

Adolescent Sexual Behavior, Drug Use, and Violence: Increased Reporting with Computer Survey Technology

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Surveys of risk behaviors have been hobbled by their reliance on respondents to report accurately about engaging in behaviors that are highly sensitive and may be illegal. An audio computer-assisted self-interviewing (audio-CASI) technology for measuring those behaviors was tested with 1690 respondents in the 1995 National Survey of Adolescent Males. The respondents were randomly assigned to answer questions using either audio-CASI or a more traditional self-administered questionnaire. Estimates of the prevalence of male-male sex, injection drug use, and sexual contact with intravenous drug users were higher by factors of 3 or more when audio-CASI was used. Increased reporting was also found for several other risk behaviors.

A small number of national surveys using large, representative samples of the United States and other populations have attempted to assess the sexual and drug-using behaviors that risk transmission of the human immunodeficiency virus (HIV) that causes acquired immunodeficiency syndrome (AIDS) (1). Because sexual activity is typically initiated in adolescence or early adulthood and because that period for many young people is characterized by greater amounts of experimentation, partner change, and risk taking than in later years, research programs with a focus on the behaviors of adolescents and young adults are of particular importance (2). AIDS is not, however, the only threat faced by young people. Interpersonal violence represents an even greater threat of morbidity and mortality (3); consequently, interpersonal violence has also received greater scrutiny in recent surveys of the adolescent and young adult population. Yet concerns have surfaced regarding the quality of survey measurements of such sensitive behaviors (4, 5). The concern most often cited is that respondents may be reluctant to report accurately about sensitive or stigmatized behaviors in which they have engaged. (Reservations are particularly strong in situations in which teenage respondents are asked to tell an adult interviewer whether,

for example, they have had a certain sexual experience or used a certain drug.) In one study (5), it was estimated that survey measurements that relied upon women's responses to questions about their abortion history during a face-to-face interview captured only 35% of the abortions performed in the United States (a conclusion based on aggregate data supplied by abortion providers for the 1984–1987 period).

The level of privacy that an interviewing mode affords a respondent can dramatically affect survey measurements of sensitive behaviors (5–7). Traditionally, surveys have attempted to encourage more accurate reporting of sensitive behaviors by allowing respondents to complete a paper-and-pencil self-administered questionnaire (paper SAQ), which they can seal in an envelope and return to the interviewer. Paper SAQs, however, require that respondents be sufficiently literate to complete a written questionnaire. In addition, because a respondent's answers together with their identification number are recorded on a paper form, some respondents may remain suspicious about the privacy of their responses. Another criticism of paper SAQs is that extensive use of contingent questioning (that is, branching or skip patterns) is difficult. Even literate respondents may have trouble following instructions for navigating through a complex self-administered form (8).

Audio-CASI technology. A computer-driven technology has been developed that can administer complex survey questionnaires in an audio format and record re-

spondents' answers without the direct participation of a survey interviewer (9). This approach, audio computer-assisted self-interviewing (audio-CASI), allows respondents to listen over headphones to spoken questions that have been digitally recorded and stored on a laptop computer. To answer, respondents press numbered keys on the computer keyboard. Questions are also displayed on the computer's screen, and respondents may respond to the visual presentation of the question rather than waiting until the audio reading has been completed. Respondents can thus answer questions in complete privacy, even if their reading ability is limited. Because survey data are stored on the drives of the computer, they are less vulnerable to inadvertent disclosure to interviewers or others. Audio-CASI also provides (10) (i) a completely standardized measurement system—every respondent (in a given language) hears the same question asked in exactly the same way; (ii) computer-controlled branching through complex questionnaires and automated consistency and range checking; and (iii) efficient multilingual administration of surveys (10, 11).

Here we report the use of this technology in a large-scale national survey, the 1995 National Survey of Adolescent Males (NSAM), which included a randomized experiment to assess the effect of this technology on the measurement of sensitive behaviors. This study was begun in January 1995 and it measured HIV-risk behaviors, drug use, and interpersonal violence among young men in the United States.

Since 1988, NSAM has tracked the sexual, contraceptive, HIV-risk, and other behaviors of a national probability sample of young men who were 15 to 19 years of age in 1988 (12). Past data have presented some intriguing methodological puzzles. A case in point is the measurement of male-male sexual contacts. Because of the potential sensitivity of reporting such behavior, the relevant NSAM questions were presented in a paper SAQ instead of being administered by the interviewer. We expected that use of this more private mode of survey administration would encourage more accurate reporting of the behavior. We found, however, that the proportion of males reporting such contacts in 1988 (2.2%) was lower than would be expected on the basis of surveys of adult men, which have recorded retrospective reports of adolescent male-male sexual behaviors of 4 to 9% (13). Further evidence of the difficulty of making such measurements was provided by the rescissions that occurred in these NSAM reports between 1988 and 1991. Eleven of the 30 young men who reported having had an oral or anal male-male contact in the

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1988 NSAM survey reported that they had never had such contacts when they were interviewed again in the 1991 survey. [Paper SAQs were used in prior rounds of the survey (14).] These considerations and our desire to increase the actual and perceived privacy of the 1995 NSAM interview context motivated us to use audio-CASI technology for measurements of the most sensitive behaviors among the new cohort of 15- to 19-year-olds recruited in the 1995 round of the survey.

Survey sample and experiment. We drew a multistage area probability sample from the population of males ages 15 to 19 who were living in households in the continental United States between February and November 1995 (15). Black and Hispanic males were oversampled. To obtain the final sample, we screened 54,265 housing units out of the 56,199 that were eligible for screening. The process identified 2240 eligible males; we completed interviews with 1729 of them. After adjusting for the 3.4% of housing units that could not be

screened, we had an overall response rate of 75% (16). (The major reasons for nonresponse were refusal by the respondent, refusal by the parent of the potential respondent, and unavailability of the potential respondent after repeated visits.) Of the 1729 young men who completed the interview, 1690 (97.7%) also completed a self-administered interview containing questions on topics that were potentially quite sensitive (including same-gender sex, drug use, and violent behaviors).

Sample weights were used to adjust for the different initial probabilities of sample selection and subsequent nonresponse. Poststratification adjustments were applied

to align the NSAM sample estimates with 1995 population estimates from the Bureau of the Census (17). To represent accurately the effect of this sample weighting and the stratified and clustered design used in drawing the 1995 NSAM sample, we used statistical software (18) that adjusted variances for our sample estimates to reflect the complex design. Our statistical inferences are intended to generalize to the universe of (noninstitutionalized) U.S. males ages 15 to 19 (Table 1).

By design, the sample included almost as many Hispanic and black respondents as white ones (Table 1). That pattern reflects our oversampling of those minorities and

Table 1. Selected social and demographic characteristics of the 1995 NSAM respondents who completed self-administered interviews. (Wgt. %, weighted percent.)

| Characteristic | N | Wgt. %* |
|---------------------------------------|------|---------|
| Race-ethnicity | | |
| Black | 474 | 14.0 |
| White | 605 | 68.4 |
| Hispanic | 539 | 12.5 |
| Other | 54 | 5.1 |
| Age | | |
| 15 years | 391 | 21.2 |
| 16 years | 371 | 20.0 |
| 17 years | 354 | 20.4 |
| 18 years | 317 | 19.1 |
| 19 years | 239 | 19.3 |
| Last year of school completed† | | |
| Currently enrolled | | |
| 8th grade or less | 262 | 14.1 |
| 9th to 11th grade | 943 | 54.0 |
| 12th grade | 116 | 7.3 |
| Some college | 45 | 3.9 |
| Not currently enrolled | | |
| 8th grade or less | 13 | 0.6 |
| 9th to 11th grade | 145 | 9.7 |
| 12th grade | 122 | 8.9 |
| Some college | 11 | 1.5 |
| Parents' education‡ | | |
| 8 years or less | 112 | 2.8 |
| 9 to 11 years | 128 | 6.4 |
| 12 years | 587 | 34.9 |
| 13 to 15 years | 285 | 18.7 |
| 16 or more years | 466 | 37.2 |
| Currently married | 18 | 1.5 |
| Unweighted N | 1672 | |

*Estimates are weighted to correct for unequal probabilities of selection and nonresponse. †Highest grade of school or year of college completed. ‡Highest grade or year of school completed by any parent or step-parent living in the household.

Table 2. Alternate estimates of prevalence of male-female and male-male sexual behaviors among 1995 NSAM respondents obtained by using different methods of questioning. For Tables 2 to 5 the odds ratio (OR) is adjusted (Adj.) for covariates [race (white, black, other as residual category), whether they have health insurance, age, whether they currently attend school, and whether they had sexual intercourse with a female], as reported in the interviewer-administered portion of the survey.

| Measurement | Estimated prevalence (per 100) | | Crude OR | Adj. OR |
|--|--------------------------------|------------|----------|---------|
| | Paper SAQ | Audio-CASI | | |
| <i>Male-female sexual contacts</i> | | | | |
| Ever had sex with a prostitute† | 0.7 | 2.5 | 3.65*** | 4.24*** |
| Ever been paid for sex‡ | 1.6 | 3.8 | 2.36* | 2.60 |
| Sexual intercourse with female within last year§ | 49.6 | 47.8 | 0.93 | 1.24 |
| 5+ lifetime female partners§ | 15.8 | 18.8 | 1.23 | 1.57* |
| Condom use at last sex (among males reporting sex)§ | 64.4 | 64.0 | 0.98 | 1.01 |
| Ever had anal intercourse w/female | 10.3 | 11.4 | 1.13 | 1.26 |
| Ever made girl pregnant§ | 7.9 | 6.5 | 0.81 | 0.98 |
| Ever fathered a child§ | 4.6 | 2.4 | 0.51 | 0.59 |
| Ever had vaginal, oral, or anal intercourse with female¶ | 68.1 | 63.9 | 0.83 | 0.81 |
| <i>Male-male sexual contacts</i> | | | | |
| Ever masturbated another male | 1.4 | 2.6 | 1.94 | 2.25* |
| Ever been masturbated by another male | 0.9 | 3.5 | 3.79** | 4.23* |
| Ever had receptive oral sex with another male (your mouth on his penis) | 0.5 | 2.3 | 5.08** | 5.68* |
| Ever had insertive oral sex with another male (your penis in his mouth) | 1.1 | 3.1 | 2.83* | 3.50* |
| Ever had insertive anal sex with another male (your penis in his rectum or butt) | 1.0 | 1.9 | 1.85 | 2.41 |
| Ever had receptive anal sex with another male (his penis in your rectum or butt) | 0.1 | 0.8 | 7.91*** | 7.85** |
| Any male-male sex | 1.5 | 5.5 | 3.84*** | 4.20*** |

*P = 0.15 or less for two-tailed test of null hypothesis that OR = 1.0. **P = 0.05 or less for two-tailed test of null hypothesis that OR = 1.0. ***P = 0.01 or less for two-tailed test of null hypothesis that OR = 1.0. †Although we have listed contact with a prostitute under male-female behaviors, the question was not gender-specific. It is possible that some contacts were with a male prostitute. ‡A total of 59 respondents reported ever being paid for sex; of those, 88% reported being paid by a female or females, 7% by a male(s), and 5% by both male(s) and female(s). An additional 11 respondents in the paper SAQ (not included in the Table 2 estimate) reported they had never been paid for sex, yet noted the gender of that person(s) in the subsequent question. §This question from the experiment repeats a question on heterosexual contact that was in the interviewer-administered portion of the survey. Because respondents may have felt compelled to answer consistently, responses to this question could be subject to a consistency bias that might have attenuated the effect of the interview mode. ||In the SAQ, respondents who reported no sexual activity were instructed to skip a series of questions on specific sexual practices. For this analysis, these respondents were recorded as not reporting this particular behavior. ¶Estimated prevalence is for responding yes to one (or more) of four questions asking whether a respondent had engaged in vaginal sex, insertive or receptive oral sex with a female, or anal sex with a female.

permits a relatively precise characterization of any differences in reported risk behaviors that may exist among the groups or in their reaction to the technology being tested in our experiment. (All subsequent tabulations use weighted data.)

All respondents initially completed an interviewer-administered survey that contained a range of questions on their relations with their peers; the sources of their education and information on sexuality and contraception; their perceptions of and attitudes toward condoms, contraceptives, and the consequences of unintended pregnancy; their heterosexual and contraceptive experiences and their knowledge and perceptions of sexually transmitted diseases (STDs); and their social background and demographic characteristics. The interviewer-administered portion of the survey lasted an average of 68 min.

Next, respondents completed a self-administered interview. This interview contained 99 of the most sensitive questions being asked in the survey, including questions on the respondent's male-male sexual experiences, drug use, STD history, experiences with violence and weapons, heterosexual oral and anal sex, and sexual orientation (19). To assess the effects of audio-

CASI versus more traditional paper SAQs on the reporting of such information, we embedded an experiment in this part of the survey. Participants were randomly assigned (at a ratio of 4:1) to a condition in which questions were administered with audio-CASI ($N = 1361$) or to a condition that used a paper SAQ ($N = 368$). Of the 1729 eligible survey respondents, 1690 completed the experiment. Because of computer problems and interviewer mistakes, a small number of those respondents ($N = 18$) were not interviewed in the mode that had been randomly assigned. These cases were excluded from our analyses. Thus, the base N for our analyses is 1672 (20).

Statistical analyses. In estimating the prevalence of reported behaviors, we focused on variations between modes of interviewing (audio-CASI versus paper SAQ). Because respondents were randomly assigned to the two interviewing conditions, the crude ratio of the odds of reporting a particular behavior in each condition provides an unbiased measure of the effect of audio-CASI on such reports relative to the more traditional paper SAQs. Our target behaviors were dichotomous variables (for example, did versus did not have male-male sex); therefore, we used log-linear modeling and logistic regression

procedures to gauge the statistical significance of any effect that was observed and to test for variations in effect across subpopulations (21). Because we wished to make inferences about the likelihood that a given effect would hold in the population at large, our analyses used the sampling weights described earlier, and our statistical tests took account of weighting and the NSAM's complex sample design (22). The P values shown in Tables 2 through 5 test the null hypothesis that given the odds ratio observed in this experiment, the "true" odds ratio would have been 1.0 (that is, no effect of audio-CASI) if the same experiment was repeated among an infinite number of similarly designed samples of the national population (23).

Although the crude odds ratio is an unbiased indicator of the effect of the survey technology, more precise measures were also calculated. Adjusted odds ratios may correct for random perturbations across experimental conditions in the distribution of factors correlated with the targeted risk behavior (24).

Estimated prevalence of risk behaviors. As shown in Table 2 (25, 26), the mode of survey administration made little difference in estimates of the prevalence of male-female sexual contacts. The only significant effect was for reporting of sexual contact with a prostitute. Respondents who were interviewed with audio-CASI were 3.6 times as likely (crude odds ratio) to report such contact as respondents who were interviewed with the paper SAQ (2.5% versus 0.7%) (27).

Although the use of audio-CASI had little effect on reporting of male-female adolescent sexual behavior, it produced highly significant increases in reports of male-male sex. Overall, respondents were almost four times as likely to report some type of male-male sex in the audio-CASI mode compared with the paper SAQ (5.5% versus 1.5%). Estimated odds ratios varied from 1.85 to 7.91 across the six measurements of passive and active masturbation and oral and anal sex with males. The individual results are not all significant, but the pattern is consistent; that is, audio-CASI was more likely than the paper SAQ to elicit a report that the respondent had engaged in male-male sex. In addition, the observed fourfold increase in the reported prevalence of male-male contact among adolescents is statistically significant ($P < 0.001$), and the estimated prevalence of such contact (5.5%) is more consistent with prevalences derived from retrospective reports provided by adult men reporting on their sexual behaviors during adolescence (4 to 9%) (13).

Table 3 presents parallel results for the reporting of drug use alone and as an adjunct to sexual behaviors. For the drug use

Table 3. Alternate estimates of prevalence of drug use, per se, and drug use during sex derived by using different methods of questioning. Results are from the 1995 NSAM.

| Measurement | Estimated prevalence (per 100) | | Crude OR | Adj. OR |
|---|--------------------------------|------------|----------|---------|
| | Paper SAQ | Audio-CASI | | |
| <i>Drug use</i> | | | | |
| Ever taken street drugs using a needle | 1.4 | 5.2 | 3.85*** | 3.90* |
| Injected drugs within last year‡ | 0.0 | 0.8 | —† | —† |
| Ever shared needle§ | 0.1 | 1.1 | 9.71** | 9.56** |
| Smoked marijuana daily during last year | 4.1 | 6.7 | 1.69* | 2.03* |
| Used crack/cocaine within last year | 3.3 | 6.0 | 1.89 | 1.96 |
| Drank alcohol last year¶ | 65.9 | 69.2 | 1.16 | 1.29 |
| Drank alcohol weekly last year# | 15.0 | 19.4 | 1.34 | 1.56* |
| Ever smoked marijuana | 41.2 | 43.3 | 1.09 | 1.30* |
| <i>Drug use and sex (among those having sex)††</i> | | | | |
| Ever had sex with someone who shoots drugs | 0.2 | 2.8 | 13.84** | 17.06** |
| You/your partner drunk or high at last heterosexual intercourse | 15.3 | 34.8 | 2.95*** | 3.04* |
| Always/often drunk or high during heterosexual intercourse last year | 2.2 | 10.8 | 5.52*** | 5.69*** |
| You/your partner had been drinking at time of last heterosexual intercourse | 13.9 | 25.4 | 2.10*** | 2.14*** |
| You/your partner used drugs at time of last heterosexual intercourse | 9.7 | 15.8 | 1.74* | 1.89* |

* $P = 0.15$ or less for two-tailed test of null hypothesis that OR = 1.0. ** $P = 0.05$ or less for two-tailed test of null hypothesis that OR = 1.0. *** $P = 0.01$ or less for two-tailed test of null hypothesis that OR = 1.0. †Odds ratio not calculated because of zero cell value. (Fisher's exact test for unadjusted frequency had a p value of 0.13 with normalized weighted data (without adjustments for impact of complex sample design and weighting). ‡Never injected drugs (question 17) recoded to no use within last year. §Never injected drugs (question 17) recoded to never shared needle. ||Never smoked marijuana (question 13) recoded to no use within last year. ¶Never drank alcohol (question 9) recoded to no alcohol use last year. #Never drank alcohol (question 9) recoded to no alcohol use last week. ††Due to questionnaire skip patterns, these questions were asked only of respondents who reported ever having sexual intercourse, including vaginal, oral, or anal intercourse with a female.

behaviors that are most commonly associated with transmission of HIV—that is, injection of illicit drugs and use of crack (a refined, smokable form of cocaine) or cocaine—the audio-CASI mode elicited substantially more reporting. Overall, the audio-CASI measurements yielded an estimate of the prevalence of injection drug use (5.2%) that is substantially higher than any prior population estimate. The estimated prevalence derived from the more traditional paper SAQ measurements was 1.4% (28).

Behaviors that commingled drug use and sex are another category that evinced a strong effect from the use of the audio-CASI technology (29). Respondents assigned to the audio-CASI condition who reported that they were sexually active were more likely than their counterparts in the SAQ condition to report that they or their partners were drunk or high when they last had heterosexual intercourse (odds ratio = 2.95); they were also more likely to report that they were “always” or “often” drunk or high when they had heterosexual sex during the past year (odds ratio = 5.5). In the audio-CASI mode, respondents who reported having sex were much more likely than SAQ respondents to report that they had had sex with someone who injected drugs (odds ratio = 13.8).

The pattern of higher estimates of prevalence in the audio-CASI mode is repeated in the NSAM measurements of violent behaviors (Table 4). Respondents in the audio-CASI mode were more likely to report that they had carried a gun in the past 30 days (12.4 versus 7.9% in the SAQ mode) (30) and to report that they had carried a knife or razor in the same period (27.1 versus 19.4%). Similar increases were found in reports of threats of violence, both those made by the respondent and those made against him.

Variations in effects across social and demographic subgroups. To determine whether the increase in reporting we observed with audio-CASI might vary across race-ethnicity or age groups, we fit a hierarchical series of log-linear models (31) to the four-way tables for each behavior reported in Tables 2 through 4 for which there was a significant difference ($P < 0.05$) in estimated prevalence across modes. The four-way table broke down the estimated prevalence of each risk behavior by three variables: mode of interview (audio-CASI versus paper SAQ), age (15 to 16 versus 17 to 19), and race-ethnicity (black, Hispanic, white, or other) (32). These analyses revealed little evidence of significant variation in the effect of the survey mode across those age and race-ethnicity groups.

Although we did not measure respondent literacy directly, we were able to iden-

tify respondents who were “not at grade level” in school or who had dropped out of high school without graduating. Respondents were coded as “at approximate grade level” if they were age 15 and had completed 8th grade or higher; age 16 and had completed 9th grade or higher; age 17 and had completed 10th grade or higher; age 18 and had completed 11th grade; or any age and had completed 12th grade. All other respondents were coded as “below grade level.” To detect variations in how audio-CASI influenced reporting in the latter group, we focused on the reporting of drug use, the combination of drug use and sex, male-male sex, and violence.

For most behaviors, no substantial differences were observed in the effect of audio-CASI across these two education strata. However, in four instances (reporting of any male-male sex, injection drug use, daily marijuana use in the past year, and crack or cocaine use in the past year), there were noteworthy differences in the effect of the survey mode. For reporting of the three drug use behaviors, audio-CASI had a strong effect (odds ratios = 2.8 to 14.1) for the subpopulation of respondents who were high school graduates or who were at their approximate grade level (Table 5). No such effect was found for the subpopulation who had dropped out of school or were still in school but seriously behind their normal grade level. For the three drug use behaviors, the paper SAQ yielded estimates that were about equivalent to those obtained with audio-CASI technology (odds ratios = 0.5 to 1.5). For the reporting of male-male sex, there were parallel increases in reporting when audio-CASI was used, but the effect was more pronounced for males who were behind in school. No male who was behind in school reported any of the six male-male sexual behaviors when complet-

ing the paper SAQ. In the audio-CASI condition, 6.2% of respondents not at grade level reported one (or more) types of male-male sexual contact. For males who were at grade level a more attenuated effect was observed [1.8% in the paper SAQ versus 5.3% in audio-CASI (33)].

For reports of serious drug use, this pattern of differential sensitivity to interview mode might imply that the segment of the population that is “on track” educationally may perceive that they have more to lose by discovery of their past drug use. Alternatively, there may be differences across groups in peer norms about the acceptability of such behavior. Similar differences in peer norms could account for a differential sensitivity to reporting of male-male sexual contacts. Data from representative national samples of adults surveyed in 1990 to 1994 indicate that tolerance of same-gender sex increases with the educational attainment of the respondent (34). Although such speculations have some intuitive appeal, they do not account for the failure to find parallel results for questions other than the four noted here.

Other results. Nonresponse to individual questions has been a persistent problem in self-administered interviews that use paper SAQs (35). Respondents in the audio-CASI mode in our experiment were less likely than respondents in the SAQ mode to use the “don’t know” or “refuse to answer” options. (The audio-CASI technology provided labeled keys for those responses.) Of the 58 questions that were designed to be answered by all respondents, an average of only 0.5% of respondents in the audio-CASI mode did not answer them, compared with an average of 2.3% of respondents in the paper SAQ mode.

Discussion. The results of this large-scale experiment indicate that respondents

Table 4. Alternate estimates of prevalence of violent behaviors derived by using different questioning methods. Data are from the 1995 NSAM.

| Measurement | Estimated prevalence (per 100) | | Crude OR | Adj. OR |
|---|--------------------------------|------------|----------|---------|
| | Paper SAQ | Audio-CASI | | |
| Someone threatened to hurt you in past year | 25.7 | 34.3 | 1.51*** | 1.61*** |
| You threatened to hurt someone in past year | 17.1 | 26.1 | 1.72*** | 1.89*** |
| Carried a gun in past 30 days | 7.9 | 12.4 | 1.66** | 1.76** |
| In physical fight within last year | 38.9 | 43.8 | 1.22 | 1.29 |
| You pulled knife or gun on someone in past year | 6.2 | 8.9 | 1.50* | 1.75** |
| Someone pulled knife or gun on you in past year | 16.9 | 21.1 | 1.32* | 1.47* |
| Carried a knife or razor in past 30 days | 19.4 | 27.1 | 1.55** | 1.68** |

* $P = 0.15$ or less for two-tailed test of null hypothesis that OR = 1.0. ** $P = 0.05$ or less for two-tailed test of null hypothesis that OR = 1.0. *** $P = 0.01$ or less for two-tailed test of null hypothesis that OR = 1.0.

in the 1995 NSAM's new cohort, a probability sample of U.S. males aged 15 to 19, were much more likely to report risky behaviors when they were interviewed with audio-CASI measurement technology than when interviewed with the more traditional paper SAQ. The magnitude of the observed effect was substantial for many behaviors, particularly those that were illicit or highly stigmatized. Thus, the estimated prevalence of past-year use of crack or cocaine almost doubled, from 3.3 to 6.0%, and the estimated proportion of adolescent males who reported ever taking street drugs with a needle more than tripled, from 1.4 to 5.2%. Although we have some concern about the interpretation of the injection drug use result (36), overall the audio-CASI estimates were considerably higher for illicit and stigmatized behaviors. These NSAM audio-CASI estimates were also higher than estimates derived from the federal government's 1995 National Household Survey on Drug Abuse. Estimates derived from that survey are that the prevalence of reported crack or cocaine use during the past year among males aged 15 to 19 was 2.6% and that the prevalence of reported injection drug use in the same group was 0.3% (37).

Varying the interview mode also affected the reporting of the co-occurrence of drug use and sexual behavior. The proportion of sexually active adolescent males who reported that they or their partner had been drunk or high at last intercourse more than doubled in the audio-CASI mode (from 15.3% in the paper SAQ condition to 34.8%). In addition, indicators of interpersonal violence increased markedly.

In planning this experiment, we were aware of prior research (5–7) showing that a private mode of survey response such as paper SAQs encouraged more complete reporting of sensitive, stigmatized, and illicit

behaviors. We anticipated that the additional benefits of computerization and an audio format for the self-administered interview would bring only modest improvements in reporting. The large differences we found were surprising. If this measurement technology provides a more accurate picture of patterns of sexual behaviors, drug use, and violence among adolescent males in the United States, then the risks they are encountering are substantially greater than was previously supposed. This conclusion assumes, of course, that the observed increase in reporting of these behaviors is, in fact, more accurate reporting. That assumption follows standard practice in much social measurement research (38); nonetheless, it remains an assumption. Yet in the present instance, there is empirical evidence to support it. The large increases in the reporting of male-male sexual contacts under audio-CASI (to 5.5% for any contact) make these measurements more compatible with estimates derived from adults' reports of their adolescent behaviors (39).

The fact that audio-CASI both increases reporting of male-male contacts and makes our estimates more consistent with those obtained from retrospective reports of adults encourages the conclusion that this technology is reducing the underreporting bias known to affect such measurements. In addition, the technology appears to have a more pronounced effect on the reporting of behaviors that are particularly sensitive, stigmatized, or subject to serious legal sanctions, compared with less sensitive areas of conduct. Thus, our analyses of the NSAM data found few reliable effects of audio-CASI on the reporting of male-female sexual contacts; the sole exception was for reporting of sexual contact with prostitutes. That behavior is arguably a more sensitive topic for adolescents than are other male-

female sexual contacts. Similarly, audio-CASI substantially increased reporting of all types of male-male sexual contacts and drug use. Here again, exceptions occurred for reports of more common and, we suspect, less sensitive behaviors such as the use of alcohol and marijuana.

Those results and complementary evidence emerging from smaller studies using local samples (40) lead us to conclude that the estimates presented here are more accurate than previous estimates derived from data collected in less private interview contexts. These estimates present a disturbing picture of the biological and social risks that confront young males in the United States at the end of the 20th century.

NOTES AND REFERENCES

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3. This situation appears to be unique to the United States. Among young males 15 to 24 years of age, the United States has the highest homicide rate among 22 industrialized nations [M. L. Rosenberg, *J. Health Care Poor Underserved* **6**, 102 (1995); H. Saner and P. Ellickson, *J. Adolesc. Health* **19**, 94 (1994); J. M. Bergstein, D. Hemenway, B. Kennedy, S. Quaday, R. Ander, *J. Trauma* **41**, 794 (1996); P. F. Adams, C. A. Schoenborn, A. M. Moss, C. W. Warren, L. Kann, *Vital Health Stat.* **10**, 1 (1992)].
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11. Multilingual audio-CASI administration was not used in NSAM but has been tested in preliminary studies [T. P. Hendershot, S. M. Rogers, J. P. Thornberry, H. G. Miller, C. F. Turner, in *Health Survey Research*

Table 5. Selected estimates of prevalence of male-male sex and drug use by mode of interview and whether respondent was at "grade level." Respondent is coded as "at grade level" if by age 15 they have completed grade 8, completed 9th grade by 16, 10th grade by 17, 11th grade by 18, or completed high school. All other respondents and those that have not completed 8 years of school are "below grade level."

| Measurement | At or above approximate grade level | | | | Below grade level | | | |
|--|-------------------------------------|------------|----------|----------|-------------------|------------|----------|---------|
| | Paper SAQ | Audio-CASI | Crude OR | Adj. OR | Paper SAQ | Audio-CASI | Crude OR | Adj. OR |
| Any male-male sex | 1.8 | 5.3 | 3.03** | 3.22*** | 0.0 | 6.2 | —† | —† |
| Ever taken street drugs using a needle | 0.3 | 4.5 | 14.11*** | 16.67*** | 6.1 | 8.7 | 1.48 | 1.22 |
| Smoked marijuana daily during last year‡ | 1.9 | 5.1 | 2.78** | 3.51** | 13.5 | 14.6 | 1.10 | 1.34 |
| Used crack/cocaine within last year | 0.9 | 5.7 | 6.67*** | 7.15*** | 13.8 | 7.4 | 0.50 | 0.50 |

* $P = 0.15$ or less for two-tailed test of null hypothesis that OR = 1.0. ** $P = 0.05$ or less for two-tailed test of null hypothesis that OR = 1.0. *** $P = 0.01$ or less for two-tailed test of null hypothesis that OR = 1.0. †Odds ratio not computed due to zero cell entries; $P = 0.011$ by Fisher exact test. ‡Never smoked marijuana (question 13) recoded to no use within the last year.

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12. L. Ku, F. L. Sonenstein, J. H. Pleck, *Fam. Plann. Perspect.* **26**, 246 (1994); *Am. J. Public Health* **83**, 1609 (1993); J. H. Pleck, F. L. Sonenstein, L. Ku, *Fam. Plann. Perspect.* **25**, 106 (1993); L. Ku, F. L. Sonenstein, J. H. Pleck, *ibid.* **24**, 100 (1993).
 13. The 1992 National Health and Social Life Survey (NHLS), for example, found that 9.1% of U.S. men in 1992 reported having had male-male contacts after puberty but only 4.9% reported such contacts after age 18. Those results imply that 4.2% of men had male-male contacts that were restricted to adolescence and some portion of the remaining 4.9% would have begun such contacts during adolescence. In a 1970 Kinsey Institute survey of a representative sample of U.S. men, 81% of the men reporting some history of male-male contact said that their first male-male experiences occurred before age 19 (6). It should also be noted that other analyses of the 1970 Kinsey Institute survey indicated that 8.4% of men reported some male-male contact that did not persist beyond age 14 [R. E. Fay, C. F. Turner, A. D. Klassen, J. H. Gagnon, *Science* **243**, 338 (1989)]. The 1992 NHLS did not assess prepubertal contacts.
 14. The design of the survey was changed in 1991 to make it more gender neutral in discussing sexual contacts and included a SAQ on male-male sexual contacts that was given before asking about male-female contacts. This change was made so that respondents would not infer that we expected only heterosexual contacts to be reported.
 15. The sample was drawn as a probability subsample of an area probability sample selected for another study conducted in 1992. Details of the multistage sampling procedures used in selecting the NSAM sample can be found in Research Triangle Institute, *National Survey of Adolescent Males: Field Report* (Research Triangle Institute, Research Triangle Park, NC, 1995), pp. 3.2–3.6. (Our analysis is based on a final data set that includes a small number of NSAM cases that were received after the field report was completed.)
 16. An additional 12 units (0.02%) were excluded because of mismatches between the original sample frame information and interviewer determination as to whether the unit was a household or group quarters.
 17. Bureau of the Census, *Preliminary Projections: Non-institutional Population by Age, Sex, Race and Hispanic Origin* (U.S. Department of Commerce, Washington, DC, May 1995).
 18. B. Shah, B. G. Barnwell, P. N. Hunt, L. M. LaVange, *Software for Survey Data Analysis (SUDAAN)* (Research Triangle Institute, Research Triangle Park, NC, 1996).
 19. After completing the self-interview portion of the survey, respondents who were age 18 and older were asked to provide a urine sample to be tested for chlamydia and gonorrhea. The results of those tests are not discussed here.
 20. Nonresponse to individual questions may reduce the *N* for individual items. However, item nonresponse rates were quite low, averaging 1.3% for the measurements shown in Tables 2 through 5. Nonrespondents to individual items have been excluded from our analyses. In addition, it should be noted that some analyses purposely restrict the population base. So, for example, our estimate of the percentage of males using “condoms at last sex” (Table 2) is restricted to those males who reported having had vaginal, oral, or anal sex with a female. Population restrictions are noted in the tables.
 21. L. A. Goodman, *J. Am. Stat. Assoc.* **63**, 1091 (1968); *Analyzing Qualitative/Categorical Data* (Haberman, Cambridge, 1978); *Analysis of Categorical Data* (Academic Press, New York, 1978); Y. Bishop, S. Feinberg, P. Holland, *Discrete Multivariate Analysis: Theory and Practice* (MIT Press, Cambridge, 1975).
 22. An alternative approach would be to treat the sample of 1672 respondents as a closed population that had been randomly assigned to one of two interviewing conditions. In that approach, neither weights nor special statistical algorithms would be required. Statistical tests using that approach would provide an appropriate answer to the question of whether audio-CASI had had a significant effect on that particular sample of respondents. The approach is reasonable, but it does not allow one to generalize the results to the national population.
 23. *P* values are based on the χ^2 statistic reported by SUDAAN (18).
 24. As a check on the adequacy of the randomization, we compared the response distributions of 62 predominantly yes-no nonattitude questions measured in the prior interviewer-administered section of the questionnaire for respondents assigned to the two experimental conditions. We were initially perplexed to find that people who were assigned to the paper SAQ condition were more likely than those in the audio-CASI condition to report in the interviewer-administered section of the survey that they were virgins. They did not, however, show significant differences on demographic variables or other sexual behaviors (for example, employment during the past year, timing of last heterosexual intercourse). Our examination indicated that this result appears to have been a random occurrence. Of the 62 comparisons, 2 were found to be significant at the $P < 0.05$ level. On the basis of probability theory, we would expect random assignment to produce (on average) at least three significant ($P < 0.05$) results in 62 independent tests. We thus conclude that the randomization was successfully executed. The adjusted odds ratios shown in Tables 2 through 5 provide statistical adjustments for observed random differences in the composition of the sample used in the two experimental conditions. These adjusted ratios were derived from logistic regression models that used the following as control variables: race (black, white, other), respondent's age, whether the respondent was attending school, whether the respondent reported during the earlier interviewer-administered section of the survey that he had ever had sex with a female, and whether the respondent was covered by health insurance. The first three characteristics were selected to take account of differences among subpopulations in our targeted behaviors; the last two variables were chosen on the basis of preliminary statistical analyses that indicated random variations between the experimental and control conditions for the two characteristics (of 62 that were examined). Use of the adjusted rather than crude odds ratios does not markedly affect our conclusions (Tables 2 to 5).
 25. In a few instances noted in Table 2, respondents in the experiment were asked again about heterosexual contacts that they had previously reported on in the interviewer-administered portion of the survey. Because respondents may have felt compelled to answer consistently rather than “honestly,” responses to the questions that were asked again could be subject to a consistency bias that might have attenuated the effect of the interview mode. Moreover, there is a weak suggestion in these results that audio-CASI may have diminished “overreporting,” which is sometimes thought to afflict measurements of highly normative behaviors, for example, reports by males of some male-female sexual experience. That effect, however, is not statistically significant and is weak compared with the effects observed on reporting of male-male sex and the other behaviors discussed [see also S. Newcomer and J. R. Udry, *J. Adolesc. Res.* **2**, 419 (1988)].
 26. Since the original tabulation of estimates for Tables 2 to 5 in this article, we detected a minor data anomaly that has been corrected in the public use data set. For four variables, the value 999 was an allowable (albeit unusual) response to questions on: (i) the number of times in past 12 months someone pulled a gun, knife, or razor on respondent; (ii) the number of times the respondent threatened to hurt someone during the last 12 months; (iii) the respondent's total number of lifetime female sexual partners; and (iv) the respondent's total number of female sex partners during the past 12 months. Similarly, the value 99 was an allowable response to a fifth question on the number of times the respondent was in a fight during the last year. Seven respondents gave one or more of these answers (999 or 99) to these questions. In our original tabulations, these extreme values were treated as missing data codes and excluded from the analysis. Correcting this error alters the reported percentages for two mode comparisons by more than 0.1 percentage points. For reporting of five or more lifetime (female) sex partners (Table 2), the results are 15.8% (SAQ) and 19.0% for audio-CASI (versus 15.8% and 18.8%, if the value 999 were treated as missing). Similarly, for respondents' reports of having threatened to hurt someone in the past year (Table 4), the results are 17.1% for SAQ and 26.3% for audio-CASI (versus 17.1% and 26.1%, if the value 999 were treated as missing). In manual editing of paper SAQs for data entry, all values of 400 or more for these variables were treated as invalid and coded as “missing data.” Thus comparison of paper SAQ estimates to audio-CASI estimates in which 999 codes are treated as missing values—as was done in Tables 2 through 5—is appropriate. If the additional values 400 to 998 were treated as missing values for the audio-CASI measurements, the audio-CASI estimates would not change by more than 0.1%.
 27. As noted in Table 2, it is possible that the prostitute was male. It should also be noted that a suggestive mode effect ($P < 0.15$) was found in Table 2 for respondents who reported that they had been paid to have sex.
 28. It should also be noted that the only internally consistent reports of injection drug use in the past year were obtained from nine males in the audio-CASI mode. One male in the paper SAQ mode gave an inconsistent report of injection drug use. Respondents in the paper SAQ condition were asked a series of questions on injecting drugs. First, they were asked if they had ever taken street drugs by using a needle. Next, they were asked how frequently they had injected drugs during the past year, whether they had ever shared a needle, and how often they had sterilized previously used needles. In the audio-CASI condition, respondents who reported they had never injected drugs were skipped out of the remaining questions. However, one respondent completing the paper questionnaire first reported never injecting drugs but later reported doing so “a few times” during the past year.
 29. The series of questions on commingling of sex and alcohol or drug use was preceded by a gate question asking “Have you ever had sexual intercourse, including vaginal, oral, or anal intercourse, with a female?” Respondents who answered “no” to that question were skipped past the series of questions on drug and alcohol use during sex. Analyses comparing responses to this question with those to questions asked separately about oral, vaginal, and anal sex suggest that some respondents may have interpreted the gate question as asking about the co-occurrence of all three types of sexual behavior. Thus, only 60.6% of paper SAQ and 54.0% of audio-CASI respondents replied “yes” to this question. In comparison, in response to four questions asking separately about vaginal sex, insertive and receptive oral sex, and anal sex with females, 68.1% of paper SAQ and 63.9% of audio-CASI respondents indicated that they had engaged in one (or more) types of sex.
 30. This finding is not likely to reflect the carrying of guns for hunting: 13.4% of males living in urban areas reported that they had carried a gun during the prior 30 days compared with 11.8% of males living in rural areas.
 31. Exploratory analyses were conducted with weights that had been normalized so that the weighted *N* equaled the sample *N*. The effect of the complex sample design was not taken into account in these initial exploratory analyses that fit a series of hierarchical log-linear models. Subsequently, odds ratios were recalculated for results that evidenced substantial disparities across schooling levels in the estimated effect of interview mode on survey response. These recalculated odds ratios and associated *P* values (Table 5) used algorithms that took account of the complex sample design.
 32. More precisely, the four categories were Hispanics, non-Hispanic whites, non-Hispanic blacks, and other.
 33. There was also a less substantial difference in the effect of mode on reporting that someone had pulled a gun on the respondent in the past year. For re-

- spondents who were at grade level, there was an insignificant mode effect (crude OR = 1.06; 17.5% in paper SAQ versus 18.4% in audio-CASI), whereas a significant ($P < 0.05$) mode effect in the same direction was found for respondents who were not at grade level (crude OR = 2.22; 15.3% in paper SAQ versus 28.5% in audio-CASI).
34. The National Opinion Research Center (NORC) General Social Survey asked the following question of national samples drawn annually between 1988 and 1994: "What about sexual relations between two adults of the same sex. Do you think it is always wrong, almost always wrong, wrong only sometimes, or not wrong at all?" Among males aged 18 and older ($N = 2877$), 86% of those who had not completed high school responded "always wrong" compared with 83% of those who left school after 12th grade, 72% of those who had completed 13 to 15 years of school, and 57% of those who had completed 16 or more years of education. (Estimated percentages are weighted to account for varying probabilities of selection into the sample.) Data were extracted and tabulated from the NORC cumulative data file [J. A. Davis and T. W. Smith, *General Social Surveys, 1972-1994* (machine-readable data file) (NORC, Chicago, IL, 1972-1994)].
 35. S. M. Rogers and C. F. Turner, *J. Sex Res.* **28**, 491 (1991); M. Witt, J. Pantula, R. Folsom, B. Cox, in (7), pp. 85-108.
 36. In particular, we note that the question on injection drug use was worded: "Have you ever taken street drugs, like heroin or cocaine, using a needle? This includes 'shooting up' and 'skin popping'" (emphasis in original). It is possible that in formulating a response, audio-CASI respondents may have focused on the initial clause "ever taken street drugs, like heroin or cocaine" in the audio format of this question, whereas respondents in the paper SAQ condition may have been more likely to notice the subsequent "using a needle" clause and the explanatory phrases "shooting up" and "skin popping" when reading the paper version of this question.
 37. These estimates are based on weighted tabulations from the public use data set for the 1995 National Household Survey on Drug Abuse (NHSDA). The NHSDA is sponsored by the Substance Abuse and Mental Health Services Administration of the Department of Health and Human Services. In 1995, the NHSDA surveyed a population sample of more than 17,000 household residents in the United States. Questions on illicit drug use were administered with paper SAQs. Our tabulations are based on the sample of 1624 males ages 15 to 19 who were included in the NHSDA survey.
 38. See, for example, N. Bradburn, S. Sudman, and Associates, *Improving Interview Method and Questionnaire Design* (Bass, San Francisco, 1979); J. J. Watterton and J. C. Duffy, *Int. Stat. Rev.* **52**, 173 (1984).
 39. We would also note that a parallel study of the effect of audio-CASI on abortion reporting found that with this technology the known underreporting of this procedure decreased. In that instance, there was an external standard (reports by abortion providers) to provide assurance that increased reporting was more accurate reporting [H. G. Miller, S. M. Rogers, J. Gribble, C. F. Turner, in *The Science of Self Report* (provisional title), A. Stone, Ed. (Lawrence Erlbaum Associates, Mahwah, NJ, in press)].
 40. R. Tourangeau and T. Smith, *Public Opin. Q.* **60**, 275 (1995); C. F. Turner, H. G. Miller, T. K. Smith, P. C. Cooley, S. M. Rogers, in *Survey and Statistical Computing 1996*, R. Banks, J. Fairgrieve, L. Gerrard, Eds. (Association for Survey Computing, Chesham, Bucks, UK, 1996).
 41. This research was supported by NIH grant R01-HD30861 with funding from the National Institute of Child Health and Human Development (NIH-NICHD), the National Institute of Mental Health (NIH-NIMH), the Office of Population Affairs, and the Centers for Disease Control and Prevention. We thank H. Zelon, F. Mierzwa, J. Chromy, D. Allen, B. Forsyth, and S. Williams for their contributions and A. Harrell, H. Miller, R. Folsom, and J. Groerer for helpful comments.

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