Objective: To test the efficacy of a school-based human immunodeficiency virus/sexually transmitted disease (HIV/STD) risk-reduction intervention for South African adolescents.

Design: A cluster-randomized, controlled design with assessments of self-reported sexual behavior collected before intervention and 3, 6, and 12 months after intervention.

Setting: Primary schools in a large, black township and a neighboring rural settlement in Eastern Cape Province, South Africa.

Participants: Nine of 17 matched pairs of schools were randomly selected. Sixth-grade students with parent or guardian consent were eligible.

Interventions: Two 6-session interventions based on behavior-change theories and qualitative research. The HIV/STD risk-reduction intervention targeted sexual risk behaviors; the attention-matched health promotion control intervention targeted health issues unrelated to sexual behavior.

Outcome Measures: The primary outcome was self-report of unprotected vaginal intercourse in the previous 3 months averaged over the 3 follow-ups. Secondary outcomes were other sexual behaviors.

Results: A total of 1057 (94.5%) of 1118 eligible students (mean age, 12.4 years) participated, with 96.7% retained at the 12-month follow-up. Generalized estimating equation analyses adjusted for clustering from 18 schools revealed that, averaged over the 3 follow-ups, a significantly smaller percentage of HIV/STD risk-reduction intervention participants reported having unprotected vaginal intercourse (odds ratio [OR], 0.51; 95% confidence interval [CI], 0.30-0.85), vaginal intercourse (OR, 0.62; 95% CI, 0.42-0.94), and multiple sexual partners (OR, 0.50; 95% CI, 0.28-0.89), when adjusted for baseline prevalences, compared with health-promotion control participants.

Conclusion: This is the first large-scale, community-level, randomized intervention trial to show significant effects on the HIV/STD sexual risk behavior of South African adolescents in the earliest stages of entry into sexual activity.

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pothesized that fewer participants in the HIV/STD risk-reduction intervention compared with the health-promotion control intervention would report unprotected vaginal intercourse during a 12-month follow-up period.

METHODS

Institutional review board No. 8 at the University of Pennsylvania, which was the designated institutional review board under the federal-wide assurances of the University of Pennsylvania and the University of Fort Hare, reviewed and approved the study. The institutional review board at the Centers for Disease Control and Prevention deferred approval to the institutional review board at University of Pennsylvania. The study was conducted in Mdantsane, an urban township (population, 177,816 persons), and Berlin (population, 2271 persons), a neighboring rural settlement near East London in Eastern Cape Province, South Africa, where Xhosa is the first language for 95.1% of the population.17 The apartheid regime created Mdantsane, the second largest South African township after Soweto, as living space for cheap African labor. Schools that taught sixth-grade students and served the general population were eligible to participate. There were 36 primary schools in Mdantsane and Berlin. One school for children with learning disabilities was ineligible, leaving 35 eligible schools, 26 in Mdantsane and 9 in Berlin. All 35 eligible schools agreed to participate in the trial. We created 17 matched pairs of schools that had similar numbers of sixth-grade students, classrooms, and classrooms with electricity—a proxy for poverty. We matched urban and rural schools separately. From the 17 matched pairs, we randomly selected 9 pairs; 7 pairs were composed of urban schools and 2 were composed of rural schools.

We used a cluster-randomized controlled trial design. Within each pair, using computer-generated random number sequences, we randomized 1 school to the HIV/STD risk-reduction intervention and the other to the health-promotion control intervention using concealment of allocation techniques designed to minimize bias in assignment of randomized clinical trials. The biostatistician (S.J.B.) in Philadelphia, Pennsylvania, conducted the computer-generated random assignments, and the project director (S.F.J.) in East London, South Africa, implemented the assignments. We enrolled the schools in the trial during a 13-month period beginning in October 2004, with all data collection completed by December 2006.

To recruit participants, Xhosa-speaking community members made announcements at the selected schools and distributed letters and consent forms for parent or guardians to all sixth-grade students. At the time of recruitment, school administrators, potential participants, and recruiters were blind to the specific intervention to which the school had been randomized, and recruiters followed a common standardized scripted recruitment procedure at all schools. At 12 schools, sixth-grade students who had written parent or guardian consent were eligible to participate. At 6 schools, where there were too few classrooms to accommodate all students who had consent, we randomly selected students as eligible from among those with consent.

We held the intervention and data collection sessions at the students’ schools during the extracurricular period at the end of the school day. Participants completed confidential questionnaires before and at 3, 6, and 12 months after the intervention. Students who completed the preintervention questionnaire and attended session 1 of the intervention were enrolled in the trial. Participants were compensated with a notebook, pen, and pencil for the 3-month follow-up; a T-shirt for the 6-month follow-up; and a backpack for the 12-month follow-up.

ASSESSMENTS

Assessments were conducted before, immediately after, and 3, 6, and 12 months after intervention via confidential questionnaires.
naries that were written in Xhosa following translation and back-translation from English. We pilot tested the questionnaire with 64 sixth-grade students from Mdantsane and Berlin. Adults from the community who were bilingual in Xhosa and English and blind to the participants' intervention assignment implemented a read-aloud procedure; students completed questionnaires at their desks while data collectors read the questions aloud. Data collectors received 2-day training that included modeling of data collection procedures and practice with performance feedback.

The primary outcome was report of unprotected vaginal intercourse measured using the question, “In the past three months, on how many days did you have vaginal intercourse without using a condom?” Vaginal intercourse was defined as “your penis in a female’s vagina” (male version) or “a boy’s penis in your vagina” (female version). Participants’ responses were coded 1 if they did not have vaginal intercourse without using a condom and 2 if they did have vaginal intercourse without using a condom. Secondary outcomes included sexual experience and recent vaginal intercourse, heterosexual anal intercourse, and multiple partners. Sexual experience was assessed using the question, “Have you ever had vaginal intercourse?” Questions regarding recent sexual activity used a 3-month reporting period. Recent vaginal intercourse was assessed using the appropriate sex-specific item, “In the past three months, did you have vaginal intercourse with a female (male)?” Similarly, recent heterosexual anal intercourse was assessed using the item, “In the past three months, have you had anal intercourse with a female?” (male version). Anal intercourse was defined using the term “anus/behind.” Having multiple partners was measured using the question, “In the past three months, how many females (male version) have you had vaginal intercourse with?” Participants’ responses were coded 1 if they had fewer than 2 partners and 2 if they had 2 or more partners.

We took several steps to increase the validity of self-reported sexual behavior. To facilitate the students’ ability to recall, we asked them to report their behaviors during a brief period (ie, past 3 months),27 wrote the dates comprising the period on a chalkboard, and gave them calendars clearly highlighting the period. We stressed the importance of responding honestly, informing them that their responses would be used to create programs for other Xhosa-speaking adolescents like themselves and that we could do so only if they answered the questions honestly. We assured the participants that their responses would be kept confidential and that code numbers rather than names would be used on the questionnaires. Participants signed an agreement pledges to answer the questions honestly, a procedure that has been shown to yield more valid self-reports regarding sensitive issues.28

SAMPLE SIZE AND STATISTICAL ANALYSIS

The a priori unit of inference in this trial was the individual. A sample size calculation was performed to detect an a priori effect size of Cohen $d = 0.25$ on unprotected intercourse, adjusting for expected variance inflation due to clustering.29 We chose $d = 0.25$ based on a meta-analysis of HIV risk-reduction intervention studies30 because, at the study’s onset, no data were available on which to base an effect-size estimate specific to the study population. Based on pilot data, we estimated an intraclass correlation coefficient of 0.00864. Assuming $\alpha = 0.05$, a 2-tailed test, intraclass correlation coefficient $= 0.00864$, $d = 0.25$, 20% attrition at 12-month follow-up, and $n = 1100$ sixth-grade students enrolled in the trial from 16 schools with an average of 67 students in each school, the trial was estimated to have 80% power to detect $d = 0.25$ effect of the intervention.

Later we decided to match schools in pairs and randomize them to interventions, although we ignored the pairing in the analyses because of the small number of pairs.31,32 Before analyzing intervention efficacy, we used $\chi^2$ and t tests to analyze attrition. In the primary analyses, the efficacy of the HIV/STD intervention compared with the health-promotion control intervention over the 3-, 6-, and 12-month follow-ups was tested using generalized estimating equation models, properly adjusting for longitudinal repeated measurements on students clustered within schools.33,34 The models were fit, and contrast statements were specified to obtain estimated odds ratios and corresponding 95% confidence intervals. Robust standard errors were used, and an exchangeable working correlation matrix was specified. The models included time-independent covariates, baseline measure of the criterion, intervention condition, and time (3 categories representing 3-, 6-, and 12-month follow-ups). However, analyses of sexual debut did not control for baseline because it was restricted to those who were sexually inexperienced at baseline. We report estimated average intervention effects over the 3 follow-ups constructed from appropriate estimate statements from fitted generalized estimating equation models and $d$ values, calculated by transforming the odds ratios using Cox transformation.35 Models assessing whether the efficacy of the intervention differed among the 3 follow-ups included the baseline measure of the criterion, intervention condition, time, and the intervention condition × time interaction.

We had intended to examine self-reported consistent condom use as a secondary outcome measure but too few participants reported sexual intercourse at baseline to allow for meaningful analyses of changes over time in condom use. Also, because of the low percentage of participants who reported sexual intercourse, we examined binary measures rather than counts of sexual behaviors in the previous 3 months. Analyses were performed using an intent-to-treat mode, with participants analyzed based on their intervention assignment, regardless of the number of intervention or data-collection sessions attended. These analyses were completed using SAS version 9 (SAS Inc, Carey, North Carolina).

We conducted analyses of school-level intervention effects to confirm the robustness of our findings from individual-level analyses. We used meta-analyses36 that allowed us to take into account the number of students in each pair of schools, giving more weight to larger pairs, similar to weighing larger studies more than smaller studies in a meta-analysis. This analytic approach also allowed us to examine whether the intervention effect size varied among the pairs of schools, just as a meta-analyst might test whether effect sizes were heterogeneous among trials. After fitting generalized estimating equation models as previously described, we constructed mean estimated proportions for each outcome for each school ($n = 18$). We treated the estimated intervention difference for each pair as a study and constructed corresponding pooled estimates of intervention differences and 95% confidence intervals based on the 9 pairs using the “metan” command in Stata version 10 (Stata Corp, College Station, Texas), assigning weights to each pair proportional to the size of schools within pairs. Finally, we constructed an 8-degree-of-freedom test of whether intervention effects were heterogeneous across pairs.

RESULTS

Of the 1898 sixth-grade students enrolled at the schools, 1396 (73.6%) returned signed consent forms, 1118 were eligible to participate, and 1057 (94.5%) participated. Table 1 shows that 538 girls and 499 boys participated. Their ages ranged from 9 to 18 years (mean [SD], 12.4 [1.2] years); 7.6% resided in Berlin; and the others resided in Mdantsane. Only 38.8% lived in a household with their father.
As shown in the Figure, all 18 schools remained in the trial to its completion. All participants attended intervention session 1; attendance at sessions 2 through 6 ranged from 97.0% to 98.6%. Follow-up return rates were excellent: 1029 (97.4%) completed the 3-month follow-up; 1030 (97.4%), the 6-month follow-up; 1022 (96.7%), the 12-month follow-up. The percentage who attended at least 1 follow-up ranged from 97.0% to 98.6%. Follow-up return rates were not different between the HIV/STD risk-reduction (98.8%) and control interventions (98.6%). Attending a follow-up session was unrelated to sex, father’s presence in the household, residing in Berlin, or sexual behavior. However, participants aged 14 to 18 years (96.0%) were less likely to return for follow-up than those aged 12 to 13 (99.2%) or 9 to 11 years (99.2%) (P = .003).

**EFFECTS OF HIV/STD RISK-REDUCTION INTERVENTION**

**Primary Outcome Measures**

**Table 2** presents descriptive statistics for sexual behaviors by intervention condition and assessment period. **Table 3** presents estimated intervention effects during the follow-up period, corresponding significance tests (both unadjusted and adjusted for baseline outcome), and intraclass correlation coefficients. A smaller percentage of participants in the HIV/STD risk-reduction intervention schools reported having unprotected vaginal intercourse in the past 3 months, averaged over follow-up (2.2%), compared with their counterparts in health-promotion control schools (4.2%), controlling for baseline unprotected vaginal intercourse (P = .01; d = 0.41).

**Secondary Outcome Measures**

Averaged over follow-up, participants in the HIV/STD risk-reduction intervention were significantly less likely to report having vaginal intercourse (4.75% vs 7.20%; P = .02; d = 0.29) and multiple sexual partners (1.83% vs 3.19%; P = .02; d = 0.42) in the previous 3 months than participants in the health-promotion control intervention, controlling for baseline prevalences.

At baseline, 96.7% of participants reported never having vaginal intercourse. Boys were less likely than girls to report sexual inexperience (93.5% vs 99.5%; P < .001). Although the percentage who were sexually inexperienced decreased to 76.8% by the 12-month follow-up, the effect of the intervention on sexual inexperience was nonsignificant. In addition, although the participants in the HIV/STD risk-reduction intervention were less likely to report having heterosexual anal intercourse in the pre-
Our results indicate that a theory-based, contextually appropriate HIV/STD risk-reduction intervention delivered in schools can be effective in shaping the sexual behavior of young adolescents before or at the beginning of their sexual lives. Averaged over the 3 follow-ups, the intervention reduced by approximately 50% the percentage of adolescents who reported unprotected vaginal intercourse compared with a health-promotion attention intervention. Moreover, the intervention’s efficacy did not differ significantly among the 3 follow-up assessment periods.

This study also revealed that, averaged over the 3 follow-ups, vaginal intercourse with multiple partners was reduced approximately 50% by the intervention compared with the control intervention. This is important because multiple partners, particularly concurrent partners, is believed to play a critical role in the spread of HIV.37,38 Interestingly, although the intervention produced a significant reduction in self-reported vaginal intercourse in the previous 3 months, it did not delay sexual debut. This contrasts with the results of a study with adolescents in Namibia9 in which the intervention delayed sexual debut but did not reduce recent vaginal intercourse.

The rates of sexual activity in this sample of young adolescents were relatively low, which presents challenges in achieving adequate statistical power. Despite this, we obtained significant effects on important sexual behavior outcomes. That school-level analyses confirmed the primary individual-level analyses strengthens confidence in the findings. Some might reason that,

### Table 2. Students Reporting Sexual Behaviors, HIV/STD Knowledge, and Self-efficacy Outcomes by Intervention Condition and Assessment Period

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>No./Total (%) by Intervention</th>
<th>Month</th>
<th>Baseline</th>
<th>Health-Promotion (n=547)</th>
<th>3</th>
<th>6</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unprotected vaginal intercourse in the past 3 mo</td>
<td>4/561 (0.71)</td>
<td>3/495 (0.61)</td>
<td>9/543 (1.66)</td>
<td>20/485 (4.12)</td>
<td>14/545 (2.57)</td>
<td>20/482 (4.15)</td>
<td>12/545 (2.20)</td>
</tr>
<tr>
<td>Vaginal intercourse in the past 3 mo</td>
<td>7/560 (1.25)</td>
<td>5/495 (1.01)</td>
<td>18/543 (3.31)</td>
<td>35/485 (7.22)</td>
<td>31/547 (5.67)</td>
<td>33/482 (6.85)</td>
<td>27/545 (4.95)</td>
</tr>
<tr>
<td>Multiple sexual partners in the past 3 mo</td>
<td>4/560 (0.71)</td>
<td>1/494 (0.20)</td>
<td>8/544 (1.47)</td>
<td>18/484 (3.72)</td>
<td>12/546 (2.20)</td>
<td>16/482 (3.32)</td>
<td>9/544 (1.65)</td>
</tr>
<tr>
<td>Sexually inexperienced</td>
<td>533/557 (95.7)</td>
<td>481/492 (97.8)</td>
<td>459/544 (84.4)</td>
<td>414/485 (85.4)</td>
<td>433/547 (79.2)</td>
<td>391/483 (81.0)</td>
<td>418/545 (76.7)</td>
</tr>
<tr>
<td>Anal intercourse in the past 3 mo</td>
<td>3/561 (0.53)</td>
<td>4/495 (0.81)</td>
<td>9/544 (1.65)</td>
<td>15/484 (3.10)</td>
<td>5/547 (0.91)</td>
<td>14/483 (2.90)</td>
<td>17/545 (3.12)</td>
</tr>
</tbody>
</table>

Abbreviations: HIV/STD, human immunodeficiency virus/sexually transmitted disease.

### Table 3. GEE Empirical Significance Tests and Effect Size Estimates for the Overall Intervention Effect (3-, 6-, and 12-mo Follow-up Assessments) Unadjusted for Baseline Prevalence and Adjusted for Baseline Prevalence

<table>
<thead>
<tr>
<th>Outcome</th>
<th>ICC a</th>
<th>OR (95% CI)</th>
<th>P Value</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unprotected vaginal intercourse in the past 3 mo</td>
<td>0.007</td>
<td>0.52 (0.31-0.87)</td>
<td>.01</td>
<td>0.51 (0.30-0.85)</td>
<td>.01</td>
</tr>
<tr>
<td>Vaginal intercourse in the past 3 mo</td>
<td>0.005</td>
<td>0.62 (0.42-0.94)</td>
<td>.02</td>
<td>0.62 (0.42-0.94)</td>
<td>.02</td>
</tr>
<tr>
<td>Multiple sexual partners in the past 3 mo</td>
<td>0.005</td>
<td>0.55 (0.31-0.98)</td>
<td>.04</td>
<td>0.50 (0.28-0.89)</td>
<td>.02</td>
</tr>
<tr>
<td>Sexually inexperienced</td>
<td>0.007</td>
<td>1.05 (0.76-1.45)</td>
<td>.78</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Anal intercourse in the past 3 mo</td>
<td>0.003</td>
<td>0.58 (0.33-1.02)</td>
<td>.06</td>
<td>0.60 (0.34-1.05)</td>
<td>.07</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; ellipses, analysis not conducted; GEE, generalized estimating equation; ICC, intraclass correlation coefficient; OR, odds ratio.

aThe ICCs were estimated by fitting a model using the GEE approach and assuming an exchangeable working correlation structure with a logit link, unadjusted for baseline, controlling for clustering of students within schools (n=18).
because we applied Western theories to behavioral change in sub-Saharan Africa, intervention effects would be weak. However, the effects were at least as strong as those in meta-analyses of interventions for adolescents in the United States.43-48 The approach of integrating behavior-change theories with qualitative information from the population, then, may yield an efficacious, contextually appropriate intervention.

Anal intercourse carries considerably higher risk of HIV transmission than vaginal intercourse.49 Although the intervention effect on anal intercourse only approached statistical significance in the individual-level analysis, the school-level analysis revealed that the HIV/STD intervention produced a significant reduction in anal intercourse compared with the control intervention.

This study has several methodological strengths. It was conducted with young people in the context of a generalized HIV epidemic. The intervention was developed using both behavior-change theories and extensive formative research and delivered by well-trained cofacilitators who used manualized content. Participants were blind to intervention condition before enrollment, thus avoiding differential self-selection bias.49 Matched pairs of schools were randomized to conditions, an attention-control intervention was used, no schools withdrew from the study, and enrollment rates, intervention attendance, and follow-up retention were excellent, strengthening internal validity. Schools were randomly selected, strengthening generalizability to other schools in the area. In addition, the analyses appropriately adjusted for clustering among participants in schools assessed longitudinally.

A limitation of the study is the reliance on self-reports of behavior. Using incidence of STDs or HIV as an outcome was not feasible in our population with a 96.7% rate of sexual inexperience. Another limitation is that the results may not generalize to all South African adolescents. Few studies have been conducted with South African individuals as young as our participants. Three studies that included adolescents comparable in age with our participants revealed rates of self-reported sexual inexperience greater than42,48,49 or similar to50 those we observed.

In conclusion, sexual transmission of HIV is a major risk faced by adolescents in sub-Saharan Africa, and interventions are needed urgently to reduce their risk. This study provides the first evidence that a theory-based, contextually appropriate intervention can reduce sexual risk behaviors, particularly unprotected vaginal intercourse, vaginal intercourse, and multiple partners, among young South African adolescents in the earliest stages of their sexual lives. Future research with more sexually experienced adolescents will have to explore whether such interventions can have an effect on condom use and STDs, including HIV.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention. Previous Presentations: Some data reported in this article were presented at the XVII International AIDS Conference; August 7, 2008; Mexico City, Mexico. Additional Contributions: The authors appreciate the contributions of Sonya Coombs, Costa Gazii, MD, Lynnette Gueits, MS, Nicole Hewitt, PhD, Janet Hsu, BA, Xoliswa Mtose, MEd, Pretty Ndyebi, Mwezeni Nela, PhD, Robert Shell, PhD, Lulama Sidloyi, Gladys Thomas, MSW, MBA, Dalena White, MBA, and Tukufu Zuberi, PhD. The authors gratefully acknowledge the comments of Tom TenHave, PhD, regarding the statistical analysis.

REFERENCES


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