual intercourse and

endorsed high sexual risk-taking behavior on at least one subsequent item. Participants with missing responses to one or more items (n = 139) were omitted from sexual risk behavior gradation

Peer Support Three items inquired about the extent to which adolescents received support from peers. Participants used a four-point response format (1 = *not at all true*; 4 = *very much true*) to respond to each of the items, which were combined for an index of perceived peer support. Sample items include “I have a friend my own age who really cares about me” and “I have a friend my own age who helps me when I’m having a difficult time.”

School Connectedness The Psychological Sense of School Membership scale (Goodenow 1993) was used to measure school connectedness. The 18 items assess participants’ sense of inclusion, acceptance, respect, encouragement, and belonging at school. Items were rated on a five-point response scale (1 = *strongly disagree*; 5 = *strongly agree*) and aggregated for a total school connectedness score.

Ease of Learner Engagement in Risk Behaviors at School Four items were constructed to determine the ease with which learners are able to engage in problem behaviors and sexual activity on school premises (e.g., “how easy is it for learners to drink alcohol on the school premises and not get caught?”). Items were rated using a four-point response scale (1 = *you would get caught for sure*; 4 = *very easy, no educator would notice*) and aggregated for a composite score.

Information About HIV, Sex, and Availability of Support We developed five single-item measures to assess frequency of HIV and sex education at school (along with the perceived helpfulness of such information) and whether schools had provided participants with information about organizations in the community (e.g., health clinics) where they could receive support.

Violence Scale Adolescents completed 12 items from the Screen for Adolescent Violence Exposure scale (Hastings and Kelley 1997) to assess experiences of violence in the home, school, and community. Using a five-point response format (1 = *never*; 5 = *always*), participants rated the 12 items with reference to each of the three aforementioned contexts (36 responses in total). Respective responses were combined for subscale totals referring to each context.

Social Cohesion Four items from the Collective Efficacy Scale (Sampson et al. 1997) were used to measure perceived social cohesion in the community. Items were completed using a five-point response scale (1 = *strongly disagree*; 5 = *strongly agree*) and aggregated for an index of social cohesion.

Community Support A single item was used to assess perceptions of community support.

Table 2 Summary statistics of the hierarchical ordinal regression model (sequential block entry) predicting sexual risk behavior

Systemic level	Determinant	DV = sexual risk behavior (none = 0, low = 1, high = 2)	
		Estimate (<i>SE</i>)	<i>AOR</i> [95% CI]
Individual (block 1)	Age	.29*** (.08)	1.33 [1.13, 1.57]
	Gender		
	Female (ref)		
	Male	.98*** (.26)	2.68 [1.61, 4.46]
	Race		
	Other (ref)		
	Black	1.46** (.46)	4.32 [1.76, 10.60]
	School grade		
	Grade 8 (ref)		
	Grade 10	.49 (.29)	1.62 [.92, 2.86]
	Substance use	.01 (.14)	1.01 [.77, 1.31]
	Alcohol use	.18*** (.04)	1.19 [1.10, 1.29]
	Model χ^2 (<i>df</i>)	250.86*** (6)	
	Nagelkerke R^2	.315	
Family/home (block 2)	Household resident with HIV		
	No (ref)		
	I do not know	-.14 (.22)	.87 [.56, 1.33]
	Yes	.34 (.53)	1.40 [.50, 3.97]
	Parental status		
	Both parents living (ref)		
	Father deceased	.29 (.27)	1.33 [.79, 2.26]
	Mother deceased	.45 (.37)	1.57 [.76, 3.22]
	Both parents deceased	.42 (.35)	1.52 [.76, 3.03]
	Parental monitoring	-.01 (.02)	.99 [.96, 1.03]
	Communication about sex	.00 (.01)	1.00 [.98, 1.02]
	Parental/caregiver support	-.12 (.12)	.89 [.70, 1.12]
	Violence at home	.03 (.04)	1.03 [.96, 1.11]
	Parent risk behavior	.25* (.12)	1.28 [1.01, 1.63]
	Model χ^2 (<i>df</i>)	269.14*** (16)	
	Block χ^2 (<i>df</i>)	18.28 (10)	
Nagelkerke R^2 (R^2 change)	.335 (.020)		
Peer (block 3)	Pressure to have sex		
	No (ref)		
	I am not sure	.57* (.29)	1.77 [1.01, 3.12]
	A little bit	1.07*** (.31)	2.90 [1.60, 5.28]
	Yes	1.36*** (.31)	3.89 [2.10, 7.20]
	Prosocial peers	.11 (.07)	1.12 [.97, 1.28]
	Peer risk behavior	.29*** (.07)	1.33 [1.17, 1.52]
	Model χ^2 (<i>df</i>)	313.56*** (21)	
	Block χ^2 (<i>df</i>)	44.43*** (5)	
Nagelkerke R^2 (R^2 change)	.383 (.048)		
School (block 4)	School		
	A (quintile 5) (ref)		
	B (quintile 4)	.29 (.44)	1.33 [.57, 3.13]
	C (quintile 5)	-.12 (.47)	.89 [.36, 2.22]
	D (quintile 3)	-.37 (.49)	.69 [.26, 1.81]
	E (quintile 2)	-.15 (.51)	.86 [.32, 2.33]

Table 2 (continued)

Systemic level	Determinant	DV = sexual risk behavior (none = 0, low = 1, high = 2)	
		Estimate (<i>SE</i>)	AOR [95% CI]
	F and G [#] (quintile 1)	.11 (.43)	1.11 [.47, 2.60]
	H (quintile 3)	-.62 (.73)	.54 [.13, 2.24]
	I (quintile 5)	-.01 (.49)	.99 [.38, 2.61]
	J (quintile 3)	.40 (.40)	1.49 [.68, 3.29]
	K (quintile 5)	-.27 (.44)	.77 [.33, 1.80]
	L (quintile 2)	-.15 (.42)	.86 [.37, 1.96]
	Ease of learner engagement in risk behaviors at school	.01 (.03)	1.01 [.95, 1.08]
	Violence at school	.01 (.04)	1.01 [.93, 1.09]
	Model χ^2 (<i>df</i>)	320.25*** (33)	
	Block χ^2 (<i>df</i>)	6.69 (12)	
	Nagelkerke R^2 (R^2 change)	.390 (.007)	
Community (block 5)	Violence in community	-.01 (.02)	.99 [.94, 1.03]
	Social cohesion	-.08* (.04)	.93 [.86, .99]
	Model χ^2 (<i>df</i>)	324.66*** (35)	
	Block χ^2 (<i>df</i>)	4.41 (2)	
	Nagelkerke R^2 (R^2 change)	.394 (.004)	

* $p < .05$, ** $p < .01$, *** $p < .001$

Procedure

Permission to conduct the study was granted by the University of KwaZulu-Natal Human and Social Science Research Ethics Committee and the Provincial Department of Basic Education, KwaZulu-Natal. Subsequently, the permission of the 12 schools in the Bergville and Central Durban Education circuits was acquired in order to obtain access to the students. This process also involved informing adolescents’ parents about the study and the nature of their child’s prospective participation in it. For those students who volunteered to participate in the study, written consent (from parents or legal guardians) and assent (from adolescents) were obtained prior to their participation. The questionnaire was translated from English into isiZulu, which was checked for accuracy using backtranslation. Participants from schools in the Bergville Education circuit completed the questionnaire in IsiZulu, whereas those within the Central Durban Education circuit requested to complete the English version. A multilingual team of fieldworkers was available to provide guidance and support to participants. Questionnaires were completed in school classrooms during predetermined timeframes allocated by each school for data collection.

Data Analyses

Statistical computations were performed in R (R Core Team 2018). Analyses were performed using a pairwise deletion approach. For all measures containing at least two items, internal consistency was estimated using omega total. We used

ordinal (proportional odds) logistic regression to examine bivariate relationships between the study variables and sexual risk behavior. Variables that revealed significant ($p < .05$) bivariate associations with sexual risk were retained for use in the primary analysis.

Systemic level predictors of sexual risk behavior were estimated using a hierarchical ordinal (proportional odds) logistic regression model. Variables were entered into the model in a series of sequential blocks (five in total), beginning with those at the individual level. The remaining blocks of variables were entered from most proximal (i.e., family) to most distal (i.e., community) with regard to the individual.² For the full model, collinearity diagnostics (all VIF values ≤ 3.28) did not reveal any multicollinearity issues (Tabachnick and Fidell 2013). Analysis of parallel lines (all p values $\geq .065$) indicated the proportional odds assumption was appropriately met (Williams 2016).

Results

Bivariate Analyses

Results of the bivariate relations between sexual risk and each of the study variables are displayed in Table 1. Within the

² Block 1 (Individual), Block 2 (Individual + Family/home), Block 3 (Individual + Family/home + Peer), Block 4 (Individual + Family/home + Peer + School), Block 5 (Individual + Family/home + Peer + School + Community).

individual level, sexual risk behavior was higher among adolescents who were older, male, black, in Grade 10, and those who reported higher alcohol and substance use. For the family/home level, participants who had someone diagnosed with HIV/AIDS living in their home, were paternal or double orphans, reported less parental monitoring and communication about sex with their parents, experienced violence at home, and endorsed greater parent risk behavior tended to engage in higher sexual risk behavior. Associations with the peer-level variables indicated sexual risk behavior was higher among adolescents who experienced more pressure to have sex and reported greater peer risk behavior, whereas sexual risk behavior was lower when peers were more prosocial. Within the school level, sexual risk behavior was higher when it was easier for learners to engage in risk behaviors at school and there was greater violence at school. Lower sexual risk behavior was found among two schools in quintile 5. For the community level, greater violence in the community and lower social cohesion were associated with higher sexual risk behavior.

Primary Analysis

Results of the hierarchical ordinal logistic regression are presented in Table 2. The overall model containing five blocks was statistically significant (Nagelkerke $R^2 = .39$, $p < .001$), with systemic-level effects found for the individual ($p < .001$) and peer ($p < .001$) levels. Although the family/home ($p = .051$), school ($p = .878$), and community ($p = .110$) level blocks did not contribute significantly to model fit, the results indicated a combination of individual, proximal, and distal variables were associated with sexual risk behavior. Specifically, being older, male, black, higher alcohol use (individual level), higher parent/caregiver engagement in risk behavior (family/home level), feeling more pressure from peers to have sexual intercourse, higher peer risk behavior (peer level), and lower social cohesion (community level) were associated with increased sexual risk behavior. All other determinants were unrelated to sexual risk behavior ($p > .05$).

Discussion

Adolescents growing up in countries where the global burden of sexually transmitted infections (including HIV) is highest are especially vulnerable to the health-related consequences of sexual risk behavior. Developing effective prevention programming requires a comprehensive understanding of contextually relevant factors associated with sexual risk behavior among key populations living in such countries. In this study, a multi-system approach was used to examine relations between a combination of individual, proximal, and distal factors and sexual risk behavior in a sample of South African adolescents living in a high HIV burdened region of the country. The findings supported a

multi-system perspective of sexual risk behavior among adolescents, as a range of factors were associated with sexual risk behavior at varying levels of proximity to the individual. This highlights the importance of considering a multi-level combination of psychosocial factors to understanding sexual risk behavior in adolescence (Salazar et al. 2010; Tenkorang and Maticka-Tyndale 2014). The findings also suggest that there may be distinctions in the importance of systemic levels depending on where factors fit in within the proximal-distal spectrum, as predominant effects were found for the individual and peer systemic levels. This notion is consistent with prior research that has found proximal factors tend to be stronger predictors of adolescent sexual risk behavior (James et al. 2013; Lansford et al. 2014).

Based on the overall model, biological factors (i.e., age, race, and sex) were among the strongest predictors of sexual risk behavior at the individual level. These findings are largely consistent with a number of reviews reporting distinctions in sexual risk behavior propensities based on biographical attributes (e.g., Toska et al. 2017). Further, the results coincide with a wealth of research highlighting the salience of alcohol use as a behavioral antecedent of sexual risk behavior (Patrick et al. 2015). A noteworthy finding was the relative importance of alcohol use, as compared to substance use, in predicting sexual risk, advocating the importance of separating the two behavioral choices when examining sexual risk behavior. Although alcohol and substance use are often highly correlated among adolescents (Capaldi 2014; Kelly et al. 2015), the neurocognitive effects of alcohol use (i.e., reduction in behavioral inhibition and impulse control) on behavior (Winward et al. 2014) may have a greater influence on sexually risky behavioral choices. Considering the prominence of alcohol use with regard to sexual risk behavior found in this study, the finding that leisure opportunities was unrelated to sexual risk behavior is of particular interest. With adolescents less likely to partake in alcohol use outside of leisure time periods (Weybright et al. 2016), the types of activities adolescents engage in during their free time may be of greater importance than their perceptions of and attitudes towards leisure opportunities.

Comparable to prior research that has found links between risky parental behavior and health-risk behaviors among adolescents (e.g., Donaldson et al. 2016), parent risk behavior was the single predictor of sexual risk behavior at the family/home level. Adolescents' sexual risk behavior was linked to their engagement in activities that resembled those included in the measure of parent risk behavior (e.g., alcohol use), suggesting that exposure to parents' maladaptive alcohol use may have a profound effect on adolescents' decisions to participate in alcohol consumption (van der Zwaluw et al. 2008). That is, parental behaviors may indirectly endorse the kinds of activities that heighten adolescents' proclivity to engage in such behaviors themselves. Furthermore, parent risk behavior (e.g., alcohol intoxication) impairs parents' functioning and the ability to effectively fulfill parental responsibilities (e.g.,

monitoring), which may lead to parent-child conflict that drives adolescents towards other extrafamilial influences and affords adolescents greater freedom to partake in health-risk behaviors (Latendresse et al. 2008).

Within the peer level, peer risk behavior and feeling greater pressure to have sex were associated with heightened sexual risk behavior. Peer influences affect adolescents' sexual risk behavior directly through their need to belong and feel accepted (Selikow et al. 2009), as well as indirectly through the types of sexual risk-related activities (e.g., alcohol use) that are promoted by peers who engage in delinquent behavior (Tomé et al. 2012). The present findings underscore the increased role of peer influences during adolescence (Liao et al. 2013), with negative peer influences exerting a stronger effect on sexual risk behavior than positive peer influences (e.g., peer support).

Similar to previous research that has found facets of social capital tend to promote safer sexual practices (Crosby et al. 2003), social cohesion emerged as a community-level factor associated with lower sexual risk behavior. This finding iterates the relevance of distal levels of influence on risky sexual behavior (Salazar et al. 2010), likely due to the impact distal systems (e.g., community) have on more proximal (e.g., individual) systems (Hutchison and Wood 2007). For example, in communities characterized by higher levels of social cohesion, adolescents have more opportunities to develop bonds with community members who can supervise, monitor, and positively shape their values (Sampson et al. 2002). Moreover, interconnected communities might have a greater influence over the norms and behavioral choices (e.g., parental monitoring) of families living within such communities (Valdimarsdóttir and Bernburg 2015). Collective social capital may also produce health benefits by diffusing knowledge about health-related issues in communities and invoking informal social control over health-related behaviors (Boyce et al. 2008).

Limitations and Future Research Directions

While our application of a multi-system approach offers promising insight into the proximal and distal factors associated with sexual risk behavior among adolescents living in an HIV endemic region of South Africa, selected methodological limitations ought to be considered. First, the findings of this study are based on cross-sectional data, thereby preventing determinations of causality. Second, participants were conveniently sampled from two school districts within a single province. Given South Africa's geographically varied demography and socioeconomic climates, indiscriminate application of the conclusions drawn in this study may neglect to appreciate contextually specific distinctions in adolescents' sexual risk behavior. Third, gradation of sexual risk behavior was based on a combination of items that captured a relatively heterogenous range of risky sexual behaviors. While this approach has the

advantage of capturing a comprehensive range of behaviors, caution should be applied in generalizing the findings to any singular sexual risk behavior. Fourth, all variables were derived from self-report measures, the accuracy of which may have been affected by task-related demands and the social context in which participation occurred (Schroder et al. 2003). Although self-report ratings are commonly applied to the study of sexual risk behavior (DiClemente et al. 2013), a broader range of factors (particularly at more distal levels) could be captured in future research by gathering data from other informants. Research is also needed to identify the relevant processes, contexts, and interplay between the determinants hitherto identified as affecting risk sexual behavior, a precursor to HIV infection. Additionally, sophisticated research designs are necessary to investigate the longitudinal influences of various individual, proximal, and distal factors on adolescents' health risk behaviors, particularly among at-risk and marginalized populations. Policies and programs that attend to the economic and social needs of families and communities, as well as those that seek to build individual competencies, will be critical for adolescents to safely navigate their development, particularly within AIDS-affected communities (Govender et al. 2018).

Conclusion

This study represents one of the few studies that has adopted a multi-system approach to examining South African adolescents' sexual risk behavior, a country that continues to have some of the highest global high HIV incidence and prevalence rates (Shisana et al. 2014; Zuma et al. 2016). The findings of this study support the understanding that narrowly focusing on individual risk and protective factors, while ignoring risk and protective factors across multiple levels, will likely undermine efforts targeting maladaptive health-risk behaviors, including the effectiveness of HIV prevention programming.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures involving participants in this study were performed in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Study approval was granted by the University of KwaZulu-Natal Human and Social Science Research Ethics Committee and the Provincial Department of Basic Education, KwaZulu-Natal.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Boyce, W., Davies, D., Gallupe, O., & Shelley, D. (2008). Adolescent risk taking, neighborhood social capital, and health. *Journal of Adolescent Health, 43*, 246–252. <https://doi.org/10.1016/j.jadohealth.2008.01.014>.
- Brook, D. W., Morojele, N. K., Zhang, C., & Brook, J. S. (2006). South African adolescents: Pathways to risky sexual behavior. *AIDS Education and Prevention, 18*, 259–272. <https://doi.org/10.1521/aeap.2006.18.3.259>.
- Capaldi, D. M. (2014). Prevention science supplemental issue commentary promoting healthy sexual practices: What we have learned from 100 years of work. *Prevention Science, 15*, S78–S80. <https://doi.org/10.1007/s11121-013-0434-2>.
- Casey, S. (2011). Elements of psychological maturity and its influence on antisocial and criminal behavior. *The Open Criminology Journal, 4*, 32–39. <https://doi.org/10.2174/1874917801104010032>.
- Crosby, R. A., Holtgrave, D. R., DiClemente, R. J., Wingood, G. M., & Gayle, J. A. (2003). Social capital as a predictor of adolescents' sexual risk behavior: A state-level exploratory study. *AIDS and Behavior, 7*, 245–252. <https://doi.org/10.1023/A:1025439618581>.
- DiClemente, R. J., Swartzendruber, A. L., & Brown, J. L. (2013). Improving the validity of self-reported sexual behavior: No easy answers. *Sexually Transmitted Diseases, 40*, 111–112. <https://doi.org/10.1097/OLQ.0b013e3182838474>.
- Donaldson, C. D., Handren, L. M., & Crano, W. D. (2016). The enduring impact of parents' monitoring, warmth, expectancies, and alcohol use on their children's future binge drinking and arrests: A longitudinal analysis. *Prevention Science, 17*, 606–614. <https://doi.org/10.1007/s11121-016-0656-1>.
- Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools, 30*, 79–90. [https://doi.org/10.1002/1520-6807\(199301\)30:1<79::AID-PITS2310300113>3.0.CO;2-X](https://doi.org/10.1002/1520-6807(199301)30:1<79::AID-PITS2310300113>3.0.CO;2-X).
- Govender, K., Naicker, S., Meyer-Weitz, A., Fanner, J., Naidoo, A., & Penfold, W. (2013). Associations between perceptions of school connectedness and adolescent health risk behaviors in south African high school learners. *Journal of School Health, 83*, 614–622. <https://doi.org/10.1111/josh.12073>.
- Govender, K., Masebo, W., Nyamaruze, P., Cowden, R. G., Schunter, B. T., & Bains, A. (2018). HIV prevention in adolescents and young people in the Eastern and Southern African region: A review of key challenges impeding actions for an effective response. *The Open AIDS Journal, 12*, 53–67. <https://doi.org/10.2174/1874613601812010053>.
- Harrison, A., Smit, J., Hoffman, S., Nzama, T., Leu, S., Mantell, J., ... Exner, T. (2012). Gender, peer and partner influences on adolescent HIV risk in rural South Africa. *Sexual Health, 9*, 178–186. <https://doi.org/10.1071/SH10150>.
- Hastings, T. L., & Kelley, M. L. (1997). Development and validation of the Screen for Adolescent Violence Exposure (SAVE). *Journal of Abnormal Child Psychology, 25*, 511–520. <https://doi.org/10.1023/A:1022641916705>.
- Houck, C. D., Hadley, W., Barker, D., Brown, L. K., Hancock, E., & Almy, B. (2016). An emotion regulation intervention to reduce risk behaviors among at-risk early adolescents. *Prevention Science, 17*, 71–82. <https://doi.org/10.1007/s11121-015-0597-0>.
- Hutchison, M. K., & Wood, E. B. (2007). Reconceptualizing adolescent sexual risk in a parent-based expansion of the theory of planned behavior. *Journal of Nursing Scholarship, 39*, 141–146. <https://doi.org/10.1111/j.1547-5069.2007.00159.x>.
- Jaccard, J., Dittus, P. J., & Gordon, V. V. (2000). Parent-teen communication about premarital sex: Factors associated with the extent of communication. *Journal of Adolescent Research, 15*, 187–208. <https://doi.org/10.1177/0743558400152001>.
- James, S., Montgomery, S., Leslie, L., & Zhang, J. (2013). Sexual risk behaviors among youth in the child welfare system. *Child and Youth Services Review, 31*, 990–1000. <https://doi.org/10.1016/j.childyouth.2009.04.014>.
- Kaufman, Z., Braunschweig, E., Feeney, J., Dringus, S., Weiss, H., Delaney-Moretlwe, S., & Ross, D. (2014). Sexual risk behavior, alcohol use, and social media use among secondary school students in informal settlements in Cape Town and Port Elizabeth, South Africa. *AIDS and Behavior, 18*, 1661–1674. <https://doi.org/10.1007/s10461-014-0816-x>.
- Kelly, A. B., Evans-Whipp, T. J., Smith, R., Chan, G. K., Toumbourou, J. W., Patton, G. C., ... Catalano, R. F. (2015). A longitudinal study of the association of adolescent polydrug use, alcohol use and high school non-completion. *Addiction, 110*, 627–635. <https://doi.org/10.1111/add.12829>.
- Labouvie-Vief, G. (2015). Cognitive–emotional development from adolescence to adulthood. In G. Labouvie-Vief (Ed.), *Integrating emotions and cognition throughout the lifespan* (pp. 89–116). Cham: Springer International Publishing.
- Lansford, J., Dodge, K., Fontaine, R., Bates, J., & Pettit, G. (2014). Peer rejection, affiliation with deviant peers, delinquency, and risky sexual behavior. *Journal of Youth and Adolescence, 43*, 1742–1751. <https://doi.org/10.1007/s10964-014-0175-y>.
- Latendresse, S. J., Rose, R. J., Viken, R. J., Pulkkinen, L., Kaprio, J., & Dick, D. M. (2008). Parenting mechanisms in links between parents' and adolescents' alcohol use behaviors. *Alcoholism, Clinical and Experimental Research, 32*, 322–330. <https://doi.org/10.1111/j.1530-0277.2007.00583.x>.
- Leijenhorst, L., Moor, B., Op de Macks, Z., Rombouts, S., Westenberg, P., & Crone, E. (2010). Adolescent risky decision-making: Neurocognitive development of reward and control regions. *NeuroImage, 51*, 345–355. <https://doi.org/10.1016/j.neuroimage.2010.02.038>.
- Liao, Y., Huang, Z., Huh, J., Pentz, M., & Chou, C. (2013). Changes in friends' and parental influences on cigarette smoking from early through late adolescence. *Journal of Adolescent Health, 53*, 132–138. <https://doi.org/10.1016/j.jadohealth.2013.01.020>.
- Mmari, K., & Sabherwal, S. (2013). A review of risk and protective factors for adolescent sexual and reproductive health in developing countries: An update. *Journal of Adolescent Health, 53*, 562–572. <https://doi.org/10.1016/j.jadohealth.2013.07.018>.
- Murray, M. (2016). Does poor quality schooling and/or teacher quality hurt black South African students enrolling for a degree at the University of KwaZulu-Natal? *PLoS One, 11*, e0153091. <https://doi.org/10.1371/journal.pone.0153091>.
- Patrick, M. E., Maggs, J. L., & Lefkowitz, E. S. (2015). Daily associations between drinking and sex among college students: A longitudinal measurement burst design. *Journal of Research on Adolescence, 25*, 377–386. <https://doi.org/10.1111/jora.12135>.
- Patton, G. C., Sawyer, S. M., Santelli, J. S., Ross, D. A., Afifi, R., Allen, N. B., ... Viner, R. M. (2016). Our future: A Lancet commission on adolescent health and wellbeing. *Lancet, 387*, 2423–2478. [https://doi.org/10.1016/S0140-6736\(16\)00579-1](https://doi.org/10.1016/S0140-6736(16)00579-1).
- Piot, P., Abdool Karim, S., Hecht, R., Legido-Quigley, H., Buse, K., Stover, J., ... UNAIDS–Lancet Commission. (2015). Defeating AIDS—Advancing global health. *The Lancet, 386*, 171–218. [https://doi.org/10.1016/S0140-6736\(15\)60658-4](https://doi.org/10.1016/S0140-6736(15)60658-4).
- R Core Team. (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. Retrieved from <https://www.R-project.org/>. Accessed 16 Oct 2018.
- Reyna, V. F., Wilhelms, E. A., McCormick, M. J., & Weldon, R. B. (2015). Development of risky decision making: Fuzzy-trace theory and neurobiological perspectives. *Child Development Perspectives, 9*, 122–127. <https://doi.org/10.1111/cdep.12117>.
- Salazar, L. F., Bradley, E. L. P., Younge, S. N., Daluga, N. A., Crosby, R. A., Lang, D. L., & DiClemente, R. J. (2010). Applying ecological

- perspectives to adolescent sexual health in the United States: Rhetoric or reality? *Health Education Research*, 25, 552–562. <https://doi.org/10.1093/her/cyp065>.
- Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*, 277, 918–924. <https://doi.org/10.1126/science.277.5328.918>.
- Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing “neighborhood effects”: Social processes and new directions in research. *Annual Review of Sociology*, 28, 443–478. <https://doi.org/10.1146/annurev.soc.28.110601.141114>.
- Sawyer, S. M., Afifi, R. A., Bearinger, L. H., Blakemore, S.-J., Dick, B., Ezeh, A. C., & Patton, G. C. (2012). Adolescence: A foundation for future health. *Lancet*, 379, 1630–1640. [https://doi.org/10.1016/S0140-6736\(12\)60072-5](https://doi.org/10.1016/S0140-6736(12)60072-5).
- Schlüter-Müller, S., Goth, K., Jung, E., & Schmeck, K. (2015). Assessment and treatment of identity pathology during adolescence. *Scandinavian Journal of Child and Adolescent Psychiatry and Psychology*, 3, 63–70. <https://doi.org/10.21307/sjcapp-2015-006>.
- Schroder, K. E., Carey, M. P., & Vanable, P. A. (2003). Methodological challenges in research on sexual risk behavior: II. Accuracy of self-reports. *Annals of Behavioral Medicine*, 26, 104–123. https://doi.org/10.1207/S15324796ABM2602_03.
- Selikow, T., Ahmed, N., Flisher, A. J., Mathews, C., & Mukoma, W. (2009). I am not “umqwayito”: A qualitative study of peer pressure and sexual risk behaviour among young adolescents in Cape Town, South Africa. *Scandinavian Journal of Public Health*, 37, 107–112. <https://doi.org/10.1177/1403494809103903>.
- Shisana, O., Rehle, T., Simbayi, L., Zuma, K., Jooste, S., Zungu, N., ... Onoya, D. (2014). *South African National HIV Prevalence, Incidence and Behaviour Survey, 2012*. Cape Town: Human Sciences Research Council Press.
- Small, S. A., & Kerns, D. (1993). Unwanted sexual activity among peers during early and middle adolescence: Incidence and risk factors. *Journal of Marriage and the Family*, 55, 941–952. <https://doi.org/10.2307/352774>.
- Ssewanyana, D., Mwangala, P. N., van Baar, A., Newton, C. R., & Abubakar, A. (2018). Health risk behaviour among adolescents living with HIV in sub-Saharan Africa: A systematic review and meta-analysis. *BioMed Research International*, 2018, 7375831. <https://doi.org/10.1155/2018/7375831>.
- Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, 28, 78–106. <https://doi.org/10.1016/j.dr.2007.08.002>.
- Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). New York: Pearson.
- Tenkorang, E. Y., & Maticka-Tyndale, E. (2014). Assessing young people’s perceptions of HIV risks in Nyanza, Kenya: Are school and community level factors relevant? *Social Science and Medicine*, 116, 93–101. <https://doi.org/10.1016/j.socscimed.2014.06.041>.
- Tomé, G., Matos, M., Simões, C., Diniz, J. A., & Camacho, I. (2012). How can peer group influence the behavior of adolescents: Explanatory model. *Global Journal of Health Science*, 4, 26–35. <https://doi.org/10.5539/gjhs.v4n2p26>.
- Toska, E., Pantelic, M., Meinck, F., Keck, K., Haghghat, R., & Cluver, L. (2017). Sex in the shadow of HIV: A systematic review of prevalence, risk factors, and interventions to reduce sexual risk-taking among HIV-positive adolescents and youth in sub-Saharan Africa. *PLoS One*, 12, e0178106. <https://doi.org/10.1371/journal.pone.0178106>.
- Valdimarsdóttir, M., & Bernburg, J. G. (2015). Community disadvantage, parental network, and commitment to social norms: Multilevel study of self-reported delinquency in Iceland. *Journal of Research in Crime and Delinquency*, 52, 213–244. <https://doi.org/10.1177/0022427814548685>.
- van de Bongardt, D., Reitz, E., Sandfort, T., & Deković, M. (2014). A meta-analysis of the relations between three types of peer norms and adolescent sexual behavior. *Personality and Social Psychology Review*, 19, 203–234. <https://doi.org/10.1177/1088868314544223>.
- van der Zwaluw, C., Scholte, R., Vermulst, A., Buitelaar, J., Verkes, R., & Engels, R. (2008). Parental problem drinking, parenting, and adolescent alcohol use. *Journal of Behavioral Medicine*, 31, 189–200. <https://doi.org/10.1007/s10865-007-9146-z>.
- Weybright, E. H., Caldwell, L. L., Ram, N., Smith, E. A., & Wegner, L. (2016). Trajectories of adolescent substance use development and the influence of healthy leisure: A growth mixture modelling approach. *Journal of Adolescence*, 49, 158–169. <https://doi.org/10.1016/j.adolescence.2016.03.012>.
- Wilkinson, A. L., El-Hayek, C., Fairley, C. K., Roth, N., Tee, B. K., McBryde, E., ... Stoové, M. (2017). Measuring transitions in sexual risk among men who have sex with men: The novel use of latent class and latent transition analysis in HIV sentinel surveillance. *American Journal of Epidemiology*, 185, 627–635. <https://doi.org/10.1093/aje/kww239>.
- Williams, R. (2016). Understanding and interpreting generalized ordered logit models. *The Journal of Mathematical Sociology*, 40, 7–20. <https://doi.org/10.1080/0022250X.2015.1112384>.
- Winward, J. L., Hanson, K. L., Tapert, S. F., & Brown, S. A. (2014). Heavy alcohol use, marijuana use, and concomitant use by adolescents are associated with unique and shared cognitive decrements. *Journal of the International Neuropsychological Society*, 20, 784–795. <https://doi.org/10.1017/S1355617714000666>.
- Zuma, K., Shisana, O., Rehle, T. M., Simbayi, L. C., Jooste, S., Zungu, N., ... Abdullah, F. (2016). New insights into HIV epidemic in South Africa: Key findings from the National HIV Prevalence, Incidence and Behaviour Survey, 2012. *African Journal of AIDS Research*, 15, 67–75. <https://doi.org/10.2989/16085906.2016.1153491>.

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.