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How accurate is our misinformation? A randomized comparison of four survey interview methods to measure risk behavior among young adults in the Dominican Republic

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ABSTRACT

Objective: To identify the most effective survey interview method for measuring risk behavior among young adults in the Dominican Republic.
Methods: 1200 young adults were randomized to one of four different survey interview methods: two interviewer-assisted methods [face-to-face interview (FTFI), and computer-assisted telephone interview (CATI)], and two self-administered methods [self-administered interview (SAI), and audio computer-assisted, self-administered interview (ACASI)]. Youth were asked about a wide range of youth-specific risk behaviors, including violence, substance use, as well as sexual and reproductive health. Quality of data collected was examined by looking at how the survey was administered, including identifying two sources of errors that typically threaten data quality[1]: (i) errors at the individual level with regards to survey methodology performance and cognitive difficulties [measured with the *Response Consistency Index* (RCI)]; and (ii) errors at the aggregate level (how desirability bias, interviewer gender, and interview privacy settings affect responses).
Results: No statistically significant differences in participant non-response rates were found at the individual level across all survey interview methods. At the individual question level, self-completion methods generated higher non-response and error rates than assisted methods. The SAI method showed the poorest performance of all four methods in terms of non-response rate (1.6%[2]) and RCI (83.0%).

At the aggregate level, the prevalence of several key risk indicators was statistically significant between methods. Using means-adjustment for covariates (μ), sexual and reproductive health-related indicators were found to have statistically significant differences among methods. Interviewer-assisted methods reported higher prevalence compared to self-administered methods. For example, when interviewer-assisted FTFI was administered, higher prevalence was reported for indicators, such as ***Ever Had Sex*** (for both genders), ***Safe Casual Sex*** (for males), and ***Transactional Sex*** (for males) than self-administered ACASI methods. On the contrary, when a SAI self-administered method was applied, results showed higher prevalence rates of concurrency among women, (e.g., sexual activity with multiple partners that overlap in time).

The study also suggests that there were differences in survey interview methods used when looking at drug and alcohol use indicators. The direction of bias differed between drug use and alcohol consumption indicators. Respondents using ACASI self-administered methods had a higher ***Drug Use*** prevalence. However, FTFI reported a higher prevalence of ***Binge Drinking*** among female participants, as compared to ACASI.

Additionally, the research team found a strong interaction with interviewer gender. In FTFI, affirmative responses to ***Sex with Same Gender*** questions were higher among men interviewed by women, than among men interviewed by men. The gender of the interviewer also seems to generate socially desirable response in

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[1] This study assumes that bias does not change with sample size. In order to increase the sample size, the data collection period was extended, leaving everything else unchanged. It is, therefore, assumed that the decreasing effects of the learning curve are negligible.
[2] Percentage of data with non-response values at the question level.

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violence risk-related indicators. That is the case for ***Victimization*** among males where the use of SAI increases the prevalence.

Furthermore, this study suggests that whenever privacy during an interview was recorded as insufficient, women tended to report sexual initiation at almost a year younger than when responding with privacy.

Conclusions: The study's findings suggest that the degree to which a specific method improves the reporting of a particular risk behavior or set of behaviors is likely to be population specific. The study's results support the researchers' initial hypothesis that higher prevalence estimates may be less valid than lower estimates in the Dominican Republic context, especially where some risk behaviors, like sexual activity, are normative and socially acceptable. More specifically, use of interviewer-assisted methods appears to significantly increase the reporting of socially-accepted behaviors, such as that both male and female populations over-report sensitive questions. Similarly, the level of privacy during the interview and interviewer's gender may have an important effect on responses, and this effect depends on the chosen survey interview method.

1. Background

There is a large stock of studies to suggest that the choice of interview method influences the frequency and type of the risk behaviors reported (Langhaug et al., 2011; Jaya et al., 2008; Mensch et al., 2008; Konings et al., 1995) and thereby the validity and reliability of survey data. Nevertheless, there is to date no consensus on which specific method produces more accurate estimates of the level of risk for different types of behaviors. Brener et al. (2006) suggest that the direction of the bias is likely to vary across populations and contexts (Gregson et al., 2002; Pienaar, 2009), as well as by gender (Mensch et al., 2003) and privacy settings (Langhaug et al., 2011; Eaton et al., 2010; Tourangeau and Smith, 1998; Brener et al., 2003; Gribble and Miller, 2000). In addition, the reliability of the responses is affected by the attitudes of respondents towards strangers (in a survey context, the interviewer), which are also known to vary cross-culturally (Weinreb, 2006).

Few studies have explored the size and direction of the bias induced by alternative survey methods. Specifically, evidence on the effects of alternative survey modes on self-reported risk behaviors is lacking. To fill this knowledge gap, the research team conducted a multi-armed trial in which 1200 young respondents in the Dominican Republic were randomly assigned to one of four survey interview methods varying in levels of privacy and cognitive difficulty. The four survey interview methods were: (1) face-to-face interview (FTFI); (2) computer-assisted telephone interview (CATI); (3) self-administered interview (SAI); and (4) audio computer-assisted self-administered interview (ACASI). The research team hypothesized that interviewer-assisted methods (FTFI, CATI) would be more sensitive to social desirability bias (SAI, ACASI) and that self-administered methods would reduce reliability of the responses due to the additional cognitive effort required from the respondents.

This study set to examine the trade-off between social desirability bias and cognitive difficulty with a view to determine which survey interview methods might produce reliable estimates of the prevalence and frequency of high-risk behaviors among youths in Latin America and the Caribbean (LAC). Furthermore, the research team aimed to pinpoint important sources of errors, such as those consistent with social desirability bias, and to discuss the extent to which these errors might be related to level of privacy or interviewer's gender, as previous studies have suggested (Langhaug et al., 2011; Tourangeau and Smith, 1998; Brener et al., 2003; Gribble and Miller, 2000; Sedla, 2010; Lothen-Kline et al., 2003).

2. Introduction

Engaging in high-risk behaviors during young adulthood may have enduring, deleterious effects, which are difficult to reverse in later stages of life. For example, substance use, delinquency, and violence are inversely associated with academic achievement during school years, as well as later in life (Chung-Do et al., 2015; Catalano et al., 2004; Soares and Naritomi, 2010). Alcohol consumption is associated with poor academic performance, increased risk for sexually-transmitted infections (STIs), depression, anxiety, personality disorders, gang involvement (Onyebuchukwu et al., 2015; Hutton, 2008; Wolitzky-Taylor et al., 2012; Swahn and Donovan, 2005), as well as juvenile crime (Munyo, 2013).

Among young women specifically, substance use, early sexual initiation, inadequate sexual health information, and poor access to family planning methods have lasting consequences. In terms of reproductive health, the use of modern contraceptive methods to prevent pregnancy and STIs among sexually active youth remains low (PAHO, 2014), and half of the estimated 1.2 million unplanned pregnancies in the LAC region occur during adolescence (Embarazo Adolescente, 2012). The region's adolescent fertility rate reached 73 per 1000 births between 2005 and 2015, standing well above other regions' rates. In addition to increasing risks of maternal, neonatal and perinatal complications at or following childbirth, early motherhood is also associated with lower rates of academic success in young mothers, whereby they drop-out of school, quit work, and become socially-excluded (Bradley and Greene, 2013; Marcotte, 2013).

The implications of adolescent risk-taking are particularly salient in the LAC region, where the proportion of young people is expected to peak in the next decade. Thus, preventing youth from engaging in high-risk behaviors is important for their short- and long-term health, educational, and social outcomes, as well as for the overall good of the LAC region in terms of economic and social development.

The accurate measurement of youth risk behaviors, which is key to developing and evaluating polices to reduce youth risk-taking, remains an inexact science. Assessing engagement in high-risk behaviors via self-administered surveys is often highly susceptible to error since many of the topics are considered sensitive and are subject to reporting bias. Furthermore, the study population, interviewer gender, privacy conditions, as well as content, structure, and survey interview method of the survey are also factors that may influence measurement accuracy among young populations. For example, previous studies (Sedla, 2010; Lothen-Kline et al., 2003) suggested that increasing the privacy of the interview setting could minimize social desirability bias. Compared to face-to-face interviews, informal confidential voting interviewing is associated with higher self-reported use of intravenous drugs and commercial sex in Bangalore, India (Phillips et al., 2013) and HIV-related risk behaviors in Manicaland, Zimbabwe (Gregson et al., 2004). Furthermore, survey respondents tend to exhibit social desirability bias when they over-report socially-approved behaviors (like voting) and under-report socially disapproved behaviors (like using illicit drugs).[3] It is worth noting that this type of bias may be motivated by socials norms or taboos, as well as fear or punishment in the context of activities punishable by law.

Traditionally, in the absence of an external gold standard, research

[3] Definition provided by the research team and based on a literature review, such as Catania et al, 1990.

on social measurement has considered measurement approaches yielding higher prevalence figures for the risk behavior to be more valid. However, recent randomized experiments for e.g., Brener et al. (2006) suggest that this approach may be biased and that it is likely that the direction of the bias may vary by population and context (Gregson et al., 2002; Pienaar, 2009).

3. Methods

3.1. Study population

The experiment was conducted in the Dominican Republic in 2010 among a random subset of young adults participating in the impact evaluation of the "Youth and Employment Program" (PJE, for its Spanish acronym). Since 2008, the PJE[4] program of the Ministry of Labor included more than 41,000 at-risk youth throughout the Dominican Republic. The program combined classroom and workplace training through an internship program and was found to reduce teen pregnancy, gang membership, violence, and other risk behaviors (World Bank, 2012).

3.2. Experimental design

A sample of 1200 youth between the ages of 18 and 30 were randomly selected from a total of 5080 participants[5] who were about to complete the follow-up survey for the PJE impact evaluation. Using multi-stage, stratified randomization, participants were randomly assigned to four groups of 300 youth each, one for each of the four survey interview methods evaluated (FTFI, CATI, SAI and ACASI, Fig. 1).

Prior to randomization, the sample was stratified by PJE assigned treatment group,[6] gender of the respondent[7] and geographical area, obtaining 150 strata. Stratifying by PJE treatment group prior to randomly assigning the survey interview method ensured that the distribution of methods within each PJE treatment group would be the balanced and hence any bias in the differences across survey interview methods could not be attributed to PJE treatment arm.

In all survey interview methods, a study interviewer contacts each participant in person and explains the survey for ACASI, FTFI and SAI methods. For surveys administered by CATI, participants were contacted by phone,[8] for which the pool of interviewers varies from the other three survey interview methods.

The research team hypothesized that the interviewer's characteristics could potentially have a strong effect on self-reported behaviors, especially when using interviewer-assisted methods (e.g., FTFI and CATI). To explore these effects in the three home-based survey interview methods, ten field interviewers were organized into five teams, each made up of one male and one female interviewer. The teams were distributed across geographical areas (Figs. 2 and 3) in such way that each team was allocated a similar number of surveys (n≈180).[9] Thus, the stratification of participants by geographic area prior to randomization ensured that no team-related effect could bias the differences between home-based methods.

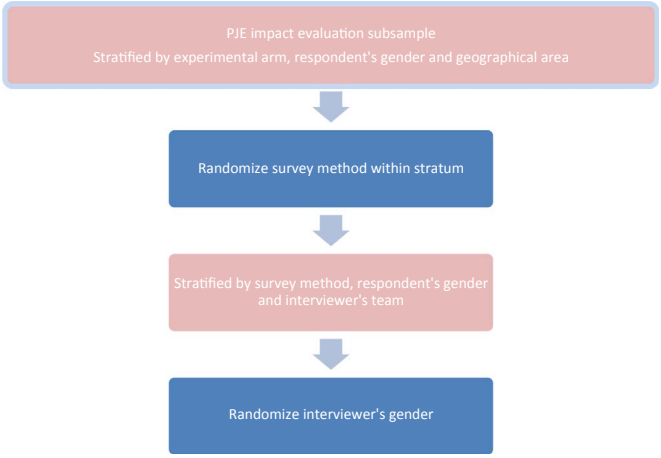

Fig. 1. Stratification and randomization process.
Source: authors

After stratification, the research team randomly allocated survey interview methods within each strata, obtaining 300 interviews in each survey interview method. Five teams were assigned to 900 home-based interviews; due to both logistic and budgetary constraints, two additional teams were employed to conduct the CATI surveys exclusively (300 interviews). They were purposely allocated to different provinces and the same amount of interviews per team (n≈180). For this reason, any difference observed between this method and the home-based methods may have been confounded by the different characteristics of these highly specialized teams; therefore the research team excluded the CATI method from some of our comparisons.

In the next stage, the sample was stratified by survey interview method, team and gender of the respondent, obtaining 48 strata. Within each of these strata, the research team randomly allocated the gender of the interviewer. Each individual was randomly assigned, with equal probability, a male or female interviewer.[10] This design ensured a balanced sample for the analysis between the interviewer's and the respondent's gender, separately for each survey interview method.

3.3. Instruments and data collection

Data were collected by a local survey firm including 10 interviewers trained in face-to-face surveys (5 male, 5 female) and were assigned to cover the sample assigned to ACASI, FTFI and SAI methods. Interviewers were divided into five gender-balanced teams and assigned to specific geographical areas as described above (Fig. 2), each was assigned a supervisor. The company also enlisted four interviewers specializing in telephone surveys (two male, two female) that were assigned to CATI method. Interviewers and supervisors were trained by the survey firm and were later evaluated and supervised by the research team.

The questionnaire was designed to capture a wide range of youth risk behaviors, including violence, substance use, and sexual and reproductive health. Table 1 shows the risk indicators together with their definitions, reference population and hypothesized direction of social desirability bias (in some cases the direction was specified by gender). The estimated direction of bias was based on a previous analysis of the PJE population and a qualitative evaluation carried out in a context similar to this study (Bautista-Arredondo et al., 2011a, 2011b).

In addition to assessment of the risk behaviors, two five-item questionnaires, a *cognitive module* and an *interviewer assessment of conditions of the interview*, were also included to assess three different

[4] PJE target population is unemployed, sub-employed or inactive youth 16–29 years old; not complete secondary school; from the poorest 40% of household and living in areas classified as Priority I and II according to the official poverty map (based on the wealth index of the Beneficiary Identification System for social programs -SIUBEN).

[5] From a total sample of 13,000 program beneficiaries.

[6] The PJE impact evaluation arms were organized as follows: (1) Technical Training Module (TTM)+ Life Skills Module (LSM) treatment+internships; (2) LSM treatment +internships, and (3) a Control Group.

[7] The study assumes there are no regional differences in terms of poverty, literacy, or exposure to technology that might affect how participants responded to the survey methods.

[8] All participants received a cell phone calling card for RD$ 150 (approximately US $4.00) as an incentive to take the survey.

[9] Geographical areas coincide with the country's provinces, except Santo Domingo, which was divided into three areas: east, north and west, plus the National District.

[10] For self-administered interviews, the research team defined the interviewer as the person who introduces the interview in the home.

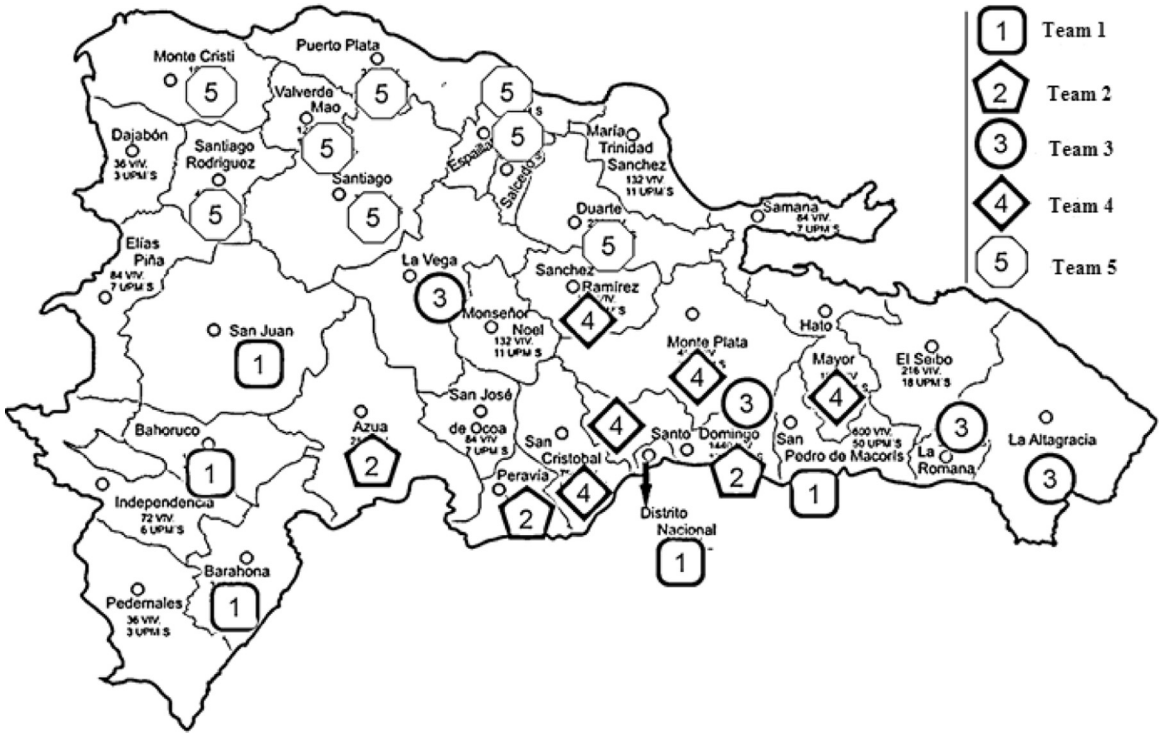

Fig. 2. Team assignment.
Source: authors

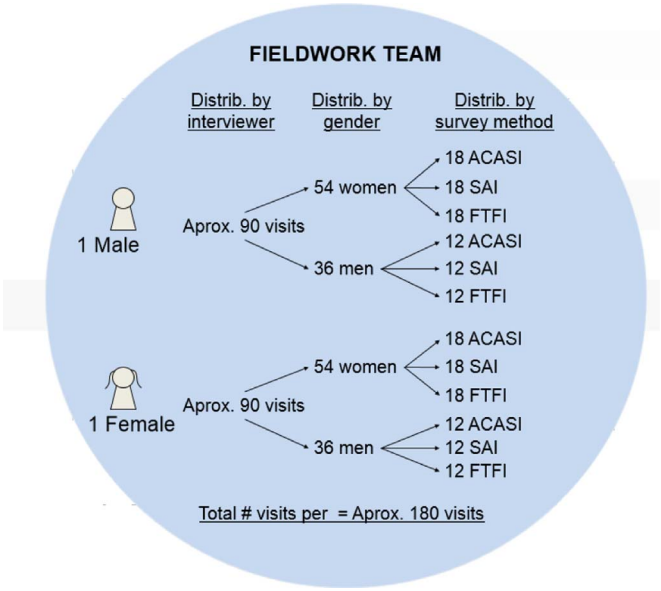

Fig. 3. Interview assignment in one field team.
Source: authors

dimensions: (i) the respondent's cognitive level; (ii) the privacy conditions during the interview; and (iii) the interviewer's perception of the cognitive status of the respondent during the interview. The purpose of the cognitive module was to assess the cognitive function of the respondent – for example, memory, problem solving, ability to perform calculations, perception, language development and the planning and execution of complex behaviors. The interviewer assessment of the conditions of the interview included number of people present when the interview was conducted, level of disruption during the interview (noisy vs. quiet environment), respondent's level of stress (calm, distracted, nervous), assessment of the respondent's cognitive status (scale from very poor to excellent), and level of cooperation of respondent with the interview (scale from easy to difficult). All questionnaires were pretested to optimize wording and structure, as well as monitor the length of each interview.

Paper questionnaires for the FTFI and SAI methods were identical, except for the instructions that were specifically designed for the interviewer or the respondent. In the CATI method, the software displayed a data entry screen identical to the paper questionnaires. In the ACASI method, the software showed the questions one at a time. Multiple-choice questions were separated into a series of ***Yes/No*** questions in the ACASI format only.

Finally, to check the consistency of some answers, the research team had access to a longitudinal telephone follow up survey conducted by the World Bank between 2009 and 2010 with the same cohort that included data on the participants' reported number of children (Table 3). The research team used this information to crosscheck the information provided in this survey for the indicator about number of (biological) children.

3.3.1. Data handling and statistical analysis

Paper questionnaires from the FTFI and SAI methods were entered by survey firm personnel using data entry software programmed to automatically check for errors at the question level. In the CATI method, interviewers used software specifically designed for telephone interviews and entered their responses directly into the computer. The software featured the same automatic checks as for the FTFI and SAI methods. In the ACASI method, respondents entered their responses directly into the computer. The ACASI software skipped between questions automatically, thus preventing skip errors. It also featured automatic checks to detect blank or out-of range responses, though checks for inconsistencies between two or more questions were excluded. The survey firm received the data collection and entry software from the research team.

Errors attributable to each particular survey interview method were estimated using several methods. First, data were reviewed to detect errors visible at the **individual level,** such as *survey non-response*, *blank responses*, *incorrect question skipping*, *out-of-range values*, and

Table 1
Risk behavior indicators considered plus hypothesized direction of bias.
Source: authors

#	Indicator	Definition	Reference population	Estimated direction of bias
Substance Abuse				
1	Ever regular smoker	Have you ever smoked at least one cigarette a day for more than 30 days?	All	+
2	Current smoker	Have you smoked at least one cigarette in the last 30 days?	All	+
3	Binge drinking	Have you had more than X[a] consecutive drinks or glasses of wine in the last 30 days?	All	+
4	Drug use	Have you ever used any drugs, including recreational illicit drugs or prescription drugs without a prescription?[b]	All	–
5	Marijuana use	Have you ever consumed marijuana?	All	+(men) –(women)
Violence				
6	Gang affiliation	Have you ever belonged to or have been affiliated with a street gang?	All	–
7	Fights	Have you been involved in a fight with other young adults in the last 12 months?	All	–
8	Intimate partner violence	Has your partner beat you or physically hurt you in the last 12 months?	All	–
Sexual Risk				
9	Sexual identity	Heterosexual, homosexual, bisexual, other	All	–(for non heterosexual)
10	STD diagnosis, ever	Have you ever been diagnosed with a sexually transmitted disease?	All	–
11	Pregnancy intentions	Plans to get pregnant in the next 6 months	Non-pregnant women	–
12	Ever had sex	Have you ever had sexual intercourse, vaginal or anal?	All	+(men) –(women)
13	Age of sexual debut	Age at first sex	Ever had sex	–
14	Lifetime sexual partners	How many sexual partners have you had in your entire life?	Ever had sex	+(men) –(women)
15	No. of sexual partners in the last 12 months	Number of sexual partners in the last 12 months	Ever had sex	+(men) –(women)
16	Concurrent sex	Six months prior to the survey, were you having sex with two or more partners at the same time?[c]	Ever had sex	+(men) –(women)
17	Same gender sex	Were any of your last three sexual partners of your same sex, or have you reported having had sexual relations with someone of your same sex ever in your life?	Ever had sex	–
18	Safe casual sex	Did you wear a male or female condom during your last sexual relation with a casual sexual partner(s)?	Youth with casual partner(s)	+
19	Commercial sex, ever	Have you ever paid for sex?	Ever had sex	–
20	Transactional sex	Have you ever been paid or received gifts or drugs for having sex?	Ever had sex	–
21	Sex under the influence of alcohol/ drugs	Used alcohol or drugs during the last sexual encounter	Ever had sex	–

[a] For men, X=5. For women, X=4.
[b] Drugs in the questionnaire: Marijuana or hashish; cocaine (powder, crack, paste or injection); glue or rubber cement sniffing, aerosol or spray inhalation; heroin; methamphetamines; ecstasy; hallucinogens (LSD, acids, PCP, mushrooms etc.); steroid pills or injections without a medical prescription, medicines (such as painkillers, stimulants, antidepressants, etc.) used as narcotics.
[c] Diseases in the questionnaire: genital herpes; chlamydia, syphilis; trichomoniasis; hepatitis B; lice infestation; condyloma (warts, HPV); pelvic inflammatory disease; HIV or AIDS.

inconsistencies between two or more questions. Second, errors visible at the **aggregate level**— such as *socially desirable response bias*— were identified. For this analysis, the research team defined social desirability bias as a portion of the difference in indicator means between two survey interview methods with different levels of privacy. However, the difference is not necessarily wholly due to social desirability, as other survey interview method features also affect the results.[11]

3.3.1.1. Errors at the individual level. The research team assessed survey *non-response* (because the respondent could not be located or because s/he declined to respond to any of the questions), as well as *question-level errors*, which were measured only among individuals who could be located and who responded to at least one of the questions in the questionnaire. Question-level errors were defined as follows: (1) **non-response errors**, where the option ***"Don't know/ No response"*** allows the participant to decline response; (2) **blank errors**, where an option box that should not be empty is empty; (3) **skip errors**, where an option box that should be empty is not empty; (4) **out-of-range errors**, where the data contains impossible values (e.g., someone aged 3 years in this group, or a single-option question with multiple choices provided); and (5) **consistency errors** between two or more questions, where responses to two or more questions have impossible values (e.g., the date of the last sexual relation with a partner comes earlier than the date of the first sexual relation).

Non-response[12] errors were measured by using interviewer, data entry operator and ACASI software records. In the assisted methods (FTFI, CATI), if a respondent declined to respond to a certain question because they felt uneasy, the interviewer entered the words *"Declines to respond."* If the respondent did not respond because they did not know or did not remember, the interviewer entered *"Doesn't know."* In the ACASI method, if the respondent failed to respond to a question, the software displayed a message in trying to understand the underlying

[11] The research team acknowledges that it cannot measure the social desirability bias component alone under the framework of this study.

[12] Non-responses offered are cases where the respondent selected the option "don't know/no response" (available in some questions in the self-administered questionnaires). The SAI method demonstrates how offering these options may induce respondents to use them more than they would if an interviewer were coding the response without offering the answer options.

causes (does not understand, does not remember, or due to privacy reasons). In the SAI[13] method, by design no distinction was made between *"Declines to respond"* and *"Does not know."*

The FTFI and CATI methods control non-response, blank responses, and skip errors. However, FTFI method interviewers produce a larger number of complex inconsistencies[14] than CATI method interviewers.[15]

Among those who agreed to complete a survey, the research team computed the Response Consistency Index (RCI),[16] the percentage of data questions for each person without detectable errors. To calculate the RCI, a rectangular matrix is constructed where each row represents an interview and each column represents one question from the questionnaire. In each cell a number *'1'* is entered if the question is answered without errors and a *'0'* if it is not. The RCI is the sum of all *'1's* in the matrix divided by the total number of cells in the row for each person, and expressed as a percent. To test the hypothesis that the two self-administered methods were more difficult from a cognitive standpoint, the research team inspected the data to detect blank responses, incorrect skips, out of-range values, and inconsistencies between two or more responses.[17]

A final indicator of error at the individual level was agreement between the respondent's reported number of children and the number reported in a previous survey with the same cohort.

3.3.1.2. Errors at the aggregate level. To test the hypothesis that the two interviewer-assisted methods are more vulnerable to social desirability bias than self-administered methods, the research team compared the mean values of each of twenty-one risk indicators shown in Table 1 by survey interview method. Since method assignment was random, the research team assumed that any statistically significant difference between methods is the result of response biases induced by the survey interview method. A general linear model (adjusted mean test) of the reported prevalence (percentage) of each behavior was calculated to obtain the pairwise difference between every two survey interview methods and used to obtain 95% CIs around each parameter estimate. The research team controlled for interview and respondent's gender, educational level of the respondent and geographical location.

Finally, the team explored whether reporting rates of risk-behavior change when the interviewer and interviewee sex match and whether they change with different privacy settings. To achieve this, a binary indicator for sex match was included as an explanatory variable in a regression that also controls for interviewer fixed effects.[18] The main goal of this design is to test for how reporting rates change when sex of the interviewer matches that of the respondent while holding constant other characteristics of the interviewer.[19] The team also estimated fixed-effect regression models that adjust for interactions of the binary sex-match indicator with mode of interview to additionally control for privacy setting effects.[20] The research team verified the robustness of the results by analyzing their sensitivity to the alternative specifications.

4. Results

4.1. Findings at the individual level

The overall survey response rate was 85%, with no statistically significant differences in non-response rates across survey interview methods. Among survey non-respondents, 90% correspond to situations where the individual could not be located, while the other 10% were refusals.

The non-response rate at the question level and the RCI were computed among those who answered at least one question in the questionnaire. Table 2 shows the percentage of data with errors, according to the type of error and survey interview method. The SAI method shows the highest non-response at the question level of the four methods, with an average RCI equal to 83%. This method had over twice as many blank and non-responses as the other survey interview methods. It also produced a large number of skip errors, which were rarely observed in the other survey interview methods (largely due to the automatic checks in place for CATI and ACASI). FTFI, CATI and ACASI performed similarly well with an RCI of 94.9%, 98% and 93%, respectively. However, FTFI and ACASI methods failed to effectively control complex inconsistencies, producing over three and five times more errors than CATI method.

Non-response to individual risk indicators illustrates a similar picture (Table 2).[21] Self-administered methods generated higher non-response rates than interviewer-administered methods. Among the self-administered methods, the ACASI method shows a lower level of nonresponse than the SAI method because the former relies on automatic checks to detect blank responses and range errors and prompts the participant for a response.[22]

Cross-checking sexual activity with the number of biological children in the previous survey revealed a number of respondents who reported that they had never had sex but who had biological children[23] (Table 3). This occurred mostly in the SAI method; in the FTFI and CATI methods, the number of such inconsistencies is one. In the ACASI method, the proportion of inconsistencies is high, particularly among women. Results suggest that the ACASI method is biased upwards due to the length of the questionnaire and the learning process for the software.

4.2. Findings at the aggregate level

At the aggregate level, there were some statistically significant differences in risk indicators between methods (Table 6). Using means

[13] In the SAI method, the cause of an error could not be determined unless options for "does not know" or "declines to respond" were explicitly provided. Including these responses is not recommended, as it well known that they induce non-response. This method shows over twice as many blank and non-responses as the other methods.

[14] Inconsistencies involving two or more questions.

[15] In the CATI method, computer assisted checks help interviewers eliminate complex inconsistencies.

[16] The non-response rate at the question level and the RCI were measured from among those who answered at least one question in the questionnaire (85% of the sample, distributed evenly among methods).

[17] Some important examples of inconsistencies between two or more questions are: Times consumed drugs in last 12 months is consistent with Frequency of consumption/ Number of lifetime sexual partners is greater than or equal to number of sexual partners in last 12 months/Number of lifetime partners in question is equal to the number of sexual partners reported in the sexual history.

[18] Interviewers are assigned between 49 and 199 interviews so that the research team can take advantage of the panel structure of the data to estimate fixed effects models using the interviewer ID as the panel dimension.

[19] These estimates show the differences within the same interviewer between reporting rates of an interviewee who is the same gender as that of the interviewer as opposed to an interviewee that is of a different gender.

[20] Interviewers are assigned to different modes of interview so that differences in reporting rates within an interviewer and across different respondents can also be adjusted by the effects of interview mode.

[21] The number of observations used to calculate risk indicators may be equal to or higher than the number of consistent observations according to the RCI. Some of the errors considered in the RCI may be ignored or corrected for the purposes of calculating risk indicators. This means that the actual data percentage for indicator analysis may be higher than the RCI.

[22] For example, in 11 of 14 non-response cases in the drug indicator (*"Have you ever used any of the following drugs? "* followed by nine different drug choices/categories) the respondent left only one of the nine questions blank For the Sexually-transmitted Infections (STI) indicator, which consisted of 11, *Yes/No* questions, non-response is lower than for drugs, probably because the STI question comes later in the survey, and respondents had learned how to avoid the control message for non-response by the time the question was asked.

[23] Consistency checks based on data from the same cohort collected by the World Bank during 2009/2010.

Table 2
Percentage of data with visible errors at the question level, according to type of error and survey method.
Source: authors.

Type of error	Survey method				
	FTFI	CATI	SAI	ACASI	Total
Non-responses offered	0.5	0.8	1.6	0.9	0.9
Blank	1.2	1.1	3.3	1.3	1.7
Skip errors	0.2	0.0	6.5	0.0	1.7
Out-of-range errors	0.0	0.0	0.2	0.0	0.1
Consistency errors between two or more questions	3.2	0.1	5.5	4.8	3.4
Total errors	5.1	2.0	17.0	7.0	7.8
RCI	**94.9**	**98.0**	**83.0**	**93.0**	**92.2**

Table 3
Number of respondents who reported that they had never had sex but who have children.
Source: authors. Based on data from World Bank PJE longitudinal evaluation telephone survey

Survey Method	Men, ever sex = 0		Women, ever sex = 0	
	Total	With children	Total	With children
FTFI	6	0	16	0
CATI	5	0	10	1
SAI	13	1	17	5
ACASI	40	8	64	44

adjusted for covariates, the research team found the following results by risk category:

4.2.1. Sexual and reproductive health

The research team found that strong, statistically significant differences exist among interview methods, whereby interviewer-assisted methods for key indicators reported higher prevalence compared to self-administered methods. For example, when interviewer-assisted FTFI is administered, higher prevalence is reported for the ***Ever Had Sexual Intercourse*** questions, compared to the ACASI method [among males, the means difference is 0.341 (p≤0.01) and among females 0.324 (p≤0.01)].

Among males, the FTFI-ACASI comparison revealed a higher prevalence of condom use in the ***Condom Use During Last Sexual Relation with a Casual Partner*** questions when using FTFI (0.275, p≤0.05). FTFI-SAI also yielded a higher prevalence for the ***Ever Been Paid for Having Sex*** (0.115, p≤0.05) questions among males, which is consistent with CATI findings (Table 4). With the FTFI method, females reported lower ages of sexual initiation than those using other interview methods; whereas females using the SAI method reported older ages [mean adjusted difference of 0.667 (p≤0.05)], compared to other methods. Whenever privacy during interview was deemed insufficient, women tended to report sexual initiation almost a year younger than when privacy exists.

For ***Sex with Same Gender***, the FTFI method revealed higher prevalence for both women and men; 4% points higher than CATI for females (Table 5), and 6% points higher than using CATI for males.

Conversely, when questioning women on ***Concurrency*** (e.g., partnerships that overlap in time), prevalence was higher when using the self-administered method compared to interviewer-assisted [comparing SAI-FTFI there is an adjusted mean of 0.114 (p≤0.01)]. Furthermore, study findings indicate a higher prevalence of concurrency among males when ACASI is used [comparing to ACASI-SAI [0.082, (p≤0.1)].

Finally, when asking about ***Plans To Get Pregnant in the Following Six Months***, CATI interview-assisted methods yielded responses intending pregnancy that were 13% points higher than FTFI method, and 9% points higher than self-administered methods (both SAI and ACASI).

4.2.2. Drug and alcohol use

When self-administered methods were used, the research team found a higher prevalence of ***Illicit Drug Use***. Among self-administered survey methods, drug use shows higher prevalence, especially when using ACASI. On the contrary, it appears that there is higher prevalence of ***Alcohol Consumption*** when SAI or FTFI is administered.

Among males, when ACASI was applied, ***Drug Consumption*** resulted in a higher prevalence with an adjusted mean of 0.116 (p≤0.05) compared to SAI. The same pattern is observed among females with an adjusted mean of 0.050 (p≤0.05) when compared to SAI. For example, when ACASI was administered among females, ***Marijuana Consumption*** reveals a difference in means of 0.037 (p≤0.05) compared to SAI method and 0.054 (p≤0.05) compared to FTFI. Similarly, when ***Alcohol Consumption*** is reported, higher prevalence is recorded if SAI is applied. When SAI is administered to females and males, a difference in means of 0.157 (p≤0.01) for females and 0.164 (p≤0.05) for males when compared to ACASI. Among females, FTFI also revealed a higher prevalence of alcohol consumption compared to ACASI with and adjusted mean of 0.132 (p≤0.01). No statistically significant differences where found between FTFI or SAI survey modes for ***Alcohol Consumption***.

4.2.3. Violence

Evidence suggests that there are no statistical differences among methods for ***Fight*** (been involved in a fight) or ***Gang Affiliation***. The research team found weak evidence of higher prevalence for ***Victimization*** (intimate partner violence) among women when SAI is compared to ACASI with an adjusted mean of 0.059 (p≤0.1). However, the authors suggest that there is an interviewer gender effect when interviewing male young adults.

4.2.4. Effect of interviewer gender

Results from a fixed effects model reveal that sex-match of respondent and interviewer matters (Tables 7 and 8). Especially, in FTFI, and for ***Sex with Same Gender,*** it shows a higher prevalence of men interviewed by women than among men interviewed by men 0.154 (p≤0.05). In contrast, for ***Binge Drinking*** and ***Ever Had Sex,*** it shows a higher prevalence when SAI method is administered and it is a female interviewing a male with values of 0.355 (p≤0.01) and 0.215 (p≤0.05), respectively. No statistical differences were found when a woman was interviewed by a man. ***Concurrency*** is another indicator that is affected by the gender of interviewer in ACASI, FTFI and SAI methods. When interviewer is female, concurrency prevalence for males is lower, especially when using (ACASI −0,161) (p≤0.05). Among females, changing to an opposite gender interviewer does not have any statistically significant effects, except for having sexual relations with same gender partner (***Sex with Same Gender***), where the use of ACASI shows an effect of (−0.072) (p≤0.05).

The gender of the interviewer generates socially desirable response in violence risk related indicators. That is the case for ***Victimization*** among males where the use of SAI produces an increasing effect of 0.125 (p≤0.05). There is also weak evidence of lowering prevalence effects for males on ***Fighting*** and ***Gang Affiliation*** when FTFI and ACASI methods are applied, respectively.

When including **privacy** as an explanatory variable, the gender of the interviewer seems to generate socially desirable response biases among men in the sexual identity indicator. In the FTFI method, the prevalence of men interviewed by women and who reported ***Sex with Same Gender*** is higher than that among men interviewed by men (Table 8). Finally, privacy seems to have a lowering effect in the reported prevalence of ***Marijuana Use*** of 0.082 (p≤0.01).

Table 4
Risk indicators by survey method and gender of respondent *(male)*.
Source: Authors

Indicator	*Male respondents*																				
	FTFI				SAI				ACASI				CATI				Total				Prob.
	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	
Ever regular smoker	101	0.0%	0.04	(0.00; 0.08)	91	2.2%	0.05	(0.01; 0.10)	94	4.1%	0.03	(0.00; 0.07)	100	0.0%	0.03	(0.00; 0.06)	386	1.5%	0.04	(0.02; 0.06)	0.812
Current smoker	101	0.0%	0.03	(0.00; 0.06)	91	2.2%	0.02	(-0.01; 0.05)	95	3.1%	0.05	(0.01; 0.10)	100	0.0%	0.05	(0.01; 0.09)	387	1.3%	0.04	(0.02; 0.06)	0.631
Binge drinking	101	0.0%	0.34	(0.24; 0.43)	86	7.5%	0.35	(0.25; 0.45)	95	3.1%	0.20	(0.12; 0.28)	100	0.0%	0.25	(0.16; 0.34)	382	2.6%	0.28	(0.24; 0.33)	0.071
Drug use	100	1.0%	0.10	(0.03; 0.17)	65	30.1%	0.08	(0.01; 0.14)	91	7.1%	0.18	(0.10; 0.25)	100	0.0%	0.07	(0.02; 0.12)	356	9.2%	0.11	(0.07; 0.14)	0.085
Marijuana use	100	1.0%	0.07	(0.02; 0.12)	65	30.1%	0.06	(0.00; 0.12)	94	4.1%	0.07	(0.02; 0.13)	100	0.0%	0.06	(0.01; 0.11)	359	8.4%	0.07	(0.04; 0.09)	0.977
Gang affiliation	101	0.0%	0.14	(0.07; 0.20)	70	24.7%	0.11	(0.04; 0.19)	96	2.0%	0.09	(0.03; 0.16)	100	0.0%	0.17	(0.10; 0.24)	367	6.4%	0.13	(0.09; 0.17)	0.437
Fights	101	0.0%	0.12	(0.04; 0.19)	76	18.3%	0.05	(0.00; 0.10)	98	0.0%	0.07	(0.02; 0.12)	100	0.0%	0.15	(0.07; 0.23)	375	4.3%	0.10	(0.07; 0.13)	0.118
Intimate partner violence	101	0.0%	0.07	(0.02; 0.12)	91	2.2%	0.05	(0.01; 0.10)	96	2.0%	0.06	(0.01; 0.11)	99	1.0%	0.05	(0.01; 0.10)	387	1.3%	0.06	(0.04; 0.08)	0.948
Sexual identity	101	0.0%	0.03	(0.00; 0.06)	79	15.1%	0.00		91	7.1%	0.02	(-0.01; 0.05)	98	2.0%	0.00		369	5.9%	0.01	(0.00; 0.03)	0.181
Ever STD diagnosis	100	1.0%	0.02	(-0.01; 0.05)	83	10.8%	0.04	(0.00; 0.08)	96	2.0%	0.05	(0.01; 0.10)	99	1.0%	0.06	(0.01; 0.11)	378	3.6%	0.04	(0.02; 0.06)	0.506
Pregnancy Intentions	na	na	na		na	na	na		na	na	na		na	na	na		na	na	na		na
Ever had sex	101	0.0%	0.94	(0.89; 0.99)	92	1.1%	0.86	(0.78; 0.94)	97	1.0%	0.59	(0.50; 0.68)	99	1.0%	0.95	(0.91; 0.99)	389	0.8%	0.84	(0.80; 0.88)	0.000
Age of sexual debut	93	2.1%	15.74	(15.34; 16.14)	71	10.1%	15.69	(15.13; 16.25)	56	1.8%	16.52	(15.80; 17.23)	93	1.1%	16.00	(15.55; 16.45)	313	3.7%	15.95	(15.70; 16.19)	0.177
Lifetime sexual partners	92	3.2%	7.90	(5.85; 9.95)	68	13.9%	7.96	(5.77; 10.14)	54	5.3%	6.57	(4.14; 9.00)	93	1.1%	8.14	(6.33; 9.95)	307	5.5%	7.75	(6.69; 8.82)	0.745
Number of sexual partners in the last 12 months	95	0.0%	3.02	(1.97; 4.07)	67	15.2%	2.40	(1.67; 3.13)	55	3.5%	3.29	(1.29; 5.29)	93	1.1%	2.20	(1.73; 2.68)	310	4.6%	2.69	(2.16; 3.22)	0.425
Concurrent sex	83	12.6%	0.08	(0.02; 0.15)	54	31.6%	0.02	(-0.02; 0.06)	51	10.5%	0.08	(0.00; 0.16)	89	5.3%	0.08	(0.02; 0.14)	277	14.8%	0.07	(0.04; 0.10)	0.451
Same gender sex	95	0.0%	0.09	(0.03; 0.16)	78	1.3%	0.04	(-0.01; 0.08)	57	0.0%	0.05	(-0.01; 0.11)	94	0.0%	0.03	(0.00; 0.07)	324	0.3%	0.06	(0.03; 0.08)	0.240
Safe casual sex	69	0.0%	0.81	(0.71; 0.91)	41	0.0%	0.63	(0.49; 0.78)	31	0.0%	0.52	(0.32; 0.71)	66	0.0%	0.77	(0.67; 0.88)	207	0.0%	0.72	(0.65; 0.79)	0.008
Ever commercial sex	95	0.0%	0.22	(0.13; 0.31)	78	1.3%	0.19	(0.11; 0.28)	56	1.8%	0.29	(0.16; 0.41)	94	0.0%	0.22	(0.14; 0.30)	323	0.6%	0.23	(0.18; 0.27)	0.648
Transactional sex	94	1.1%	0.16	(0.08; 0.24)	70	11.4%	0.07	(0.01; 0.13)	56	1.8%	0.09	(0.01; 0.17)	94	0.0%	0.15	(0.07; 0.23)	314	3.4%	0.12	(0.08; 0.16)	0.260
Sex under the influence of alcohol/drugs	94	1.1%	0.29	(0.19; 0.38)	71	10.1%	0.32	(0.22; 0.43)	56	1.8%	0.34	(0.22; 0.45)	93	1.1%	0.28	(0.19; 0.36)	314	3.4%	0.30	(0.26; 0.35)	0.840

NR = item level non response rate in reference population. Obs. = number of effective observations used to calculate mean (ie. after dropping non response).
na = data not available.
Prob. = p-value of null difference between means across survey methods.

Table 5
Risk indicators by survey method and gender of respondent *(female)*.
Source: Authors

Indicator	*Female respondents*																				
	FTFI				SAI				ACASI				CATI				Total				Prob. (2)
	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	Obs.	NR	Mean	CI 95%	
Ever regular smoker	160	0.0%	0.01	(−0.01;0.02)	153	3.8%	0.01	(−0.01;0.02)	157	0.6%	0.01	(0.00;0.03)	155	0.0%	0.01	(−0.01;0.03)	625	1.1%	0.01	(0.00;0.02)	0.879
Current smoker	160	0.0%	0.01	(−0.01;0.02)	153	3.8%	0.01	(−0.01;0.02)	157	0.6%	0.03	(0.00;0.06)	155	0.0%	0.01	(−0.01;0.02)	625	1.1%	0.01	(0.00;0.02)	0.111
Binge drinking	159	0.6%	0.26	(0.20;0.33)	138	13.2%	0.25	(0.18;0.33)	156	1.3%	0.12	(0.06;0.17)	155	0.0%	0.15	(0.09;0.22)	608	3.8%	0.20	(0.16;0.23)	0.001
Drug use	154	3.8%	0.03	(0.00;0.05)	114	28.3%	0.01	(−0.01;0.03)	151	4.4%	0.07	(0.03;0.11)	155	0.0%	0.01	(−0.01;0.02)	574	9.2%	0.03	(0.01;0.04)	0.006
Marijuana use	154	3.8%	0.00		114	28.3%	0.00		158	0.0%	0.03	(0.00;0.06)	155	0.0%	0.01	(−0.01;0.02)	581	8.1%	0.01	(0.00;0.02)	0.018
Gang affiliation	159	0.6%	0.04	(0.01;0.08)	120	24.5%	0.04	(0.01;0.08)	157	0.6%	0.04	(0.01;0.07)	155	0.0%	0.07	(0.03;0.11)	591	6.5%	0.05	(0.03;0.07)	0.530
Fights	159	0.6%	0.08	(0.04;0.12)	131	17.6%	0.05	(0.01;0.09)	156	1.3%	0.04	(0.01;0.08)	155	0.0%	0.05	(0.02;0.09)	601	4.9%	0.06	(0.04;0.08)	0.516
Intimate partner violence	160	0.0%	0.06	(0.03;0.10)	150	5.7%	0.08	(0.03;0.13)	158	0.0%	0.05	(0.02;0.08)	155	0.0%	0.10	(0.05;0.14)	623	1.4%	0.07	(0.05;0.09)	0.416
Sexual identity	159	0.6%	0.00		119	25.2%	0.00		147	7.0%	0.02	(0.00;0.04)	152	1.9%	0.02	(0.00;0.04)	577	8.7%	0.01	(0.00;0.02)	0.131
Ever STD diagnosis	159	0.6%	0.18	(0.12;0.23)	138	13.2%	0.14	(0.08;0.20)	154	2.5%	0.14	(0.08;0.19)	155	0.0%	0.23	(0.16;0.31)	606	4.1%	0.17	(0.14;0.20)	0.090
Pregnancy Intentions	153	1.9%	0.07	(0.03;0.10)	137	8.7%	0.11	(0.06;0.16)	146	1.4%	0.11	(0.06;0.16)	147	0.0%	0.20	(0.13;0.26)	583	3.0%	0.12	(0.09;0.15)	0.005
Ever had sex	160	0.0%	0.90	(0.85;0.95)	157	1.3%	0.89	(0.85;0.94)	154	2.5%	0.58	(0.50;0.67)	155	0.0%	0.94	(0.89;0.98)	626	0.9%	0.83	(0.80;0.86)	0.000
Age of sexual debut	143	0.7%	16.20	(15.83;16.56)	128	8.6%	16.95	(16.48;17.41)	89	1.1%	16.82	(16.22;17.42)	144	0.7%	16.80	(16.40;17.19)	504	2.9%	16.67	(16.45;16.89)	0.054
Lifetime sexual partners	143	0.7%	2.66	(2.28;3.03)	125	10.7%	3.16	(2.59;3.73)	90	0.0%	3.14	(2.49;3.80)	145	0.0%	2.41	(2.08;2.75)	503	3.1%	2.80	(2.55;3.05)	0.063
Number of sexual partners in the last 12 months	143	0.7%	1.13	(1.04;1.23)	122	12.9%	1.25	(1.13;1.36)	90	0.0%	1.22	(1.10;1.35)	145	0.0%	1.06	(0.97;1.16)	500	3.7%	1.16	(1.10;1.21)	0.053
Concurrent sex	134	6.9%	0.04	(0.01;0.07)	104	25.7%	0.17	(0.10;0.24)	88	2.2%	0.05	(0.00;0.09)	137	5.5%	0.02	(0.00;0.05)	463	10.8%	0.06	(0.04;0.09)	0.000
Same gender sex	144	0.0%	0.04	(0.01;0.07)	137	2.1%	0.07	(0.03;0.11)	89	1.1%	0.02	(−0.01;0.05)	142	2.1%	0.01	(−0.01;0.02)	512	1.3%	0.04	(0.02;0.05)	0.053
Safe casual sex	21	0.0%	0.67	(0.45;0.89)	22	8.3%	0.55	(0.31;0.78)	23	0.0%	0.48	(0.26;0.70)	27	0.0%	0.67	(0.48;0.85)	93	2.1%	0.59	(0.48;0.70)	0.480
Ever commercial sex	144	0.0%	0.00		133	5.0%	0.00		89	1.1%	0.00		142	2.1%	0.00		508	2.1%	0.00		.
Transactional sex	141	2.1%	0.05	(0.01;0.09)	126	10.0%	0.07	(0.03;0.12)	90	0.0%	0.08	(0.02;0.13)	142	2.1%	0.07	(0.03;0.11)	499	3.9%	0.07	(0.04;0.09)	0.822
Sex under the influence of alcohol/drugs	140	2.8%	0.15	(0.09;0.21)	119	15.0%	0.21	(0.13;0.29)	na	na	na		142	2.1%	0.11	(0.06;0.17)	na	na	na		na

NR = item level non response rate in reference population. Obs. = number of effective observations used to calculate mean (ie. after dropping non response).
na = data not available.
Prob. = p-value of null difference between means across survey methods.

Table 6
Difference in risk indicators by survey method.
Source: authors

Indicator	*Male respondents*									*Female respondents*								
	Unadjusted difference			**Adjusted difference**			**Unadjusted difference**			**Adjusted difference**								
	SA-FTF	**ACAS-SA**	**FTF-ACAS**	**SA-FTF**	**ACAS-SA**	**FTF-ACAS**	**SA-FTF**	**ACAS-SA**	**FTF-ACAS**	**SA-FTF**	**ACAS-SA**	**FTF-ACAS**
Ever regular smoker	0.015	−0.023	0.008	−0.017	0.009	0.007	0.000	0.006	−0.006	0.003	0.005	−0.008
Current smoker	−0.008	0.031	−0.023	−0.007	0.032	−0.025	0.000	0.025	−0.026	0.007	0.026	−0.032
Binge drinking	0.012	−0.149 **	0.137 **	0.062	−0.164 **	0.102	−0.011	−0.138 ***	0.149 ***	0.025	−0.157 ***	0.132 ***
Drug use	−0.023	0.099 *	−0.076	−0.065	0.116 **	−0.051	−0.017	0.057 ***	−0.040 *	0.004	0.050 **	−0.054 **
Marijuana use	−0.008	0.013	−0.004	−0.043	0.041	0.003	0.000	0.032 **	−0.032 **	0.001	0.037 **	−0.038 ***
Gang affiliation	−0.024	−0.021	0.045	−0.041	−0.005	0.046	−0.002	−0.003	0.006	0.014	−0.008	−0.006
Fights	−0.066	0.019	0.047	−0.079	0.021	0.058	−0.028	−0.009	0.037	−0.032	0.010	0.023
Intimate partner violence	−0.014	0.008	0.007	0.007	0.006	−0.012	0.018	−0.029	0.012	0.032	−0.059 *	0.027
Sexual identity	−0.030 *	0.022	0.008	−0.023	0.008	0.015	0.000	0.020 *	−0.020 *	0.003	0.016	−0.019 *
Ever STD diagnosis	0.016	0.016	−0.032	0.004	0.004	−0.008	−0.038	−0.001	0.040	−0.073	0.023	0.050
Pregnancy Intentions	na	na	na	na	na ***	na ***	0.044	0.000	−0.044	0.035	0.016	−0.051
Ever had sex	−0.082 *	−0.271 ***	0.353 ***	−0.049	−0.292 ***	0.341 ***	−0.008	−0.307 ***	0.316 ***	−0.037	−0.288 ***	0.324 ***
Age of sexual debut	−0.052	0.828 *	−0.776 *	−0.155	0.667	−0.512	0.750 **	−0.125	−0.624 *	0.677 **	−0.153	−0.524
Lifetime sexual partners	0.054	−1.382	1.328	−0.195	−1.140	1.334	0.503	−0.016	−0.487	0.618	0.041	−0.659 *
Number of sexual partners in the last 12 months	−0.618	0.888	−0.270	−0.919	1.071	−0.152	0.113	−0.024	−0.089	0.152 *	−0.027	−0.125
Concurrent sex	−0.066 *	0.060	0.006	−0.048	0.082 *	−0.034	0.136 ***	−0.128 ***	−0.008	0.114 ***	−0.108 **	−0.005
Same gender sex	−0.056	0.014	0.042	−0.045	0.014	0.031	0.024	−0.043 *	0.019	0.018	−0.043	0.025
Safe casual sex	−0.177 **	−0.118	0.295 ***	−0.117	−0.158	0.275 **	−0.121	−0.067	0.188	−0.064	−0.111	0.175
Ever commercial sex	−0.029	0.093	−0.065	−0.062	0.120	−0.058	0.000	0.000	0.000	na	na	na
Transactional sex	−0.088 *	0.018	0.070	−0.115 **	0.031	0.084	0.022	0.006	−0.028	0.026	0.005	−0.031
Sex under the influence of alcohol/drugs	0.037	0.015	−0.052	0.077	−0.015	−0.062	0.060	na	na	0.023	na	na

Unadjusted difference is between simple means. Adjusted difference adjusts for covariates.
SA-FTF = Difference between self-administered interview and face-to-face interview.
ACAS-SA = Difference between audio computer-assisted self-administered interview and self administered interview.
FTF-ACAS = Difference between face-to-face interview and audio computer-assisted self-administered interview.
Level of significance $p \leq 0.05$ (*), $p \leq 0.01$ (**), and $p \leq 0.001$ (***).
na = data not available.

Table 7
Effect on risk indicators when interviewer gender changes from same sex as respondent to opposite sex (*models without privacy*).
Source: Authors

Indicator	*Both gender respondents*				*Male respondents*				*Female respondents*			
	All modes	**FTF**	**SA**	**ACAS**	**All modes**	**FTF**	**SA**	**ACAS**	**All modes**	**FTF**	**SA**	**ACAS**
Ever regular smoker	−0.007	−0.018	0.033 *	0.008	0.017	−0.025	0.073	0.015	0.001	−0.012	0.016	0.001
Current smoker	−0.006	−0.029 *	0.006	0.008	0.008	−0.051	0.053	0.035	−0.010	−0.014	−0.011	−0.006
Binge drinking	0.033	−0.006	0.132 *	−0.010	0.077	0.023	0.355 ***	−0.089	−0.022	−0.036	−0.033	0.000
Drug use	0.025	−0.005	0.051	0.039	0.014	−0.068	0.084	0.055	0.033	0.036	0.038	0.027
Marijuana use	−0.001	0.007	0.030	−0.030	−0.016	−0.005	0.061	−0.073	0.001	0.006	0.011	−0.011
Gang affiliation	−0.008	0.010	0.000	−0.032	−0.032	0.004	0.057	−0.128 *	0.003	0.014	−0.050	0.030
Fights	−0.010	−0.015	−0.026	0.007	−0.046	−0.136 *	0.016	0.003	0.007	0.060	−0.039	−0.009
Intimate partner violence	0.016	0.034	0.035	−0.020	0.008	0.012	0.125 **	−0.095	0.013	0.044	−0.033	0.025
Sexual identity	0.014	0.005	0.002	0.032	0.024	0.019	0.007	0.044	0.005	0.001	0.001	0.012
Ever STD diagnosis	−0.003	−0.020	0.023	−0.007	−0.011	−0.016	−0.034	0.011	−0.014	−0.036	0.029	−0.029
Pregnancy Intentions	na	na	na	na	na	na	na	na	0.053	−0.005	0.096	0.072
Ever had sex	0.018	−0.015	0.036	0.033	0.041	0.009	0.215 **	−0.071	−0.006	−0.038	−0.061	0.077
Age of sexual debut	−0.065	0.275	−0.461	−0.100	−0.201	0.965 *	−1.327 *	−0.816	0.181	0.034	0.121	0.471
Lifetime sexual partners	−0.009	−1.226	1.039	0.612	−0.401	−3.934	1.855	2.849	−0.209	−0.187	0.365	−0.953
Number of sexual partners in the last 12 months	−0.378	−0.828	0.412	−0.616	−0.995	−2.098	1.466	−1.934	0.045	−0.045	0.173	0.022
Concurrent sex	−0.036	−0.034	0.005	−0.083 *	−0.058	−0.039	0.012	−0.161 **	0.013	−0.019	0.079	−0.011
Same gender sex	0.059 ***	0.090 **	0.074 **	-0.010	0.115	0.154 **	0.121 *	0.044	0.010	0.033	0.048	−0.072 *
Safe casual sex	0.015	−0.021	−0.150	0.207	−0.037	−0.076	−0.210	0.218	−0.051	0.281	−0.129	−0.203
Ever commercial sex	na	na	na	na	0.053	0.097	−0.011	0.062	na	na	na	na
Transactional sex	0.011	0.019	−0.009	0.024	0.011	0.050	0.009	−0.051	0.001	−0.011	0.010	0.007
Sex under the influence of alcohol/drugs	0.000	−0.033	0.024	0.056	−0.024	−0.116	0.063	0.024	−0.027	0.001	−0.060	na

Effects from fixed-effects model.
Level of significance $p \leq 0.05$ (*), $p \leq 0.01$ (**), and $p \leq 0.001$ (***).
na = data not available.

Table 8
Effect on risk indicators when interviewer gender changes from same sex as respondent to opposite sex (*models with privacy*).
Source: authors

Indicator	*Respondents of both sexes*				*Male respondents*				*Female respondents*			
	All modes	**FTF**	**SA**	**ACAS**	**All modes**	**FTF**	**SA**	**ACAS**	**All modes**	**FTF**	**SA**	**ACAS**
Ever regular smoker	0.007	−0.017	0.034 *	0.008	0.016	−0.025	0.070	0.014	0.003	−0.013	0.019	0.003
Current smoker	−0.009	−0.028 *	0.007	−0.004	0.006	−0.049	0.049	0.029	−0.016	−0.013	−0.010	−0.023
Binge drinking	0.030	−0.011	0.140 **	−0.021	0.075	0.021	0.360 ***	−0.100	−0.033	−0.051	−0.029	−0.018
Drug use	0.024	−0.004	0.052	0.035	0.012	−0.062	0.084	0.045	0.030	0.034	0.031	0.024
Marijuana use	−0.002	0.008	0.033	−0.034	−0.018	−0.001	0.059	−0.082 *	−0.002	0.004	0.009	−0.016
Gang affiliation	−0.007	0.015	0.001	−0.034	−0.028	0.001	0.048	−0.108 *	0.001	0.022	−0.052	0.018
Fights	−0.014	−0.023	−0.025	0.004	−0.046	−0.134 *	0.014	0.001	0.000	0.048	−0.041	−0.017
Intimate partner violence	0.013	0.035	0.034	−0.029	0.008	0.014	0.125 **	−0.098	0.005	0.041	−0.041	0.012
Sexual identity	0.014	0.005	0.003	0.034	0.023	0.021	0.007	0.038	0.009	0.002	0.002	0.021
Ever STD diagnosis	−0.005	−0.017	0.012	−0.007	−0.009	−0.016	−0.031	0.014	−0.019	−0.028	0.010	−0.036
Pregnancy Intentions	na	na	na	na	na	na	na	na	0.054	−0.006	0.094	0.079
Ever had sex	0.023	−0.015	0.041	0.045	0.046	0.007	0.216 **	−0.057	0.002	−0.038	−0.050	0.091
Age of sexual debut	−0.067	0.286	−0.484	−0.107	−0.227	0.924 *	−1.237	−0.938	0.149	0.008	0.075	0.450
Lifetime sexual partners	−0.014	−1.224	1.005	0.651	−0.263	−3.762	1.683	3.277	−0.172	−0.170	0.428	−0.910
Number of sexual partners in the last 12 months	−0.389	−0.794	0.393	−0.678	−0.853	−1.918	1.232	−1.469	0.057	−0.041	0.189	0.046
Concurrent sex	−0.035	−0.033	0.006	−0.083 *	−0.055 *	−0.033	0.012	−0.161 **	0.015	−0.017	0.077	−0.004
Same gender sex	0.059 ***	0.092 **	0.074 **	−0.011	0.120 ***	0.164 **	0.116 *	0.053	0.012	0.035	0.049	−0.071 *
Safe casual sex	0.010	−0.071	−0.151	0.256 *	−0.024	−0.083	−0.201	0.353 *	−0.053	0.111	−0.017	−0.195
Ever commercial sex	.	.	.	.	0.060	0.113	−0.025	0.086	na	na	na	na
Transactional sex	0.012	0.023	−0.009	0.019	0.019	0.062	0.006	−0.036	−0.005	−0.016	0.006	−0.002
Sex under the influence of alcohol/drugs	0.001	−0.031	0.027	0.045	−0.017	−0.105	0.062	0.032	−0.010	0.017	−0.044	na

Effects from fixed-effects model.
Level of significance p ≤ 0.05 (*), p ≤ 0.01 (**), and p ≤ 0.001 (***).
na = data not available.

5. Discussion

The success and credibility of research on youth risk-taking behavior is based largely on the quality of the data used. In this paper, the research team discusses errors and sources of bias that threaten data quality using a sample of youth in the Dominican Republic. Although most studies comparing the effects of alternative survey interview methods have assessed the prevalence of specific self-reported risk behaviors using only two methods (Bautista-Arredondo et al., 2011; Van de Looij-Jansen and de Wilde, 2008; Wright et al., 1998), this study is the first to compare the effectiveness of various survey interview methods, which vary in the level of privacy and cognitive demands, at measuring youth risk behavior in Latin American and the Caribbean. To the best of the research team's knowledge, and in contrast to previous studies (such as Brener et al., 2006, or Tourangeau and Smith, 1998), results suggest that in some instances, lower prevalence rates may be more accurate than higher prevalence rates in specific contexts, suggesting that *less* risky behaviors might be more accurate.

The research team found that certain risk behaviors that are tolerated by adults and considered as a right in LAC (e.g., ***Sexual Behavior, Alcohol Consumption***) are over-reported in interviewer-assisted methods, while those considered taboo or illegal (e.g., ***Illicit Drug Use, Violence, or Concurrency***) are reported less frequently. These findings are bolstered by data from a qualitative study among Dominican youth (Bautista-Arredondo et al., 2011b) that suggest that sexuality is considered a positive behavior by youth and alcohol consumption is considered to be common entertainment among youth and not harmful to health.

The ***first objective*** was to examine differences in overall non-response and individual question-level errors. The research team found no statistical difference in terms of non-response rates between home-based methods and the CATI method. Among individual question-level errors, the SAI method generated the lowest RCI. Some argue (Jenkins and Dillman, 1995) that this may be due to various cognitive flaws arising as a direct consequence of youth responding without any assistance or supervision whatsoever, with the exception of the written instructions on the questionnaire. The FTFI and CATI methods control non-response, blank responses, and skip errors because they rely on skilled interviewers. However, FTFI method interviewers produce a larger number of complex inconsistencies (inconsistencies involving two or more questions) than CATI method interviewers. This is because in the CATI method, computer assisted checks help interviewers eliminate complex inconsistencies. The ACASI method manages to control non-responses, blank responses and skip errors as efficiently as the FTFI and CATI methods. This is accomplished by replacing the interviewer and using software that controls blank responses and out-of-range values and adapts the flow of the interview to prevent incorrect question skipping. The ACASI method, by software design, fails to effectively control complex consistencies.

There is some evidence that the ACASI method shows a prevalence of ***Ever had Sex*** approximately 30 points lower than the FTFI and SAI methods. To confirm that the ACASI method is biased, the research team used a telephone survey conducted by the World Bank between 2009 and 2010 among the same youth cohort, which recorded data on the participants' number of children. The research team compared the

number of respondents who reported that they had never had sex but who had children (Table 3). In the ACASI method, the number of inconsistencies is abnormally high, particularly among women. Such a difference cannot be explained by a socially desirable response bias. The research team believes that due to the length of the questionnaire and the learning process for the software, where the interviewer got to know how to advance faster in the questionnaire, a skipping pattern developed that was independent from reality or circumstances. The fact that prevalence for specific indicators were lower with ACASI (usually those located at the end of the survey) means that they might use ***"No"*** as a systemic response pattern.

The ***second objective*** of this study was to test the hypothesis that self-administered and interviewer-administered methods may yield different results. The research team also hypothesized that privacy of the interview and the gender of interviewer may have an important interaction with this association, supporting the idea that direction bias can be population specific. The research team found that among interviewer-assisted methods, FTFI tends to yield higher prevalence for **sexual and reproductive health-related** indicators, as well as ***Alcohol Consumption***. Furthermore, ***Illicit Drug Use*** is not acceptable in the Dominican Republic, and the research team consequently observed a lower prevalence of illicit drug use in the interviewer-assisted methods compared to self-administered methods (especially when ACASI is applied). These findings are consistent with studies reporting that the effect of survey interview method is setting-specific (Gregson et al., 2002; Pienaar, 2009) and dependent on local norms around acceptable and unacceptable behavior. What is considered acceptable behavior in LAC, may not be in an another region. For example, while concurrency among females in the Dominican Republic is considered a sensitive matter, in certain Sub-Saharan Africa countries it is seen as acceptable (Caldwell and Caldwell, 1996; Caldwell et al., 1989). It may also explain why studies using ACASI in particular have yield mixed results across regions. Some ACASI-based studies show high prevalence of risk behaviors (Langhaug et al., 2011; Ghanem et al., 2005; Rogers et al., 2005; Rathod et al., 2011), while others present inconsistencies or are inconclusive about its effectiveness (Jaya et al., 2008; Mensch et al., 2003; Johnson et al., 1992; Jennings et al., 2002), or show comparatively lower prevalence (Mensch et al., 2008; Testa et al., 2005; Hallfors et al., 2000).

Results suggest that, among women, the SAI method shows a higher prevalence of ***Partnership Concurrency*** (e.g., partnerships that overlap in time) than the other methods. It seems that this difference cannot be explained solely by the nonresponse rate of the SAI method. Concurrency may well be a sensitive subject for this group of women, who opt to not reveal overlapping sexual partnerships when interviewed through the FTFI or ACASI methods. Also, it may be related to the underlying trust of computers, the youth's relationship to technology and their willingness. There is weak evidence that, among men, the FTFI method shows a higher prevalence of ***Safe Casual Sex*** than the other methods. This difference may originate in a socially desirable response bias, where the response the youth consider socially desirable is a greater use of condoms than the real one. Also among men, there is weak evidence that the FTFI method shows a higher prevalence of ***Transactional Sex*** than the other methods. This could also be explained by a socially desirable response bias.

The CATI method generated findings close to those of the FTFI method. In the CATI method, the prevalence of ***Sex with Same Gender*** was lower than in the FTFI method, which may originate in a socially desirable response bias, if telephone calls inspire less privacy or confidence than face-to-face interviews.

The ACASI method shows a higher prevalence in ***Drug Consumption*** than the FTFI and SAI methods. This may be explained by the design and structure of the software's platform, where multiple-choice questions are broken down into a series of independent questions, and this results in the participants spending more time on a single question, perhaps increasing recall. Nevertheless, the foregoing does not explain the higher prevalence of marijuana consumption observed in women, which may be explained by the attitude of women to marijuana and hence desirable response bias. Higher levels of reported use may be also explained by increased privacy conditions ensured by ACASI.

The ***third objective*** of the study was to determine whether the interviews were affected by the level of privacy or the interviewer's gender, as suggested in previous studies (Langhaug et al., 2011; Eaton et al., 2010; Tourangeau and Smith, 1998; Brener et al., 2003; Gribble and Miller, 2000; Sedla, 2010; Lothen-Kline et al., 2003). Evidence from this study supports the hypothesis that privacy effects on reporting. The gender of the interviewer matters, especially when interviewing men. It seems to generate socially desirable response biases in key indicators. This is the case for concurrency or gang affiliation. In the FTFI method, the prevalence of men interviewed by women and who ***Reported Concurrency*** is lower than that among men interviewed by men. This could be explained by the assumption that men consider it undesirable to admit to women this type of behavior. Strong evidence suggests that when privacy is ensured, the prevalence of men interviewed by women and who reported ***Sex with Same Gender*** was higher than among men interviewed by men. This may be explained by the assumption that men consider as undesirable to admit to other men that they have sex with other men.

The authors also suggest that there is an interviewer gender effect in key violence indicators. That is the case when using FTFI and asking about ***Gang Affiliation*** whose prevalence is lower than that among men interviewed by men. Regarding FTFI method and in agreement with previous studies (Davis et al., 2010), it may be that respondents feel more comfortable disclosing information that might be viewed as victimizing to female interviewers (Dailey and Claus, 2001; Pollner, 1998), while disclosure of behaviors that might be viewed by some as behaviors of choice, such as illicit gang affiliation or being involved in a fight, may be higher to male interviewers (Fendrich et al., 1999; Johnson and Parsons, 1994). Likewise, gender seems to have a strong effect in the case for ***Victimization*** when using SAI, showing a higher prevalence when a male is interviewed by a woman. This result is supported by recent research that suggests that survey format influences males more than females on sensitive self-disclosure measures (Booth-Kewley et al., 2007; Kiesler and Sproull, 1986).

5.1. Limitations

There are several limitations of this study. The most important limitation is that the risk behaviors were self-reported and objective biomarkers, or other "gold standard" measurement methods, were not available. Thus, the research team did not know the true prevalence of the reported risk behaviors in the study population. The research team had to make assumptions about which method is likely least affected by bias using the results from the four survey interview methods and supplementary data about social norms and data from prior surveys.

Another limitation of the study is that the research team found that the ACASI method identified a much lower prevalence of youth who reported ever having sex, even compared to SAI, which should have been similar. The research team hypothesized that this is a direct consequence of the unsupervised nature of ACASI surveys. Many youth may have responded that they had never had sex in order to complete the questionnaire faster. This motivation may be higher in ACASI than in SAI, since the ACASI method did not offer any hints as to how much of the questionnaire was left to complete, whereas in the SAI method, youths knew approximately how many pages and questions were yet to be completed. As a result, the research team could only test the ACASI method for alcohol and drug consumption since a large proportion of youth skipped out of the sexual behavior modules by responding that they had never had sex. Thus, although the ACASI method solves several of the quality problems observed in the SAI method, it also has quality problems of its own, which may be related to lack of supervision

or motivation.

Another limitation is that the CATI method used different interviewers than the other three methods (which share same groups of interviewers), so the observed differences may be wholly or partially due to differential effects between the two groups of interviewers.

Finally, the study sample is drawn from youth who are already part of an impact evaluation, so the sample may be more motivated, willing, and enthusiastic about completing the survey than youth in the general population. This may limit the generalizability/external validity of this component of the results.

5.2. Recommendations

Recent studies reveal the benefits of technological developments, such as audio computer assisted self-interviewing (ACASI) in interview methodology, especially for surveys of sensitive behavior and information (Eaton et al., 2010). However, data from this study suggest that the selection of method depends not only on the technology available and the behavior of interest, but also on the specific population under study and the conditions of the interview. In terms of data quality, the research team found that the SAI method is vulnerable to high non-response rates and errors, which may make this a less desirable survey administration option to measure youth risk-taking behavior, especially in the case of longer surveys. In terms of soliciting affirmative responses to a variety of risk behaviors, the research team found that risk behaviors that are socially acceptable tend to be reported more frequently in the interviewer assisted methods, suggesting that for some risk-behaviors, social desirability bias may still be a significant issue. It is tempting to choose self-administered methods to deal with socially desirable response bias and to reduce costs. However, it turns out that properly applying a self-administered method is extremely complex, and there is a risk that the final result does not produce data quality.

For surveying sexual behavior and illicit drug consumption, if FTFI is chosen, efforts should be focused on reducing complex inconsistencies. One way to obtain data quality similar to that of the CATI method is by integrating new technologies that allow interviewers to administer questionnaires on computers and record the data as they would in a CATI setting and making much easier for real-time data collection. If the ACASI method is chosen, it may minimize social desirability bias if the survey is short and controls for non-response and complex inconsistencies. Additionally, the population sample would need to be literate and technology friendly. Harrison and Hughes (1997) show that measuring levels and patterns of illicit drug use, their correlates and related behaviors requires the use of self-report methods, such as ACASI. However, the validity of self-reported data on sensitive and highly stigmatized behaviors such as drug use was questioned, and the research team suggests the need to use biomarkers to validate results (urinalysis or hair analysis).

The **length of the questionnaire** is a determining factor when choosing a survey interview method. Self-administered methods are vulnerable to high non-response rates and complex inconsistencies, partly because of cognitive difficulties. The longer the questionnaire, the harder it will be to avoid using complex questions and instructions. Administering the survey by telephone does not generate completeness issues or higher decline rates in the interview. Moreover, the CATI method may offer better data quality than the FTFI method.

Lastly, the **privacy and confidentiality conditions** provided during the interview have considerable bearing on the validity of the results obtained, reducing the number of responses influenced by social desirability bias (Sedla, 2010; Lothen-Kline et al., 2003). To this end, the interview characteristics must be specifically designed to offer privacy and ensure respondents that no relative or acquaintance—not even the interviewer—will be able to link their responses to their identity. Through the proper choice of survey interview method, the privacy of the interview can be protected. For example, self-administered methods offer more privacy than when interviewers are present (Langhaug et al., 2011; Tourangeau and Smith, 1998; Brener et al., 2003; Gribble and Miller, 2000). However, the great weakness of these methods is that, by forgoing the interviewers' assistance, the quality of the responses is highly dependent on the questions' degree of difficulty and on the cognitive level and motivation of the respondent. Furthermore, empirical evidence suggests that risk behavior surveys conducted in schools produce higher response rates than those completed at home (Mensch et al., 2003), allowing respondents to participate anonymously, without the risk of their parents seeing the responses.

Similarly, the level of **comprehension or difficulty** of the survey may influence the choice of method and therefore the quality of the collected information. Support from the interviewer or computer allows for an increase in response rates and reduction of erroneous skips, inconsistencies, out-of-range responses, and blanks. Without the support of the interviewer, the quality of the responses is highly dependent on the respondent's level of comprehension, which, in turn, depends on his or her age and education level.

Therefore, the **interviewer's attributes** (e.g., ethnicity, age, and gender, among others) are very important because they can influence the direction (the sign) and magnitude of the reported risk behavior, by possibly inducing a response bias toward whatever value is considered socially acceptable.

Lastly, the research team found that information quality depends on **how intrinsic biases are minimized** in the interview process, so the best way to validate the information gathered is to triangulate it through biomarker tests (e.g., urine and hair analyses, etc.). These can eliminate some of the researchers' concerns about the veracity of an adolescent's or young adult's responses. Biological tests are accurate and objective. Another way to verify that the information is reliable is to perform a psychometric analysis on the instruments, allowing for the measurement of a variable or predefined psychological behavior.

Since comprehension and social desirability bias are two of the three main sources of bias in measuring self-reported risk behaviors (along with recall bias), more rigorous evidence from the LAC region is needed to understand how to improve questionnaire design (length, order of the questions, location of skips etc.) and survey interview method in order to obtain more accurate data on actual risk behavior prevalence and be able to better inform policymaking in the region.

Survey interview methods may be related to the degree of perceived social censure of particular behaviors and these vary between cultures and demographic groups. Designing and implementing a qualitative evaluation among the population of study may guide the researcher on desirability bias direction, acceptable or taboo behaviors, as well as provide a good understanding of how sensitive is a behavior in an specific context or population.

Contribution and implications

This is the first study to compare the effectiveness of various survey interview methods used to measure youth risk-taking behavior in Latin America and the Caribbean, varying in level of privacy and cognitive demands. The results indicate that the sociocultural context, respondent and interviewer gender, and the level of privacy of the interview greatly impact response rates, data quality, and reporting bias. The researchers' recommendation is to use self-administered methods, such as self-administered interviews and ACASI, for brief and simple questionnaires that are likely to be unaffected by cognitive difficulties of the respondent. Additional research in the region to support these findings is necessary, including studies that integrate biomarkers into validation processes.

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Erratum regarding missing Declaration of Competing Interest statements in previously published articles

Declaration of Competing Interest statements were not included in published version of the following articles that appeared in previous issues of Development Engineering. Hence, the authors of the below articles were contacted after publication to request a Declaration of Interest statement:

1. "The pursuit of balance in sequential randomized trials" (Development Engineering, Volume 1, 2016, Pages 12–25) 10.1016/j.deveng.2015.11.001
2. "Electrification for "Under Grid" Households in Rural Kenya" (Development Engineering, Volume 1, 2016, Pages 26–35) 10.1016/j.deveng.2015.12.001
3. "A Proposed Integrated Data Collection, Analysis and Sharing Platform for Global Development" (Development Engineering, Volume 1, 2016, Pages 36–44) 10.1016/j.deveng.2015.12.002
4. "Avoided emissions of a fuel-efficient biomass cookstove dwarf embodied emissions" (Development Engineering, Volume 1, 2016, Pages 45–52) 10.1016/j.deveng.2016.01.001
5. "BALANCING TECHNICAL AND USER OBJECTIVES IN THE REDESIGN OF A PERUVIAN COOKSTOVE" (Development Engineering, Volume 2, 2017, Pages 12–19) 10.1016/j.deveng.2016.05.001
6. "Comparative performance of five Mexican plancha-type cookstoves using Water Boiling Tests" (Development Engineering, Volume 2, 2017, Pages 20–28) 10.1016/j.deveng.2016.06.001
7. "How Accurate is Our Misinformation?: A Randomized Comparison of Four Survey Interview Methods to Measure Risk Behavior among Young Adults in the Dominican Republic" (Development Engineering, Volume 2, 2017, Pages 53–67) 10.1016/j.deveng.2016.06.002
8. "Experimenting with Concepts from Modular Product Design and Multi-Objective Optimization to Benefit People Living in Poverty" (Development Engineering, Volume 2, 2017, Pages 29–37) 10.1016/j.deveng.2016.12.002
9. "On LPG usage in rural Vietnamese households" (Development Engineering, Volume 2, 2017, Pages 1–11) 10.1016/j.deveng.2016.12.003
10. "Rapid Prototyping a School-based Health Program in the Developing World" (Development Engineering, Volume 2, 2017, Pages 1–11) 10.1016/j.deveng.2016.12.003
11. "Limestone calcined clay cement as a low-carbon solution to meet expanding cement demand in emerging economies" (Development Engineering, Volume 2, 2017, Pages 82–91) 10.1016/j.deveng.2017.06.001
12. "Piloting the use of accelerometry devices to capture energy expenditure in agricultural and rural livelihoods: Protocols and findings from northern Ghana" (Development Engineering, Volume 2, 2017, Pages 114–131) 10.1016/j.deveng.2017.10.001
13. "Estimating the price (in)elasticity of off-grid electricity demand" (Development Engineering, Volume 3, 2018, Pages 12–22) 10.1016/j.deveng.2017.12.001
14. "Computer Security for Data Collection Technologies" (Development Engineering, Volume 3, 2018, Pages 1–11) 10.1016/j.deveng.2017.12.002
15. "Do financial diaries affect financial outcomes? Evidence from a randomized experiment in Uganda" (Development Engineering, Volume 3, 2018, Pages 72–82) 10.1016/j.deveng.2018.02.001
16. "Utilizing publicly available satellite data for urban research: Mapping built-up land cover and land use in Ho Chi Minh City, Vietnam" (Development Engineering, Volume 3, 2018, Pages 83–99) 10.1016/j.deveng.2018.03.001
17. "A trip to work: Estimation of origin and destination of commuting patterns in the main metropolitan regions of Haiti using CDR" (Development Engineering, Volume 3, 2018, Pages 133–165) 10.1016/j.deveng.2018.03.002
18. "Prototyping methods and constraints for small-to-medium sized enterprises in East Africa" (Development Engineering, Volume 3, 2018, Pages 117–124) 10.1016/j.deveng.2018.05.002
19. "Techno-economic feasibility of lighting protection of overhead transmission line with multi-chamber insulator arrestors"

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(Development Engineering, Volume 3, 2018, Pages 100–116) 10.1016/j.deveng.2018.05.003
20. “Addressing technical barriers for reliable, safe removal of fluoride from drinking water using minimally processed bauxite ores” (Development Engineering, Volume 3, 2018, Pages 175–187) 10.1016/j.deveng.2018.06.002
21. “Design for Localisation: a case study in the development and implementation of a low head propeller turbine in Nepal” (Development Engineering, Volume 5, 2020, 100051) 10.1016/j.deveng.2020.100051
22. “Toilet Alarms: A Novel Application of Latrine Sensors and Machine Learning for Optimizing Sanitation Services in Informal Settlements” (Development Engineering, Volume 5, 2020, 100052) 10.1016/j.deveng.2020.100052
23. “High-mast lighting as an adequate way of lighting pedestrian paths in informal settlements?” (Development Engineering, Volume 5, 2020, 100053) 10.1016/j.deveng.2020.100053