

The feasibility of audio computer-assisted self-interviewing in international settings

NIMH Collaborative HIV/STD Prevention Trial Group*

Objective: To determine the feasibility of using audio computer-assisted self-interviewing (ACASI) for data collection in developing countries, and to compare responses to questions eliciting sensitive information about sexual behavior using ACASI versus computer-assisted personal interviewing (CAPI) in five developing countries.

Design: A feasibility study determined whether ACASI could be used in populations in developing countries. A follow-up, randomized crossover study compared responses to questions eliciting sensitive information about sexual behavior using ACASI versus CAPI.

Methods: The NIMH Collaborative HIV/STD Prevention Trial conducted a feasibility study of ACASI in convenience samples in China, India, Peru, and Russia, then a randomized crossover ACASI versus CAPI study among volunteers in these countries plus Zimbabwe.

Results: Approximately equal numbers of men and women completed the feasibility study; the results suggested a high comfort level among participants. Married respondents in China and India appeared to give unreliable responses on sexual activity. In the crossover study, the pattern of responses to sensitive questions showed few differences. In China, higher rates of sexual risk were reported on CAPI. In Peru and Russia, differences by mode were found in the number of partners in the past year.

Conclusion: Despite variable computer experience and literacy, feasibility study participants reported ease in completing ACASI, and preferred a computer to an interviewer for answering sensitive questions, or had no preference. In the crossover study, most participants gave similar responses on both modes of survey administration. ACASI appears to be feasible in these settings, although low literacy may pose problems if participants cannot clarify questions.

© 2007 Lippincott Williams & Wilkins

AIDS 2007, **21** (suppl 2):S49–S58

Keywords: developing nations, knowledge/attitude/practice studies, sexual behavior, survey methods

Introduction

The evaluation of HIV prevention programmes depends on the collection of reliable and valid reports of personal risk behaviors [1], particularly in heterosexual epidemics, in which unprotected sexual intercourse is the principal mode of transmission. Although it is critical that valid data be obtained to determine intervention programme effectiveness, it is also apparent that inaccurate reports of sexual behaviors occur in survey-based evaluations [2]. Survey researchers have responded to this problem by developing approaches to elicit accurate responses about highly stigmatized or sensitive behaviors (e.g. adolescent sexual activity, condom use, interpersonal sexual violence) by changing how surveys are conducted [3] and altering the

mode of survey administration [4–7]. These approaches include the development of computerized assessments, notably computer-assisted personal interviewing (CAPI), conducted either face-to-face or by telephone [8], and audio computer-assisted self-interviewing (ACASI) [9,10].

A growing body of evidence indicates that increasing privacy during an interview can improve the completeness and accuracy of reporting of sensitive and illegal behaviors in population-based surveys [4,11,12]. Initially, the only way to afford privacy to interviewees was to use self-administered questionnaires, in which the respondent had only some degree of certainty that answers to sensitive questions would not be seen directly by another person. Unfortunately, subjects had to be able to read and navigate

* See Appendix B for members of the NIMH Collaborative HIV/STD Prevention Trial Group.

through questionnaires that often involved complex skip patterns. The reading skills of people at risk of HIV are often inadequate to complete self-administered forms, especially in many developing countries, where literacy may be an issue. Moreover, even people who can read well may have difficulty following data collection forms containing detailed questions and unfamiliar conventions defining complicated skip patterns [13]. Also, self-administered questionnaires are subject to respondent rumination, missing data, and changed responses, and bystander presence alone may influence responses [14]. Telephone surveys promised a high degree of anonymity [15], but increasingly low response rates in the 1990s rendered this approach infeasible for collecting survey sample data on sexual practices. The low coverage of telephones in many developing countries suggests that this mode of data collection may not prove feasible for widespread use as an evaluation approach.

In the late 1980s, computer-assisted interviewing was promoted to enhance face-to-face data collection. In CAPI, interviewers administer questionnaires using a computerized layout of the questionnaire, in which the questions and all possible responses are preprogrammed. This type of system enhances the accuracy and timeliness of data collection. It automatically executes skips and branching through complex questionnaires, conducts consistency and range checks, and produces a clean, machine-readable data file that requires no data entry, thereby reducing costs and maximizing reliability. This mode of data collection minimizes field editing and transmits accurate data quickly from the field.

The CAPI system is robust and can be used by interviewers in a broad range of settings using light-weight laptops, handheld computers, or even mobile telephones. Interviewers and respondents report few, if any, problems using this technology, and both parties frequently report a preference for CAPI to self-administered questionnaires. Because it is interviewer-administered, however, CAPI does not provide privacy, and sensitive and illegal behaviors may continue to be underreported by survey respondents because social desirability and impression management remain part of the interview process. In the 1990s, a new technology incorporated sound recording with CAPI technology, audio computer-assisted self-interviewing (ACASI). ACASI has all the advantages of CAPI, but instead of having an interviewer administer the interview, the respondent listens to an audio track recorded for, and linked to, each question. Respondents listen to the questions using a headset and move through the survey at their own pace. If illiterate, survey respondents can be instructed to push buttons on the touch screen that are color coded or have graphical representations of answer categories to indicate their response to each question.

The majority of the published studies comparing ACASI with other modes of data collection (including CAPI, self-

administered questionnaire, interviewer-administered questionnaire, or telephone interviews) have focused on western countries [4,16,17]. Generally, higher rates of sensitive behavior are found on ACASI compared with interview [18–22] and self-administered questionnaire [23,24].

Interest in the use of these interviewing techniques in international settings has increased recently [25]. A study of 664 Thai college students found that ACASI led to higher reports of sexual activity compared with self-administered questionnaires, but the sample size was too limited to detect statistically significant differences [26]. A feasibility study of ACASI in Zimbabwe showed high acceptability, but the study reported on few sensitive behaviors [27]. A study of abortion in three groups of Mexican women showed the highest rates of reported abortion among women completing a randomized response approach, followed by self-administered questionnaires, with less frequent reports of abortion by women assigned to ACASI or interviewer-administered questionnaires [28]. Mensch *et al.* [29] examined self-reports of sexual activity from 4348 unmarried adolescent girls and boys in two communities in Kenya who were assessed using three interview modes: face-to-face interviewer-administered interviews; questionnaire self-administration; and ACASI. Results for girls were mixed and differed by community and mode of administration. Results for boys were somewhat more consistent, but had important, unexpected findings. The authors concluded that empirical research in developing countries to evaluate the interview mode is essential [30]. Although several randomized studies have evaluated whether sensitive behaviors are better elicited using ACASI in developing country settings, findings to date lack consistency and replication.

The NIMH Collaborative HIV/STD Prevention Trial (hereafter, the Trial) sought to determine the effectiveness of a community popular opinion leader approach to stimulating HIV risk reduction behavior change in developing countries. This study is a collaboration of diverse research groups, working in dramatically different cultural settings: food markets in southern China, urban slums in India, barrios in Peruvian coastal cities, vocational and trade school dormitories in Russia, and growth point rural villages in Zimbabwe. Before beginning the community-randomized, controlled trial of the community popular opinion leader approach, we first conducted a series of studies to help plan the Trial, including an ethnographic study, two small ACASI feasibility studies, and a series of epidemiological studies. The ACASI feasibility studies are the subject of this report.

Given the inconsistent findings in the literature on the feasibility and validity of ACASI in the developing world, we were interested in determining whether ACASI was feasible in the Trial's diverse settings, where computer use has not been common until the past few years, and whether

we would obtain higher reports of sensitive behaviors using ACASI compared with interviewer-administered surveys, as has been shown in western countries. Therefore, we first conducted a feasibility study at four of the Trial sites to determine whether ACASI technology could be used in field conditions at these sites. The aims of this study were to: (i) develop and test a process for translating and programming the questionnaire to be administered by ACASI; (ii) evaluate the cultural acceptability of ACASI in collecting data on sensitive HIV risk behaviors; and (iii) identify and resolve logistical and technical issues associated with using computers in non-office settings. Next, a randomized crossover study comparing CAPI and ACASI was conducted at all five Trial sites to assess the relative validity of data collected on sensitive topics using these two different interview modes and to compare the amount of time required for survey administration for the two modes.

Methods

Audio computer-assisted self-interviewing feasibility study

In each country, a convenience sample, balanced by sex, of between 30 and 40 respondents was selected from areas similar to those selected for the planned epidemiological studies: markets in Fuzhou, China; slum communities in Chennai, India; barrios in Lima and Chiclayo, Peru; and vocational and trade school dormitories in St Petersburg, Russia. Zimbabwe joined the Trial too late to be included in the feasibility study. All participants gave informed consent, were given a description of the ACASI procedures and trained to use the computer, and completed the ACASI in their language of choice. The ACASI included approximately 80 questions dealing with demographics, residential stability, health, HIV and other sexually transmitted disease (STD) testing history, the use of alcohol and illicit drugs, sexual history, condom use, and other potentially sensitive topics. In addition, 11 feedback questions were included to assess participants' comfort with the ACASI and preferences regarding interview mode. Participants were given headphones with which to listen to each question and the possible answers, and used touch-screens for data input. After completing the ACASI, selected participants were debriefed by a staff ethnographer about their experiences while completing the interview. Frequencies of responses to sensitive and non-sensitive questions were examined for each country, with particular attention to the feedback questions.

Crossover audio computer-assisted self-interviewing versus computer-assisted personal interviewing comparison study

A convenience sample of between 50 and 200 community volunteers, with approximately equal numbers of men and women, was recruited in each of the five countries from

areas similar to those selected for the epidemiological studies and in the same age ranges: markets in Fuzhou, China, ages 18–40 years; slums in Chennai, India, ages 18–40 years; barrios in Lima and Trujillo, Peru, ages 18–30 years; dormitories in St Petersburg, Russia, ages 18–30 years; and the villages of Manhenga in Mashonaland Central province and Nkayi in Matabeleland North province in Zimbabwe, ages 16–30 years. Participants were randomly assigned to complete an assessment interview via CAPI or ACASI, after providing informed consent and being trained to use the ACASI computer (for those randomly assigned to the ACASI group). Two or 3 days later, participants returned and completed the same interview using the other interviewing method. The interview included approximately 90 questions covering demographics, health, STD history, alcohol and drug use, sexual activity and other sensitive topics. Many were questions that had been used for the ACASI feasibility study, although no respondent feedback questions were included.

Analyses were conducted separately for each country. Sex and age distributions were first compared between the two randomized groups, ACASI first, CAPI second (hereafter ACASI first) and CAPI first, ACASI second (hereafter CAPI first), to verify that imbalances did not occur by chance alone. Participant responses to the following 11 potentially sensitive questions were compared between the first and second interview:

'Have you ever had a genital ulcer?' yes/no

'Have you ever had an abnormal urethral or vaginal discharge?' yes/no

'Have you ever had any (other) sexually transmitted diseases?' yes/no

'Have you ever been tested for HIV infection?' yes/no

'How often do you usually drink alcohol?' (binary variable created with 1, drink at least once a week; 0, drink less than once a week/do not drink alcohol)

'How often do you get drunk?' (binary variable created with 1, get drunk at least once a week; 0, get drunk less than once a week/do not get drunk)

'Have you ever exchanged money, goods, shelter, or anything else for sex?' yes/no

'Have you tried to obtain condoms in the past 3 months?' yes/no

'In the past 3 months, have you used drugs to get high?' yes/no

'Do you personally know or have you known someone with HIV or AIDS?' yes/no

'How likely is it that you will become infected with HIV?' (binary variable created with 1, likely, somewhat likely, very likely, I am already infected with HIV; 0, unlikely, not likely at all, very unlikely, somewhat unlikely).

Sex behavior questions were also compared between the first and second interview, including 'Have you ever had sexual intercourse?', 'With how many different people have you had sexual intercourse during the past year?', and 'With how many different people have you had sexual intercourse during the past 3 months? The number of unprotected acts in the past 3 months was determined on the basis of the reported frequency of sex in the past 3 months and the number of times a condom was used. For participants who reported they had never had sex, the number of partners and the number of unprotected acts were coded as zero. The number of unprotected acts was also coded as zero for participants who reported no partners in the past 3 months.

For binary outcomes, the pattern of yes–no or 1–0 responses given by participants over time was examined (same response on each interview, 'no'/0 on the first interview but 'yes'/1 on the second, 'yes'/1 on the first interview but 'no'/0 on the second). Statistical significance for the null hypothesis of no difference in responses between the ACASI and CAPI methods was determined by Prescott's test [31,32]. For continuous variables (e.g. unprotected acts, number of partners), the difference between the first and second interview period responses (ACASI minus CAPI or CAPI minus ACASI) was calculated for each individual. These period differences were then compared for the two groups (ACASI first versus CAPI first), with statistical significance for a difference in responses between the two groups determined by the Wilcoxon rank sum test [31,32]. Exact tests to determine statistical significance were used for all countries except China, where the normal approximation was used because of the larger sample size.

Results

Audio computer-assisted self-interviewing feasibility study

During the study period, August–October 2000, 30 market workers in Fuzhou, China, 40 residents from slum communities in Chennai, India, 30 young adults from barrios in Lima and Chiclayo, Peru, and 30 students from vocational and trade school dormitories in St Petersburg, Russia, participated in the ACASI feasibility study. Approximately equal numbers of men and women participated in each country (Table 1). Participants in China and India were older than those in Peru and Russia and more were married, reflecting the higher age range. In general, those selected in China and India had little previous experience with computers, whereas the young, well-educated students in Russia had a high degree of computer literacy, and most participants in Peru had previous exposure to computers. The median time required to complete the same questionnaire translated into the local language was 17 min in Russia, 24 min in China, 25 min in Peru, and 35 min in India. This wide range may reflect differential ease in completing the interview, difficulties in understanding some questions at some sites, or cultural differences in the tendency to ponder questions or to take the interview seriously.

In each country, few questions had more than one 'Don't know' or 'Refuse' response. In China and India, four to seven people responded 'Don't know' on each of three questions related to STD testing (ever been tested for syphilis, gonorrhoea, other STD), although the question 'Have you ever been tested for HIV infection?' was answered by all in India, and only one in China indicated 'Don't know'. Two participants from Russia answered 'Don't know' to 'Have you ever had sexual intercourse?' perhaps reflecting ambiguity over whether the withdrawal method of contraception or oral sex constitute sex acts. Among those who said they had ever had sex, few refused to answer any of the potentially sensitive questions

Table 1. Audio computer-assisted self-interviewing feasibility study: respondent characteristics.

	China		India		Peru		Russia	
	Count	%	Count	%	Count	%	Count	%
Sample size	30		40		30		30	
Time to complete ACASI (min)								
Median	24		35		25		17	
Range	14–41		10–55		14–48		10–32	
Male	15/30	50	21/40	53	14/30	47	17/30	57
Age (years)								
Median	29		27		22		19	
Range	19–40		18–42		17–33		17–22	
Married	20/30	67	29/40	73	6/30	20	1/30	3
Ever had sex 'yes'	7/29 ^a	24	22/40	55	19/29 ^a	66	21/28 ^a	75
Married, ever had sex 'yes'	6/19	32	17/29	59	6/6	100	1/1	100
Married, ever had sex 'yes' (female)	2/8	25	7/15	47	3/3	100	0	

ACASI, Audio computer-assisted self-interviewing.

^aOne participant from China, one from Peru, and two from Russia answered 'Don't know'.

about sexual history, including number of partners and condom use. No 'Refuse' responses were given in China, and when they occurred in the other countries, typically no more than two people refused to answer a particular question. In China and India, however, participants appeared to give inconsistent responses to the question regarding sexual activity. Only a fraction of married respondents in these countries reported that they had ever had sex: 32% (6/19) in China and 59% (17/29) in India.

The majority of participants in each country reported a high level of comfort entering their answers into the computer (Table 2), ranging from 82% in India to 100% in Russia. When asked whether the computer ensures sufficient privacy, approximately 40% in China, India, and Peru, and only 23% in Russia responded 'Yes, absolutely'. In China, Peru, and Russia, 60% or more of participants felt the computer provided more privacy in

answering questions, would be better for getting honest answers to questions on topics such as sexual behavior and drug and alcohol use, and said they would prefer answering these types of questions with a computer compared with an interviewer. In India, although approximately 20–30% agreed, roughly 40–60% felt the computer and an interviewer gave the same amount of privacy, would result in equally honest answers, and did not have a preference for the interview mode. Most participants said they would prefer to hear a female voice, although in Peru approximately equal numbers said they did not have a preference. Between 67 and 77% of participants indicated that they had been 'Absolutely honest' in answering the questions in the interview.

In response to findings in the ACASI feasibility study, we made several improvements to the ACASI computer program before the crossover study:

Table 2. Audio computer-assisted self-interviewing feasibility study: participant responses to feedback questions.

Question	China N = 30	India N = 40	Peru N = 30	Russia N = 30
How easy was it for you to hear the questions? [very easy, easy, somewhat hard, very hard] ^a				
Very easy or easy	23/30 (77%)	32/38 (84%)	29/30 (97%)	28/29 (97%)
How easy was it to answer the questions using the computer? [very easy, easy, somewhat hard, very hard] ^a				
Very easy or easy	25/30 (83%)	28/40 (70%)	29/30 (97%)	29/30 (97%)
How comfortable did you feel entering your answers into the computer? [very comfortable, comfortable, somewhat uneasy, very uneasy] ^a				
Very comfortable or comfortable	26/30 (87%)	31/38 (82%)	29/30 (97%)	30/30 (100%)
Do you think that using the computer ensures sufficient privacy? [yes, absolutely; it probably does; not sure; it probably does not; no, absolutely not] ^a				
Yes, absolutely	11/29 (38%)	17/39 (44%)	13/30 (43%)	7/30 (23%)
It probably does	9/29 (31%)	9/39 (23%)	11/30 (37%)	13/30 (43%)
Which do you feel gives you more privacy in answering questions: a computer or an interviewer?				
Computer	20/29 (69%)	11/38 (29%)	23/29 (79%)	25/30 (83%)
Interviewer	3/29 (10%)	9/38 (24%)	0	1/30 (3%)
They give the same amount of privacy	6/29 (21%)	16/38 (42%)	6/29 (21%)	4/30 (13%)
Which do you feel would be better for getting honest answers to questions about topics like sexual behavior, and drug and alcohol use: a computer or an interviewer?				
Computer	18/30 (60%)	9/36 (25%)	19/29 (66%)	26/30 (87%)
Interviewer	4/30 (13%)	9/36 (25%)	3/29 (10%)	3/30 (10%)
Answers are equally honest with both	8/30 (27%)	18/36 (50%)	7/29 (24%)	1/30 (3%)
Which do you feel more comfortable giving answers to about topics like sexual behavior, and drug and alcohol use: a computer or an interviewer?				
Computer	18/30 (60%)	11/37 (30%)	25/30 (83%)	23/30 (77%)
Interviewer	2/30 (7%)	7/37 (19%)	1/30 (3%)	2/30 (7%)
I feel equally comfortable with both	10/30 (33%)	19/37 (51%)	4/30 (13%)	5/30 (17%)
Which would you prefer for answering questions about topics like sexual behavior, and drug and alcohol use: the computer or the interviewer?				
Computer	18/30 (60%)	8/39 (21%)	19/29 (66%)	22/30 (73%)
Interviewer	2/30 (7%)	7/39 (18%)	0	2/30 (7%)
I do not have a preference	10/30 (33%)	24/39 (62%)	10/29 (34%)	6/30 (20%)
If you were going to participate in a 45 minute interview, would you prefer to give your answers to a computer, an interviewer, or a combination?				
Computer	15/30 (50%)	5/39 (13%)	13/30 (43%)	19/30 (63%)
Interviewer	2/30 (7%)	7/39 (18%)	0	1/30 (3%)
Combination of computer and interviewer	8/30 (27%)	6/39 (15%)	11/30 (37%)	7/30 (23%)
I do not have a preference	5/30 (17%)	21/39 (54%)	6/30 (20%)	3/30 (10%)
Would you prefer to hear questions asked with a female voice or a male voice?				
Female voice	19/30 (63%)	25/40 (63%)	13/30 (43%)	20/30 (67%)
Male voice	1/30 (3%)	10/40 (25%)	5/30 (17%)	3/30 (10%)
I do not have a preference	10/30 (33%)	5/40 (13%)	12/30 (40%)	7/30 (23%)
How honest have you been in answering the questions in this interview? [absolutely honest, somewhat honest, honest about half of the time, not very honest, not honest at all] ^a				
Absolutely honest	20/30 (67%)	26/39 (67%)	22/30 (73%)	23/30 (77%)
Somewhat honest	7/30 (23%)	10/39 (26%)	7/30 (23%)	7/30 (23%)

^aAll possible response choices are shown in brackets. Counts and percentages are not shown for all choices.

Participants were forced to enter a response (can include 0, Refuse, Don't know) for questions requiring a numerical response or when error messages appeared. Previously, participants in the feasibility study could press 'Enter' without actually entering a numeric value and the system assigned a value of '0'.

Edit checks were included for questions to prevent an answer from being inconsistent with the response to the previous question (just before the current question). In the feasibility study, edit checks were not included; for example, individuals could indicate that they had had sex five times and used a condom 10 of those times.

Refuse/Don't know answers in the feasibility study allowed the respondent to skip out as though the answer had been 'No'. In the crossover study, participants were forced to answer subsequent related questions (in most cases).

A number box was added to the ACASI screen to allow participants to see the number they were entering for questions requiring a numerical response.

Several sites retranslated the questionnaire incorporating more colloquial language.

If a participant did not answer a question after approximately 60 s, the question was repeated.

Additional text was added before asking the first question on sex (ever had sexual intercourse) to provide a transition into the sensitive questions. If the participant took a long time to answer the sex questions, additional text appeared encouraging participants to answer these sensitive questions in a truthful manner.

The screen saver and monitor power-saver settings were disabled on the computer so that screens did not go blank when a participant took additional time to answer a question.

Crossover audio computer-assisted self-interviewing versus computer-assisted personal interviewing comparison study

Between December 2000 and May 2001, a total of 445 volunteers in five countries participated in the crossover study, with sample sizes ranging from 54 people in Zimbabwe to 199 in China. The two randomized groups (ACASI first and CAPI first) were similar with respect to sex and age, demonstrating the success of the local randomizations (Table 3).

The median time (minutes) required to complete the ACASI was longer than for the CAPI in all countries except Russia (ACASI versus CAPI, China: 18 versus 12, India: 32 versus 15, Peru: 20 versus 13, Russia: 11 for each, Zimbabwe: 25 versus 11). Notably, in India and Zimbabwe, the interviews took twice as long to complete on ACASI compared with CAPI. In Russia, investigators felt that the rapid completion time on both modes may suggest that insufficient attention was paid to the task or, alternatively, that the Russian students were more familiar with computer technology.

The pattern of participant response pairs on the ACASI and CAPI was examined for 11 potentially sensitive questions concerning STD history, alcohol and drug use, sex trade, the purchase of condoms, and the likelihood of becoming HIV infected (see Methods). The majority of respondents gave the same answer to these questions at both interviews. No statistically significant differences were found between the ACASI and CAPI responses to

Table 3. Crossover audio computer-assisted self-interviewing versus computer-assisted personal interviewing comparison study: demographic characteristics for audio computer-assisted self-interviewing first versus computer-assisted personal interviewing first.

Country	Sex				<i>P</i> value ^a	Age (years)		
	Male		Female			Median	Range	<i>P</i> value ^a
	Count	%	Count	%				
China (<i>N</i> = 199)								
ACASI first	55/100	55	45/100	45	1.0	28	18–40	0.3
CAPI first	54/99	55	45/99	45		30	18–40	
India (<i>N</i> = 63)								
ACASI first	13/29	45	16/29	55	0.8	29	18–40	0.8
CAPI first	17/34	50	17/34	50		28.5	20–40	
Peru (<i>N</i> = 69)								
ACASI first	14/31	45	17/31	55	0.6	22	18–30	0.6
CAPI first	20/38	53	18/38	47		22	18–30	
Russia (<i>N</i> = 60)								
ACASI first	16/30	53	14/30	47	0.8	20	18–24	0.1
CAPI first	14/30	47	16/30	53		19	18–24	
Zimbabwe (<i>N</i> = 54)								
ACASI first	12/26	46	14/26	54	1.0	20	16–29	0.9
CAPI first	12/28	43	16/28	57		20	16–29	

^a*P* value for a difference between the audio computer-assisted self-interviewing (ACASI) first and computer-assisted personal interviewing (CAPI) first groups on sex by Fisher's exact test; on age by the Wilcoxon rank sum test.

Table 4. Crossover audio computer-assisted self-interviewing versus computer-assisted personal interviewing comparison study: sex behavior outcomes by randomized group for China, India and Peru.

Question ^a	China				India				Peru			
	Yes ACASI		Yes CAPI		Yes ACASI		Yes CAPI		Yes ACASI		Yes CAPI	
	No CAPI ^b	Same on both	No ACASI ^c	Same on both	No CAPI	Higher on ACASI	No ACASI	Higher on CAPI	No CAPI	Higher on ACASI	No CAPI	Higher on CAPI
Ever had sex?												
ACASI first	3 (3%)	78 (78%)**	19 (19%)	73 (74%)	1 (3%)	1 (3%)	1 (3%)	1 (3%)	1 (3%)	1 (3%)	1 (3%)	1 (3%)
CAPI first	2 (2%)	73 (74%)	23 (23%)	73 (74%)	0	5 (15%)	5 (15%)	5 (15%)	3 (8%)	3 (8%)	0	35 (92%)
Question	Higher on ACASI	Same on both	Higher on CAPI	Same on both	Higher on ACASI	Higher on CAPI	Higher on ACASI	Higher on CAPI	Higher on ACASI	Higher on ACASI	Higher on CAPI	Same on both
No. of partners in past year												
ACASI first	10 (10%)	68 (69%)**	20 (20%)	71 (72%)	5 (19%)	3 (11%)	3 (11%)	3 (11%)	6 (21%)	6 (21%)	2 (7%)	21 (72%)*
CAPI first	5 (5%)	71 (72%)	22 (22%)	71 (72%)	0	8 (26%)	8 (26%)	8 (26%)	5 (13%)	5 (13%)	0	33 (87%)
No. of partners in past 3 months												
ACASI first	2 (2%)	79 (80%)**	18 (18%)	70 (71%)	0	1 (4%)	1 (4%)	1 (4%)	5 (17%)	5 (17%)	7 (24%)	17 (59%)
CAPI first	5 (5%)	70 (71%)	23 (23%)	70 (71%)	4 (13%)	6 (19%)	6 (19%)	6 (19%)	7 (19%)	7 (19%)	1 (3%)	29 (78%)
No. of unprotected acts in past 3 months												
ACASI first	16 (18%)	42 (47%)**	31 (35%)	51 (55%)	7 (33%)	2 (10%)	2 (10%)	2 (10%)	8 (28%)	8 (28%)	2 (7%)	19 (66%)
CAPI first	15 (16%)	51 (55%)	27 (29%)	51 (55%)	5 (20%)	6 (24%)	6 (24%)	6 (24%)	6 (18%)	6 (18%)	4 (12%)	23 (70%)

^aIndividuals lacking a response to the same question on one or both interviews could not be included in the counts for that question. Therefore, the total number of participants in each group does not always add up to the number randomized.

^bResponse was 'yes' on the audio computer-assisted self-interviewing (ACASI) and 'no' on the computer-assisted personal interviewing (CAPI).

^cResponse was 'yes' on the CAPI and 'no' on the ACASI.

* $P \leq 0.05$ for a difference between ACASI and CAPI responses by the Wilcoxon rank sum test.

** $P \leq 0.01$ for a difference between ACASI and CAPI responses by Prescott's test (Ever had sex) or the Wilcoxon rank sum test.

any of these questions in any country except for one question in Peru. For example, in response to 'Have you ever been tested for HIV infection?' most people said 'No' on both interviews or 'Yes' on both interviews, with only one to four people (depending on the country) saying 'No' on one interview and 'Yes' on the other. In Peru, in response to 'How likely is it that you will become HIV infected?' six participants said 'likely' with CAPI but 'unlikely' with ACASI ($P=0.04$).

ACASI and CAPI responses to 'Have you ever had sex?' and three other sexual behavior outcomes were compared for each study site (Table 4 and Table 5). Consistent differences in responses by interview mode occurred only in China, where more participants reported ever having sex, a greater number of partners in the past year and in the past 3 months, and a greater number of unprotected sex acts in the past 3 months on CAPI than they did on ACASI ($P<0.01$ for each). In most cases when a difference in the number of partners was reported, only one more partner was reported on the CAPI compared with the ACASI.

No significant differences were found between ACASI and CAPI responses on any of the four sexual behavior outcomes in India or Zimbabwe. Most people said 'Yes' on both interviews or 'No' on both interviews to 'Have you ever had sex?' and for most, the same number of partners and unprotected acts were reported on each interview. In Peru, a statistically significant difference between interview methods was found for the number of partners in the past year ($P=0.02$). Among the participants whose responses changed from one interview

to the next, a larger number of partners was reported at ACASI than at CAPI, although in most cases only one more partner was reported. Although not statistically significant, there was a trend to report more unprotected acts in the past 3 months on ACASI compared with CAPI ($P=0.06$). Differences were not found in Peru on the other two sexual behavior outcomes. All Russian participants reported the same response on both of their interviews to 'Have you ever had sex?', and no differences were found by interview mode on the number of partners or the number of unprotected acts in the past 3 months. In Russia, however, a statistically significant difference was found between ACASI and CAPI responses on the number of partners in the past year ($P=0.04$), with a greater number of partners reported by some people on CAPI than on ACASI. This difference could be explained by participants trying to appear closer to perceived social norms in a personal interview, which would not be necessary when responding to questions asked by a computer.

Discussion

We conducted a feasibility study to determine whether ACASI could be used successfully to conduct interviews containing potentially sensitive questions in diverse settings in China, India, Peru, and Russia, and a randomized crossover study to compare results obtained by ACASI versus CAPI in the same four countries plus Zimbabwe. Despite the varying levels of literacy and exposure to computers by country, most feasibility study

Table 5. Crossover audio computer-assisted self-interviewing versus computer-assisted personal interviewing comparison study: sex behavior outcomes by randomized group for Russia and Zimbabwe.

Question ^a	Russia			Zimbabwe		
	Yes ACASI No CAPI ^b	Yes CAPI No ACASI ^c	Same on both	Yes ACASI No CAPI	Yes CAPI No ACASI	Same on both
Ever had sex?						
ACASI first	0	0	30 (100%)	0	0	26 (100%)
CAPI first	0	0	28 (100%)	1 (4%)	0	27 (96%)
Question	Higher on ACASI	Higher on CAPI	Same on both	Higher on ACASI	Higher on CAPI	Same on both
No. of partners in past year						
ACASI first	2 (7%)	7 (23%)	21 (70%)*	2 (8%)	2 (8%)	22 (85%)
CAPI first	2 (7%)	5 (18%)	21 (75%)	3 (11%)	0	25 (89%)
No. of partners in past 3 months						
ACASI first	2 (7%)	3 (11%)	23 (82%)	2 (8%)	2 (8%)	22 (85%)
CAPI first	6 (21%)	2 (7%)	20 (71%)	2 (7%)	0	26 (93%)
No. of unprotected acts in past 3 months						
ACASI first	3 (12%)	5 (20%)	17 (68%)	0	2 (9%)	20 (91%)
CAPI first	2 (9%)	1 (4%)	20 (87%)	7 (27%)	3 (12%)	16 (62%)

^aIndividuals lacking a response to the same question on one or both interviews could not be included in the counts for that question. Therefore, the total number of participants in each group does not always add up to the number randomized.

^bResponse was 'yes' on the audio computer-assisted self-interviewing (ACASI) and 'no' on the computer-assisted personal interviewing (CAPI).

^cResponse was 'yes' on the CAPI and 'no' on the ACASI.

* $P\leq 0.05$ for a difference between ACASI and CAPI responses by the Wilcoxon rank sum test.

participants reported that it was easy to enter their answers into the computer, that they felt comfortable doing so, and that they preferred the computer rather than an interviewer for answering questions about topics such as sexual behavior and drug and alcohol use, or had no preference. In the crossover study, most participants gave the same responses on both their ACASI and CAPI. Only in China did responses on sexual behavior outcomes differ consistently by interview mode, with more people reporting sexual activity and a greater number of partners at CAPI.

Both studies indicated that it was possible to use ACASI in the settings selected in each of the five countries. ACASI is a more standardized method of assessment because with CAPI interviewers may use probes beyond the standard set even though they are instructed not to do so. ACASI may, however, present problems for people with low educational levels if they cannot clarify a question that they do not understand. Nevertheless, both ACASI and CAPI can be used with people who are not literate, and both interview modes simplify response input over self-administered questionnaires because data are entered in real time and do not require remote data entry at a later time. Accordingly, both ACASI and CAPI lead to fewer data entry errors because the skip patterns are programmed into the computer and are executed as the interview is administered. Although ACASI provides a more private experience for participants, and less staff time is required to administer ACASI questionnaires because they are self-administered, ACASI generally takes longer to administer than CAPI. We found this in all research sites with the exception of Russia, where the participants had more exposure to technology and, as they were students, were of a younger age. Alternatively, the Russian students may have paid less attention to the task; it is not known what reason accounts for the similar time in responding to the surveys.

On the basis of our results, the Trial leadership decided to use ACASI for the first epidemiological study in Peru, Russia, and Zimbabwe and use CAPI in China and India. To ensure a common method of administration of assessments during the Trial, however, investigators adopted CAPI as the standard for all subsequent assessments. This was largely driven by the inconsistent findings in China, and the longer duration of the interviews in most countries for ACASI compared with CAPI. It should be noted that the number of people who participated in the crossover study was approximately three times as large in China as in the other countries, which may have increased our ability to detect interview mode differences in that country. Even without considering statistical test results, a difference by mode appears more consistent across the four sexual behavior outcomes in China, and statistical test results were not considered when making the decision to use CAPI during the Trial. Most importantly, few differences in

responses were found in general between the two methods in the other countries, and in all countries we did not find the consistently higher reporting rates of sensitive sexual behaviors on ACASI that had been anticipated. This lack of differential in reporting among participants in the other countries was important in our selection of CAPI for the Trial.

References

1. Dare OO, Cleland JG. **Reliability and validity of survey data on sexual behaviour.** *Health Transit Rev: AIDS Impact and Prevention in the Developing World: Demographic and Social Science Perspectives* 1994; **4 (Suppl.):**93–110.
2. Newman JC, Des Jarlais DC, Turner CF, Gribble J, Cooley P, Paone D. **The differential effects of face-to-face and computer interview modes.** *Am J Public Health* 2002; **92:**294–297.
3. Johnson AM, Copas AJ, Erens B, Mandalia S, Fenton K, Korovessis C, et al. **Effect of computer-assisted self-interviews on reporting of sexual HIV risk behaviours in a general population sample: a methodological experiment.** *AIDS* 2001; **15:** 111–115.
4. Turner CF, Ku L, Rogers SM, Lindberg LD, Pleck JH, Sonenstein FL. **Adolescent sexual behavior, drug use, and violence: increased reporting with computer survey technology.** *Science* 1998; **280:**867–873.
5. Liu H, Detels R. **An approach to improve validity of responses in sexual behavior study in a rural area of China.** *AIDS Behav* 1999; **3:**243–249.
6. Metzger DS, Koblin B, Turner C, Navaline H, Valenti F, Holte S, et al., for the HIVNET Vaccine Preparedness Study Protocol Team. **Randomized controlled trial of audio computer-assisted self-interviewing: utility and acceptability in longitudinal studies.** *Am J Epidemiol* 2000; **152:**99–106.
7. Macalino GE, Celentano DD, Latkin C, Strathdee SA, Vlahov D. **Risk behaviors by audio computer-assisted self-interviews among HIV-seropositive and HIV-seronegative injection drug users.** *AIDS Educ Prev* 2002; **14:**367–378.
8. Gribble JN, Miller HG, Cooley PC, Catania JA, Pollack L, Turner CF. **The impact of T-ACASI interviewing on reported drug use among men who have sex with men.** *Substance Use Misuse* 2000; **35:**869–890.
9. Lessler JT, O'Reilly JM. **Mode of interview and reporting of sensitive issues: design and implementation of audio computer assisted self-interviewing.** In: Harrison L, Hughes A, editors. *The validity of self-reported drug use: improving the accuracy of survey estimates.* National Institute on Drug Abuse Research Monograph No. 17. Rockville, MD: National Institute on Drug Abuse 1997; pp. 366–382.
10. Jones R. **Survey data collection using audio computer assisted self-interview.** *West J Nurs Res* 2003; **25:**349–358.
11. Turner CF, Rogers SM, Miller HG, Miller WC, Gribble JN, Chromy JR, et al. **Untreated gonococcal and chlamydial infection in a probability sample of adults.** *JAMA* 2002; **287:**726–733.
12. Krawczyk CS, Gardner LI, Wang J, Sadek R, Loughlin AM, Anderson-Mahoney P, et al., for the Antiretroviral Treatment and Access Study Group. **Test-retest reliability of a complex human immunodeficiency virus research questionnaire administered by an audio computer-assisted self-interviewing system.** *Med Care* 2003; **41:**853–858.
13. Rosen CS, Henson BR, Finney JW, Moos RH. **Consistency of self-administered and interview-based Addiction Severity Index composite scores.** *Addiction* 2000; **95:**419–425.
14. Aquilino WS, Wright DL, Supple AJ. **Response effects due to bystander presence in CASI and paper-and-pencil surveys of drug use and alcohol use.** *Substance Use Misuse* 2000; **35:**847–867.
15. Aitken JF, Youl PH, Janda M, Elwood M, Ring IT, Lowe JB. **Comparability of skin screening histories obtained by telephone interviews and mailed questionnaires: a randomized cross-over study.** *Am J Epidemiol* 2004; **160:**598–604.

16. Perlis TE, Des Jarlais DC, Friedman SR, Arasteh K, Turner CF. **Audio-computerized self-interviewing versus face-to-face interviewing for research data collection at drug abuse treatment programs.** *Addiction* 2004; **99**:885–896.
17. Des Jarlais DC, Paone D, Milliken J, Turner CF, Miller H, Gribble J, et al. **Audio-computer interviewing to measure risk behaviour for HIV among injecting drug users: a quasi-randomised trial.** *Lancet* 1999; **353**:1657–1662.
18. Ghanem KG, Hutton HE, Zenilman JM, Zinba R, Erbeling EJ. **Audio computer assisted self interview and face to face interview modes in assessing response bias among STD clinic patients.** *Sex Transm Infect* 2005; **81**:421–425.
19. Williams ML, Freeman RC, Bowen AM, Zhao Z, Elwod WN, Gordon C, et al. **A comparison of the reliability of self-reported drug use and sexual behaviors using computer-assisted versus face-to-face interviewing.** *AIDS Educ Prev* 2000; **12**:199–213.
20. Jennings TE, Lucenko BA, Malow RM, Devieux JG. **Audio-CASI vs interview method of administration of an HIV/STD risk of exposure screening instrument for teenagers.** *Intern J STD AIDS* 2002; **13**:781–784.
21. Ellen JM, Gurvey JE, Pasch L, Tschann J, Nanda JP, Catania J. **A randomized comparison of A-CASI and phone interviews to assess STD/HIV-related risk behaviors in teens.** *J Adolesc Health* 2002; **31**:26–30.
22. Murphy DA, Durako S, Muenz LR, Wilson CM. **Marijuana use among HIV-positive and high-risk adolescents: a comparison of self-report through audio computer-assisted self-administered interviewing and urinalysis.** *Am J Epidemiol* 2000; **152**:805–813.
23. Webb PM, Zimet GD, Fortenberry JD, Blythe MJ. **Comparability of a computer-assisted versus written method for collecting health behavior information from adolescent patients.** *J Adolesc Health* 1999; **24**:383–388.
24. Boekeloo BO, Schiavo L, Rabin DL, Conlon RT, Jordan CS, Mundt DJ. **Self-reports of HIV risk factors by patients at a sexually transmitted disease clinic: audio vs written questionnaires.** *Am J Public Health* 1994; **84**:754–760.
25. Bakker I, Twisk JWR, van Mechelen W, Mensink GBM, Kemper HCG. **Computerization of a dietary history interview in a running cohort; evaluation within the Amsterdam Growth and Health and Longitudinal Study.** *Eur J Clin Nutr* 2003; **57**:394–404.
26. Rumakom P, Guest P, Chinvarasopak W, Utmarat W, Sontanakanit J. **Obtaining accurate responses to sensitive questions: a comparison of two data collection techniques.** Bangkok: Population Council; 1999.
27. Van de Wijgert J, Padian N, Shiboski S, Turner C. **Is audio computer-assisted self-interviewing a feasible method of surveying in Zimbabwe?** *Int J Epidemiol* 2000; **29**:885–890.
28. Lara D, Ellertson C, Diaz C, Strickler J. **Measuring the prevalence of induced abortion in Mexico City: Comparison of four methodologies.** Paper presented at the 24th Population Conference of the International Union for the Scientific Study of Population. Salvador de Bahia, Brazil, 18–24 August 2001 [Abstract].
29. Mensch BS, Hewett PC, Erulkar AS. **The reporting of sensitive behavior by adolescents: A methodological experiment in Kenya.** *Demography* 2003; **40**:247–268.
30. Hewett PC, Erulkar AS, Mensch BS. **The feasibility of computer-assisted survey interviewing in Africa; experience from two rural districts in Kenya.** *Soc Sci Comput Rev* 2004; **22**:1–16.
31. Jones B, Kenward G. *Design and analysis of crossover trials.* New York: Chapman and Hall; 1989.
32. Senn S. *Crossover trials in clinical research.* New York: John Wiley and Sons; 1993.