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T-ACASI Reduces Bias in STD Measurements: The National STD and Behavior Measurement Experiment

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Background: **Although telephone surveys provide an economical method for assessing patterns of diagnosed sexually transmitted diseases (STDs) and STD-related behaviors in populations, the requirement that respondents report such information to human telephone interviewers introduces an opportunity for substantial reporting bias. Telephone computer-assisted self-interviewing (T-ACASI) surveys substitute a computer for human interviewers when asking sensitive questions.**

Methods: **A randomized experiment was embedded in a telephone survey that drew probability samples of the populations of the United States (N = 1543) and Baltimore city (N = 744). Respondents were randomly assigned to have sensitive questions asked either by a T-ACASI computer or by a human telephone interviewer.**

Results: **Respondents interviewed by a T-ACASI computer were more likely to report STD symptoms [dysuria, genital sores, genital discharge, and genital warts; adjusted odds ratios (ORs) = 1.5–2.8] and a diagnosis of gonococcal or chlamydial infection during the past year (adjusted ORs = 3.6 and 6.1). T-ACASI respondents with a main sex partner in the past year were more likely to report that their partner has had an STD (adjusted OR = 2.4). For some measurements, the impact of T-ACASI was strongest among younger and less-educated respondents. When sampling weights were applied to project National STD and Behavior Measurement Experiment results to the populations of the United States and Baltimore, we found that reliance on data obtained by human interviewers would underestimate the annual incidence of chlamydial and gonococcal infections in these populations by factors of 2.4 to 9.7.**

Conclusions: **Compared with human telephone interviewers, T-ACASI surveys obtain increased reporting of STD symptoms, infections, and STD-related behaviors.**

IN THE ABSENCE OF POPULATION surveys that collect and test biologic specimens,[1–3] estimates of the burden of sexually transmitted diseases (STDs) in a population must rely upon either counts of diagnosed infections reported to local health departments or respondents' self-reports of STD symptoms and diagnoses provided in surveys. Both of these sources underestimate the true burden of infection in a population. STD cases are well known to be underreported to health departments.[4] The extent of this undercount bias is not thought to be uniform over time or localities, and inferences about trends over time or variations across jurisdictions in diagnosed infections are subject to nontrivial inaccuracy. Similarly, survey respondents are often hesitant to admit stigmatized, illicit, or embarrassing behaviors to a human interviewer[5–8] —a concept often attributed to "social desirability" bias.[9]

Eliminating the requirement that respondents disclose STD-related and other sensitive information to human interviewers substantially increases the likelihood that this information will be reported in population surveys and clinical measurements.[10–19] Until recently, telephone surveys could not offer a fully private mode of questioning comparable to the paper self-administered questionnaires and audio computer-assisted self-interviewing (audio-CASI) technology used for in-person surveys.

In 1995, we adapted an audio-CASI system to support complex telephone surveys.[20–22] A randomized experiment embedded in the 1996 to 1998 Urban Men's Health Survey compared results obtained with this Telephone audio-CASI (T-ACASI) system with those obtained by human interviewers. This experiment found that T-ACASI respondents were more likely to report use of a range of illegal drugs, concern about their current drug use, and exchange of money or drugs for sex.[23] Subsequent work by our group and collaborators has found that T-ACASI increased reporting of sensitive and stigmatized behaviors, including illicit (but not licit) drug use, same-gender and heterosexual sexual behaviors and "unpopular attitudes" in general population samples, and teen smoking in a regional sample.[22,24–27] A growing body of evidence amassed by other researchers has yielded generally supportive evidence of the

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A supplementary survey/questionnaire is available via the ArticlePlus feature at www.stdjournal.com. Please go to the May 2008 issue and click on the ArticlePlus link posted with the article in the Table of Contents to view this material.

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positive impact of T-ACASI on reporting of sensitive sexual and STD-related behaviors.[28–30]

The National STD and Behavior Measurement Experiment

The National STD and Behavior Measurement Experiment (NSBME) was designed to assess the impact of T-ACASI on reporting of STDs and a range of other sensitive characteristics and behaviors. In this article, we report NSBME findings for survey questions asking about respondents' history of STD symptoms and diagnoses, health care for STD symptoms, and interactions with their main partner about STDs.

Methods

The protocol for this research was approved and supervised by Institutional Review Boards at the Research Triangle Institute and the University of Massachusetts at Boston, MA.

Sample and Experimental Design

As described more completely in prior publications,[25,31,32] the NSBME experiment was embedded in a telephone survey of a probability sample of women and men aged 18 to 45 years residing in US households with working land line telephones. The survey was conducted between September 1999 and April 2000. Two sample strata were recruited for this survey measurement experiment: (a) a sample of the telephone-accessible US household population aged 18 to 45 (national stratum), and (b) a parallel sample of the telephone-accessible population of the city of Baltimore, MD (Baltimore stratum). The Baltimore stratum was included to allow a comparison of results from the NSBME survey[3] with those from a similar in-person survey conducted between 1997 and 1998.

For the national stratum, 14,250 telephone numbers were generated, and 12,322 telephone numbers (86.5%) were successfully screened for eligibility. Of these screened telephone numbers 2183 were found to be residential numbers with 1 or more eligible English-speaking respondents aged 18 to 45. One eligible household member of these households was randomly selected for participation in the survey (without substitution). Of the 2183 target respondents in the national strata 1452 (66.5%) completed interviews (66.5%) and 91 (4.2%) completed partial interviews that included at least 1 substantive questionnaire section. Up to a maximum of 91 calls (mean = 11.3) were made to screen households and complete an interview in the national stratum.

The second sample stratum was drawn to represent the adult population of Baltimore, MD. For this stratum, 7498 telephone numbers were generated and 6326 (84.4%) were successfully screened for eligibility. Screening identified 1072 households with an eligible respondent, and 697 of these eligible respondents completed interviews (65.0%). An additional 47 respondents (4.4%) completed partial interviews. Up to a maximum of 82 calls (mean = 12.3) were made to screen households and complete an interview in the Baltimore stratum.

Interview Modes

Telephone numbers were randomly assigned to the telephone interviewer-administered questioning (T-IAQ) or T-ACASI conditions before their release to the telephone survey unit. After screening and recruitment into the study, telephone interviewers at the Center for Survey Research (University of Massachusetts, Boston, MA) conducted the survey either by asking questions of the respondent and recording their answers (T-IAQ condition) or by transferring the respondent to the T-ACASI system.

Survey Measurements

The NSBM experiment included 35 questions that asked about communication with partner(s) about sexual behaviors and STD prevention, recognition of both actual and *fictitious* STDs, incidence of STD symptoms and health care treatment for these symptoms, if any, and STD diagnoses. Survey questions were adapted from a range of widely cited national surveys from the United States and Britain,[33–37] including Tanfer's National Survey of Men, Catania et al.'s National AIDS Behavior Survey, Johnson et al.'s National Survey of Sexual Attitudes and Lifestyles, Sonenstein et al.'s National Survey of Adolescent Males, and Laumann et al.'s National Health and Social Life Survey. Symptoms and diseases covered included dysuria, genital sores or blisters, genital discharge, genital warts, gonorrhea, chlamydia, genital phlemoria (*a fictitious STD*), pelvic inflammatory disease (PID), and *any* STD "such as herpes, gonorrhea, or syphilis." Although the descriptions in this article make use of formal terms such as "dysuria," our survey questions used common English phraseology, e.g., "Have you EVER had a burning feeling when you urinate?"

Typical sequences of STD questions asked were (a) whether respondents had ever heard of a specific STD, e.g., chlamydia; (b) whether they had ever been diagnosed with that STD; (c) recency of their last diagnosis; and (d) total number of lifetime diagnoses with this STD. Respondents who did not recognize an STD were not asked the subsequent 3 questions about that STD; similarly persons with no history of that STD were not asked the 2 follow-up questions about recency and number of infections. On average, sexually experienced respondents answered 16 of the 35 STD-related questions included in the NSBME. Wordings for all of these survey questions can be found in both an on-line publication[38] and also in *STD*'s Article Plus repository.

Statistical Analysis

Our analyses are intended to answer 2 major questions:

- Compared with human telephone interviewers, does T-ACASI change the likelihood that respondents will report STD symptoms, infections and treatment, discussion of STDs with their sexual partner, partner's STDs, and avoidance of sex because of concerns about STD transmission?
- Is the magnitude and direction of the T-ACASI effect, if any, homogeneous across subpopulations defined by social and demographic factors, such as gender, age, and education?

The NSBME also included 2 questions on a *fictitious* STD to provide a crude indicator of the extent, if any, to which T-ACASI might encourage false claims of STD knowledge or diagnoses.

To answer our major questions, we combine the NSBME's national and Baltimore sample strata. These combined sample strata are treated as a population that has been randomly allocated to 1 of 2 experimental conditions: T-ACASI or T-IAQ interview mode. Data in these analyses are unweighted, and our statistical analyses assess the likelihood that observed fluctuations in survey responses across the 2 interview modes arose by chance from the random allocation of respondents to 1 of the 2 experimental groups. When this null hypothesis is rejected, we conclude that the mode of interview had an effect on survey response.

To assess the magnitude of this effect, we compute the crude odds ratios (ORs) for our STD measurements comparing responses obtained by T-ACASI and T-IAQ. Because the availability of touchtone phones and differential sample loss in the 2 conditions could introduce undetected divergence in the sociodemographic composition of the respondents assigned to the 2 modes, we also report adjusted ORs controlling for the impact of deviations in sample composition. Adjusted ORs are calculated using multivariate logistic regression models that control for sample strata (national and Baltimore), gender, age group (18–25, 26–35, 36–45), educational level (<high school, high school, some college, ≥4-year college degree), marital status (married, cohabiting, divorced or widowed or separated, unmarried), race or ethnicity (non-Hispanic black, non-Hispanic white, non-Hispanic other, Hispanic), and 2 levels of urbanization [21 largest metropolitan statistical areas vs. other locales; see Ref. 25 for a list of metropolitan statistical areas].

Tests of the homogeneity of estimated T-ACASI mode effects were conducted by first obtaining maximum-likelihood estimates of logit models that predicted each STD measurement as a function of interview mode and the social or demographic variables of interest: gender, sample strata (the United States or Baltimore), years of education, age, race (black vs. nonblack), and marital status (married or living with partner vs. other). The fit of this model was then compared using a likelihood ratio test to the fit of a model that added an additional term representing the mode-by-demographic factor interaction. Our tests of homogeneity were targeted on the most important mode effects—in particular, those that were (a) statistically significant, (b) reasonably large (ORs >2.0 or ORs <0.50), and (c) involved questions answered by a substantial majority of respondents (N > 1700). In addition to the foregoing analyses, we accommodated a reviewer's concerns by conducting similar analyses checking for mode-by-stratum interactions for all of the STD measurements reported in Tables 1 and 2.

In our final analysis, estimates of STD burden for the United States and Baltimore populations were calculated separately by survey mode using sampling and poststratification weights[39] to project the sample data to the national and Baltimore city populations. All statistical analyses were carried out using Stata, versions 6.0 and 8.0.[40]

Results

Sample Equivalence

Previously published analyses tested the equivalence of T-IAQ and T-ACASI samples by gender, age, marital status, education, race or ethnicity, region, urbanization, and sample strata. No comparison produced evidence of nonequivalence with a P value less than 0.28.[25,31]

Partner's STD Status and Communication

Over half of all sexually experienced respondents reported never avoiding sex to prevent STD transmission (Table 1). Reports of never avoiding sex were greater in T-ACASI than in T-IAQ (59.0% vs. 53.9%, OR = 1.2, P <0.05), but the difference was of borderline significance when adjusted for demographic characteristics (OR = 1.2, P = 0.08). Table 1 also presents results for questions about the respondent's "main sex partner during the past

TABLE 1. Reporting of Avoidance of Sex and Discussions About Sex and STDs With Main Partner in the Past Year*

Measurement	T-ACASI %	T-IAQ %	OR (95% CI)	Adjusted OR (95% CI)
All respondents				
Never avoided sex to prevent STD†	59.0	53.9	1.2‡ (1.0–1.5)	1.2§ (1.0–1.5)
Base N	920	1147	—	—
For respondents who had a main partner in the past year‖				
Partner ever had STD	7.9	3.5	2.3¶ (1.5–3.7)	2.4¶ (1.5–3.7)
Base N	785	988	—	—
Never talked about protecting against STDs	48.2	41.4	1.3# (0.6–0.9)	1.3‡ (0.6–0.9)
Base N	784	987	—	—
Talked about STD protection *before* first sexual contact with partner				
If talked to partner**	82.0	83.0	0.9 (0.7–1.3)	0.9 (0.7–1.4)
Base N	405	571	—	—
Frequency of discussion about sex life (test for linear association, P <0.001††)				
Once a week	47.6	40.1	1.4# (1.1–1.6)	1.4# (1.1–1.7)
Once or twice a month	24.7	23.0	—	—
Once a month	8.8	15.8	—	—
Less than once a month	13.4	11.5	—	—
Never	5.5	9.6	—	—
Base N	782	973	—	—

*This analysis treats merged unweighted sample data from the United States and Baltimore strata as a population that has been randomly assigned to the 2 experimental conditions: T-ACASI or T-IAQ interviewing. For all 5 measurements reported in this table, statistical tests were performed of the null hypothesis that the estimated mode effects (ORs) were homogeneous across sample strata (the United States vs. Baltimore). The null hypothesis was not rejected in any of these tests. P values for these tests exceeded 0.40 for 4 measurements and were 0.18 for measurement of speaking with partner once a week or more about sex life.
†Question excludes 97 (4.3%) participants who reported never having sex with anyone. Of them, 57.6% of the 33 sexually inexperienced T-IAQ participants and 44.4% of the 54 sexually inexperienced T-ACASI participants reported avoiding sex to prevent an infection (P = 0.235).
‡P <0.05; §P <0.10.
‖Participants who reported never having a sex partner in their lifetime skipped questions about partnerships (main sex partner last year and ever having an ongoing sexual relationship that lasted at least 1 month). We report on questions asked about the main partner.
¶P <0.001; #P <0.01.
**Excludes respondents who reported never talking to main sex partner about protecting against STDs.
††Mantel-Haenszel test for linear association for all categories listed from most frequent to never.

TABLE 2. Reported Incidence of STD-Related Symptoms, Lack of Treatment for Symptoms, Recognition and Reported Incidence of STDs, and PID*

Measurement	T-ACASI %	T-IAQ %	OR (95% CI)	Adjusted OR (95% CI)
Symptoms in last year				
Burn when urinate	13.1	9.5	1.5† (1.1–1.9)	1.5† (1.1–1.9)
Genital sores or blisters	3.9	1.4	2.8† (1.6–5.0)	2.8† (1.5–4.8)
Genital discharge or dripping	6.4	3.3	2.0† (1.3–3.0)	2.2‡ (1.4–3.3)
Genital warts	0.8	0.4	2.0 (0.6–6.1)	1.9§ (0.6–5.9)
Base N	950–953	1181–1185	—	—
No treatment for last symptom				
Burn when urinate	29.1	22.1	1.4‖ (1.0–2.0)	1.4¶ (1.0–2.0)
Base N	327	389	—	—
Genital sores or blisters	54.4	50.0	1.2 (0.5–2.7)	—#
Base N	68	36	—	—
Genital discharge or dripping	22.1	12.9	1.9¶ (1.0–3.7)	1.7 (0.8–3.4)
Base N	136	124	—	—
Genital warts	14.3	10.9	1.4 (0.4–4.7)	—#
Base N	49	46	—	—
Recognition of STDs				
Heard of gonorrhea	92.6	96.1	0.5‡ (0.3–0.7)	0.5‡ (0.3–0.7)
Heard of Chlamydia	83.0	81.8	1.1 (0.9–1.4)	1.1 (0.8–1.3)
Heard of PID	61.6	62.7	1.0 (0.8–1.1)	0.9 (0.8–1.1)
Heard of genital phlemoria**	27.1	20.9	1.4† (1.2–1.7)	1.5‡ (1.2–1.8)
Base N	954–955	1184–1186	—	—
Incidence of STDs††				
Gonorrhea, annual incidence‡‡	0.8	0.3	3.3¶ (0.9–12.6)	3.6¶ (0.9–13.8)
Chlamydia, annual incidence‡‡	1.2	0.3	4.6‖ (1.3–16.5)	6.1† (1.6–22.9)
Genital phlemoria,** lifetime incidence	0.3	0.1	3.7 (0.4–35.9)	—#
Base N	952–954	1183–1185	—	—
Incidence of PID				
PID, 5-yr incidence (women only)§§	1.6	1.7	0.9 (0.4–2.2)	1.0 (0.4–2.2)
Base N	563	695	—	—

*This analysis treats merged unweighted sample data from the United States and Baltimore strata as a population that has been randomly assigned to the 2 experimental conditions: T-ACASI or T-IAQ interviewing. For 15 of the 16 measurements reported in this table, statistical tests were performed of the null hypothesis that the estimated mode effects (ORs) were homogeneous across sample strata (the United States vs. Baltimore). The null hypothesis was not rejected in any of these tests. *P* values for these tests exceeded 0.50 for 11 measurements, were in the range 0.40 to 0.49 for 3 measurements, and were 0.17 for reporting of burning on urination. Because only 4 respondents (1 in the T-IAQ condition and 3 in the T-ACASI condition) reported being diagnosed with the fictitious disease "genital phlemoria," the required model could not be fit to this 16th measurement because of the presence of cells with zero counts in the 3-way tabulation of Diagnosis by Mode by Strata. (Of the 4 respondents reporting a diagnosis of genital phlemoria, none were from the national strata in the T-ACASI condition.)

†$P < 0.01$; ‡$P < 0.001$.

§There were no reports of genital warts within the past year in some locales and in the "non-Hispanic other" ethnic group, so this logistic regression adjustment did not control for race or ethnicity and urbanicity.

‖$P < 0.05$; ¶$P < 0.10$.

#Because of small numbers, odds ratios are not adjusted for possible subgroup differences.

**Genital phlemoria is a fictitious disease.

††Participants who reported that they had "never heard of the disease" are included in the category as never having the disease.

§§Although PID is a disorder of the female reproductive tract, we purposely asked this question on PID to both men and women. Two men (excluded here) reported that they had been diagnosed with PID.

‡‡Because of the low annual incidence of these 2 infections, logistic regression models could not control for all social and demographic variables.

NA indicates not applicable.

year." The odds that respondents assigned to the T-ACASI condition reported that their main partner in the past year had a history of STDs were 2.3 times higher than for respondents in the T-IAQ condition (7.9% vs. 3.5%, $P < 0.001$) and 1.3 times higher for reporting that they had never talked to their partner about protecting themselves against STDs (48.2% in T-ACASI vs. 41.6% in T-IAQ, $P < 0.05$). Among those respondents who reported talking about STD protection, there was no difference in reporting that it occurred before rather than after first engaging in sexual activity (82.0% vs. 83.0%, NS). T-ACASI respondents were, however, more likely to report more frequent discussions of their sex life with their main partner. Thus, 47.6% of T-ACASI respondents reported having such discussions weekly compared with 40.1% of respondents in the T-IAQ condition ($P < 0.01$), whereas 5.5% of T-ACASI respondents reported *never* having such discussions compared with 9.6% or T-IAQ respondents ($P < 0.001$ for linear trend across 5 categories of frequency of discussion).

STI Symptoms and Disease

The top panel of Table 2 compares the reported incidence in the past year for 4 STI-related symptoms: dysuria, genital sores,

TABLE 3. Significant and Borderline Variations in T-ACASI Mode Effects Across Subpopulations With *P* Values for Test of Interaction

Measurement	Subgroup*	Estimated Prevalence		OR	*P* Value for Interaction
		T-ACASI %	T-IAQ %		
Genital sores in past year	Black	5.96	0.65	9.17	0.027
	Nonblack	3.22	1.73	1.86	
	Age 18–25	4.59	0.34	13.50	0.045
	Age 36–35	3.07	1.62	1.90	
	Age 36–45	4.28	1.97	2.17	
	High school or less	4.38	1.29	3.40	0.127
	Some college	3.50	0.74	4.73	
	College graduate	3.86	2.30	1.68	
	Married or cohabiting	2.47	1.72	1.44	0.058
	Not married or cohabiting	5.14	1.17	4.39	
Partner ever had an STD	Age 18–25	10.91	2.95	3.70	0.053
	Age 36–35	8.74	4.29	2.04	
	Age 36–45	5.48	3.21	1.71	
Genital discharge in past year	Married or cohabiting	8.82	3.09	2.85	0.051
	Not married or cohabiting	4.34	3.34	1.30	

*For presentation purposes, interaction results are displayed for educational level and age using 3 categories to define subpopulations. In the statistical analysis, these variables were analyzed as metric variables and interaction terms were created by multiplying them by a binary (0, 1) variable indicating whether the respondent was interviewed by T-ACASI or not.

genital discharge, and genital warts by interview mode. In each instance, T-ACASI increased the odds that these symptoms were reported by factors of 1.5 to 2.8. With the exception of genital warts—for which reported incidences were less than 1%—all of these results are statistically reliable ($P < 0.001$). The second panel of Table 2 tests for differences in the likelihood that symptomatic respondents would report that they had sought treatment for their symptom. For all 4 symptoms, T-ACASI respondents were more likely than T-IAQ respondents to report that they did *not* seek medical treatment for their symptoms (ORs = 1.2–1.9). These results are statistically reliable or borderline for reporting of dysuria and genital discharge but not for the other 2 symptoms that were reported by fewer than 50 respondents in the T-IAQ condition.

The third panel of Table 2 examines reported recognition of gonorrhea, chlamydia, PID, and 1 fictitious STD (genital phlemoria). Although the majority of respondents had heard of gonorrhea, significantly fewer respondents in T-ACASI reported knowing of the disease (96.1% vs. 92.6%; adjusted OR = 0.5, $P < 0.001$). T-ACASI respondents were, however, more likely to claim knowledge of the fictitious disease, genital phlemoria (adjusted OR = 1.5, $P < 0.001$). No statistically reliable difference was found for reported recognition of chlamydia or PID.

The final 2 panels of Table 2 examine the reported incidence in the past year of these same STDs for all respondents and PID for females. Respondents were substantially more likely to report chlamydial and gonococcal infections in the past year when interviewed by a T-ACASI computer rather than a human interviewer (adjusted OR = 6.1, $P < 0.01$ and adjusted OR = 3.6, $P < 0.10$, respectively). No statistically reliable differences were found between interview modes in reporting of PID or the fictitious disease, genital phlemoria. (Only 4 respondents reported being diagnosed with genital phlemoria: 1 in the T-IAQ and 3 in the T-ACASI condition.)

Homogeneity of Interview Mode Effects

To test the homogeneity of the T-ACASI effect, we selected measurements that met the following criteria: (a) the unadjusted estimate of the mode effect had an OR outside the range 0.49 ≥ OR ≥ 1.99; (b) the sample size for the T-ACASI versus T-IAQ mode comparison included most of the NSBME sample (N > 1700); and (c) the statistical reliability of estimates of both the unadjusted and adjusted mode effects were significant with $P < 0.05$. Four measurements from Tables 1 and 2 meet these criteria: reporting that your partner ever had an STD; and reporting that you had genital blisters, genital discharge, or a chlamydia diagnosis during the past year.

Estimates of the T-ACASI mode effect for each of these measurements were tested for homogeneity across subpopulations defined by gender, years of education, age, race (black vs. nonblack), marital status (married or living with partner vs. other), and sample strata (United States vs. Baltimore).

Our analysis identified 6 statistically reliable or suggestive instances of heterogeneity across population subgroups in the estimated impact of T-ACASI. The pattern of results for these 7 instances is shown in Table 3. It can be seen that

- as respondents' educational level increased, the impact of T-ACASI on reporting of genital sores ($P = 0.13$) in the past year decreased;
- as respondents' age increased, the impact of T-ACASI decreased for reporting of genital sores in the past year ($P = 0.05$) and partner ever having an STD ($P = 0.05$);
- the impact of T-ACASI on reporting of genital sores in the past year was greater for black than for nonblack respondents ($P = 0.03$); and
- the impact of T-ACASI on reporting of genital discharge in the past year was stronger for respondents who were married or living with a partner ($P = 0.05$) than for other respondents, but the reverse pattern was found for reporting of genital sores or blisters ($P = 0.06$).

To accommodate a reviewer's concern, we conducted parallel tests for mode-by-strata interactions for the 21 crude ORs reported in Tables 1 and 2. (These analyses are designed to detect vari-

TABLE 4. Estimated Population Incidence[a] of Reported Chlamydial and Gonococcal Infections by Sample Strata and Survey Method

Infection Incidence*	T-ACASI %	T-IAQ %	OR	95% CI
Gonorrhea				
The United States, annual	0.65	0.12	5.6	0.6–57.2
Baltimore, annual	1.99	0.73	2.8	0.5–16.1
OR (Baltimore vs. the United States)	3.1	6.4[†]	—	—
95% CI	0.6–15.9	0.6–70.8	—	—
The United States, ever in lifetime	4.85	2.81	1.8	0.9–3.4
Baltimore, ever in lifetime	12.92	10.99	1.2	0.7–2.2
OR (Baltimore vs. the United States)	2.9[‡]	4.3[§]	—	—
95% CI	1.6–5.4	2.3–8.1	—	—
Chlamydia				
The United States, annual	0.79	0.34	2.4	0.4–13.5
Baltimore, annual	3.67	0.39	9.7[∥]	1.1–84.9
OR (Baltimore vs. the United States)	4.8[∥]	1.2	—	—
95% CI	1.2–18.7	0.1–13.1	—	—
The United States, ever in lifetime	5.64	4.63	1.2	0.7–2.1
Baltimore, ever in lifetime	11.09	9.11	1.2	0.7–2.3
OR (Baltimore vs. the United States)	2.1[∥]	2.1[∥]	—	—
95% CI	1.2–3.7	1.2–3.7	—	—

*Annual incidence calculated as reporting of an infection diagnosed during previous year. Survey did not ask about multiple infections with the same pathogen diagnosed during previous year. Lifetime statistic is percent of population estimated to have 1 or more diagnosed infections with pathogen during lifetime.

[†]$P < 0.10$; [‡]$P < 0.01$; [§]$P < 0.001$; [∥]$P < 0.05$.

[a]Unlike the preceding estimates, this analysis uses sampling and poststratification weights to project results to the populations sampled, i.e., adults aged 18 to 45 residing in households in the United States and in Baltimore City, MD, who were accessible by landline telephones. ORs were calculated using Stata survey estimation procedure svylogit. Unlike Tables 1 and 2, statistical tests in this table do not combine sample strata. The smaller underlying sample sizes for each strata decrease precision of these estimates resulting in very wide 95% CIs for the calculated T-ACASI vs. T-IAQ odds ratios.

ation in the magnitude or direction of the impact of T-ACASI in the Baltimore vs. national strata.) In no instance could we reject the null hypothesis that the mode effect was homogeneous across the 2 sample strata. In 18 cases, the *P* values for the interaction test exceeded 0.40; in 2 cases they were in the range 0.17 to 0.18; and in 1 case the test could not be conducted because of sparse cell counts.

Population Estimates

Table 4 presents separate T-ACASI and T-IAQ estimates of the burden of STDs in the populations of the United States and Baltimore city. Unlike preceding tables, this table is derived from an analysis that used sampling and poststratification weights to project sample results to the populations from which they were drawn, i.e., adults aged 18 to 45 who resided in households in the United States and in Baltimore, MD, who were accessible by landline telephones. The impact of T-ACASI on population estimates of STD incidence in the population is substantial. Estimates of the annual incidence of self-reported gonococcal and chlamydial infections increase by factors of 2.4 to 9.7.

In considering these results, it should be borne in mind that the purpose of this analysis is not to test the null hypothesis that T-ACASI increases reporting of incident STD infections. This impact of T-ACASI has been demonstrated in Tables 1 and 2 using unweighted data from respondents in both sample strata. Rather, this analysis is intended to provide readers with an appreciation of the likely understatement of populationwide STD burdens that occurs when T-IAQ surveys are used. Because this analysis does not combine sample strata, the smaller sample sizes for each strata (N′s = 1543 and 744 vs. 2287 combined) decrease statistical precision, resulting in wide 95% confidence intervals for the calculated T-ACASI versus T-IAQ ORs within each sample strata.

It can be seen from Table 4 that the impact of T-ACASI upon population estimates of lifetime exposure to these infections is attenuated but consistently positive (ORs = 1.2–1.8). Furthermore, this table illustrates that use of T-ACASI can unmask important regional differences in STD incidence. Thus, comparison of T-IAQ-derived estimates of annual chlamydial incidence in Baltimore with those for the United States failed to reject the conclusion that they were equivalent (0.34% vs. 0.39%, $P > 0.5$). T-ACASI increased reporting of chlamydial infections in both populations, and it revealed that Baltimore has a substantially higher (self-reported) annual incidence of chlamydia than that in the United States (3.7% vs. 0.8%, $P = 0.017$).

Discussion

Our results indicate that the answer to our first research question is consistently positive. T-ACASI substantially increases the likelihood respondents will report their own STD symptoms and diagnosed infections as well as their partner's history of infection. The magnitude of the observed effects of T-ACASI was often dramatic. The adjusted odds that respondents would report chlamydial and gonococcal infections during the past year, for example, increased by factors of 6.1 and 3.6 when the measurements were made by T-ACASI rather than by a human interviewer.

T-ACASI also increased the likelihood respondents would report that they did not seek treatment for STD symptoms, never talked to their partner about protecting themselves against STDs, and never avoided sex because of concerns about STD transmission. In each of these cases, it could be argued that T-ACASI reduced the "social desirability" bias contaminating our T-IAQ measurements—although other interpretations are plausible. One could, among many alternatives, speculate that the T-ACASI interview mode reduced respondents' embarrassment, which led to more complete reporting.

There was one exception to the general pattern of T-ACASI measurements producing more frequent reports of what we presumed to be socially undesirable or embarrassing facts. Respondents interviewed by T-ACASI reported more frequent discussions of their "sex life" with their partner. We found this result puzzling because we assumed that frequent communication between partners about their sex lives would be more socially desirable and less embarrassing than reporting never talking to one's partner about sex. It is unclear whether this is an anomalous result or merely evidence of an erroneous assumption on our part. It is possible, for example, that respondents viewed reporting frequent discussions of sex with their partners as suggesting that they were having sexual problems or that they were "talking dirty" to stimulate each other.

We found one additional anomaly of a different sort. Respondents were more likely to recognize our fictitious disease, *genital phlemoria,* when responding to a T-ACASI computer rather than to a human interviewer. Because we had only one such question in the NSBME, it is unclear whether generalization is warranted. (As one reviewer observed, this might have been a spurious result. Because Tables 1 and 2 report 21 comparisons, one might have expected one spurious result at the 0.05 level in 21 tests, assuming the tests were independent.) It is worth emphasizing, however, that although 27% of T-ACASI respondents and 21% of T-IAQ respondents had "heard" of genital phlemoria, only 4 respondents reported being diagnosed with this fictitious disease (1 T-IAQ respondent and 3 T-ACASI respondents). Clearly, however, additional research on this phenomenon is needed.

Overall, our results are consistent with a growing body of studies that find that T-ACASI increases reporting of stigmatized and sensitive sexual behaviors, illicit drug use, teen smoking, and unpopular social attitudes.[22–30] It is reasonable to infer that the privacy afforded by T-ACASI is responsible for this increased reporting. Our respondents' evaluations of their experience support this interpretation. After the main survey was completed, T-ACASI respondents were asked a brief series of questions about their participation. When asked which survey method most people would prefer for asking "questions on sensitive topics such as anal sex and STDs," 87% of respondents reported thinking that most people would prefer T-ACASI; 72% thought T-ACASI was "best for protecting privacy," and 80% thought T-ACASI was "best for getting the most honest answers."

Our T-ACASI results indicate considerably higher estimated annual and lifetime incidence of gonococcal and chlamydial infection in Baltimore, MD, than in the rest of the United States. For our T-ACASI measurements, ORs were 3.1 and 4.8, respectively, for estimated annual incidence in Baltimore versus the United States; and 2.9 and 2.1 for lifetime incidence (Table 4). These results are consistent with reporting to Baltimore and other US Health Departments of diagnosed gonococcal and chlamydial infections. For the year 2000, Centers for Disease Control and Prevention reported an annual incidence of 886 reported gonococcal infections per 100,000 in Baltimore versus only 132 per 100,000 in the United States as a whole. Similarly for that year, Centers for Disease Control and Prevention[41] reported an annual incidence of 859 reported chlamydial infections per 100,000 in Baltimore versus 258 per 100,000 in the United States. The (incomplete) congruence of our T-ACASI measurements with these results provides some confidence that the T-ACASI measurements are measuring valid population differences in infection incidence. Although human interviewing also yields differences in the same direction in 3 of 4 comparisons, we note that the estimated annual incidence of chlamydial infection is virtually identical in Baltimore and the United States (OR = 1.2, NS) when human telephone interviewers—rather than T-ACASI—are used to collect these data.

The answer to our second research question is less clear cut. There was ample evidence that the magnitude of the T-ACASI mode effect varied across subpopulations, but in no instance was the variation found for all 4 STD measurements we studied. In addition, 2 apparently similar STD measurements (genital discharge and genital sores in the past year) evidenced significant but opposite patterns of variation in the estimated impact of T-ACASI for married or cohabiting respondents (vs. others). We do, however, have 3 logically consistent results for education and age. The impact of T-ACASI declined with increasing age and increasing education. This result mirrors the recent report of a parallel variation by educational level and age in the estimated impact of T-ACASI on respondents' willingness to express "unpopular" opinions.[27] Younger and less-educated respondents seem to be most affected by the privacy afforded by T-ACASI.

Finally, it is clear from our population projections for the United States and Baltimore city that STD measurements made by human interviewers substantially understate the burden of sexually transmitted infections in the population. When respondents are afforded the privacy of a T-ACASI interview, the estimated annual incidence of diagnosed gonococcal and chlamydial infections rose by factors of 2.4 to 9.7. Reporting bias in T-IAQ surveys apparently depresses reporting of recent STD diagnoses, leading to a substantial underestimation of the burden of these STDs in the population.

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