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A systematic review and meta-analysis of quantitative interviewing tools to investigate self-reported HIV and STI associated behaviours in low- and middle-income countries

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ABSTRACT

Objective Studies identifying risks and evaluating interventions for human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs) often rely on self-reported measures of sensitive behaviours. Such self-reports can be subject to social desirability bias. Concerns over the accuracy of these measures have prompted efforts to improve the level of privacy and anonymity of the interview setting. This study aims to determine whether such novel tools minimise misreporting of sensitive information.

Methods Systematic review and meta-analysis of studies in low- and middle-income countries comparing traditional face-to-face interview (FTFI) with innovative tools for reporting HIV risk behaviour. Crude odds ratios and 95% confidence intervals were calculated. Cochran's chi-squared test of heterogeneity was performed to explore differences between estimates. Pooled estimates were determined by gender, region, education, setting and question timeframe using a random-effects model.

Results We found and included 15 datasets in the meta-analysis. Most studies compared audio computer assisted self interview (ACASI) with FTFI. There was significant heterogeneity across studies for three outcomes of interest: 'ever had sex' ($I^2=93.4\%$, $p<0.001$), non-condom use ($I^2=89.3\%$, $p<0.001$), and number of partners ($I^2=75.3\%$, $p<0.001$). For the fourth outcome, 'forced sex' there was homogenous increased reporting by non-FTFI methods (OR 1.47; 95% CI 1.11-1.94). Overall, non-FTFI methods were not consistently associated with a significant increase in the reporting of all outcomes. However, there was increased reporting associated with non-FTFI with region (Asia), setting (urban), education (more than 60% had secondary education) and a shorter question timeframe.

Conclusion Contrary to expectation, differences between FTFI and non-interviewer administered interview methods for the reported sensitive behaviour investigated were not uniform. However, we observed trends and variations in the level of reporting according to the outcome, study and population characteristics. FTFI may not always be inferior to innovative interview tools depending on the sensitivity of the question as well as the population assessed.

Keywords: Interview, review, meta-analysis, bias

Introduction

Intervention programmes aimed at reducing HIV and STI incidence often rely on self-reported measures of behaviours because of the difficulties in directly measuring the infrequent occurrences of infection. Such self-reports are subject to recall bias and social desirability bias [1]. Concerns over the accuracy of these measures have prompted efforts to improve data collection through the modification of interview modes [2].

Different systematic and methodological reviews of research into sexual behaviour have been published in the last decade [1-5]. Most have been sceptical that the dominant mode of data collection – face-to-face interviews (FTFI) – is the most effective means of gathering high quality data, and have urged the adoption of alternative methods [6]. There are a number of reasons that may lead to inconsistencies between actual and self-reported behaviour such as poor recall and the desire to conceal socially prohibited behaviour. In general, intentional misreporting of sensitive behaviours is motivated either by a desire to underreport socially proscribed behaviour or a tendency to exaggerate socially desirable behaviour [1]. Examples are culturally dependent and may depend on intervention efforts.

Several studies suggest that improving the level of privacy and anonymity that an interview method affords can greatly enhance the accuracy of self-reporting, particularly stigmatising or illegal behaviour [1][4]. As a result, researchers have developed alternatives to the FTFI such as self-administered questionnaires (SAQ). Whilst SAQs are thought to reduce biases associated with FTFI, variable literacy levels amongst respondents and difficulties in following complicated skip patterns mean that responses on SAQs may be less internally consistent [1]. Computerisation attempts to deal with these challenges, including computer-assisted personal interviewing (CAPI) which evolved into computer-assisted self-interviewing (CASI). Computer-based responses were then amalgamated with tape-recorded questioning to create audio-CASI (ACASI).

A growing body of research in the United States indicates that computer-based interviews can dramatically increase reports of sensitive behaviour, such as multiple partners or injecting drug use, compared with interviewer-administered surveys [7-12]. However, relatively few studies have been conducted in low- and middle-income countries comparing ACASI with FTFI [13-20], and the results of these studies do not seem to be consistent across behaviours [21-31]. More recently, handheld personal digital assistants (PDAs) have emerged as a tool for collecting risk behaviour data, due to the advantages

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3 of portability [32-33]. Such computerised methods may still pose some challenges for participants with
4 low literacy and less experience with technology.
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8 Non-computerised interview tools have also been developed for enhancing privacy among low literacy
9 populations, these include tape-recorded interviews which were trialled in China [34], informal
10 confidential voting interviews (ICVI) developed in Zimbabwe [35-36], polling booth surveys (PBS) in
11 India [37-38], and assisted self-completion questionnaires in Tanzania (ASCQ) [39-40]. Interviewer bias
12 aside, even highly motivated and uninhibited respondents may have trouble being able to recollect past
13 sexual events [1]. In another strategy the introduction of coital diaries in several low- and middle-income
14 countries has achieved some success in minimising recall bias [41-45].
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22 There are a number of published papers on alternative methods to collect sensitive information.
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24 Although these studies provide insight, few quantitatively compare new tools with the traditional FTFI
25 within one population. This paper aims to review the empirical data collected in low- and middle-
26 income countries (since over 90% of HIV infections take place in these populations [5]) that compare
27 FTFI with innovative interview tools for reporting HIV-risk behaviour, including sexual behaviour and
28 injecting drug use (IDU). The purpose of this review is to determine if new non FTFI techniques reduce
29 misreporting by reducing interviewer bias or otherwise.
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Methods

Search strategy

A systematic review of existing literature on alternative interview tools was conducted in three stages. Firstly electronic searches of PubMed, LILACS, Web of Knowledge and Embase were carried out from June 2008 to November 2008 (details of search terms are provided in the Appendix). The Pubmed search was updated in April 2009. Titles were evaluated and irrelevant articles discarded. Potentially relevant publications' abstracts were evaluated and the manuscripts were retrieved as PDFs or paper copies for evaluation. These searches were complemented with searches in general engines (for example, Google scholar). Finally the bibliographies of relevant papers identified for inclusion were also searched to identify additional relevant publications. Six authors were contacted, all of whom replied, to provide additional information that was not available from the published article [16][22][26][31][35][39].

Two independent investigators (AEP and GBG) screened all the records to determine relevant records. A short list was then prepared by both and checked for compatibility.

Inclusion criteria

Types of study: We included any study (randomised control trial or observational studies) investigating the reporting of HIV risk behaviour, including sexual information or IDU, which compared interviewing tools with the paper-based FTFI.

Types of population: We accepted all studies that took place in low- and middle-income countries (according to World Bank classification), in order to examine the feasibility of alternative interview methods in resource-poor settings. There was no restriction on date or language of publication. Only one paper was returned in Chinese and this was translated into English for the analysis.

Types of intervention: There was no restriction by study design. The influence of study design was explored in the analysis. To simplify the comparison between methods, recall bias will not be explored in this review.

Types of outcome: Four potentially sensitive outcomes available in all papers were identified and included for review:

- 1) **'Have you ever had sex'**: since many studies focused on adolescents, it was assumed that social desirability bias may be particularly great among school pupils concerned about peer stigma and adult punishment for pre-marital sex. For example, in Tanzania school pupils are severely punished if they are found to have had sex [46]. Therefore, according to our hypothesis a higher proportion should report ever having sex in the alternative interview method.
- 2) **Non-condom use** included a range of questions such as *lifetime*, *last 6 months*, *last 2 weeks*, and *last sex act*. Although there was no uniform question asked across all papers, it was assumed that it is socially undesirable to report non-condom use regardless of time frame, therefore respondents would be more likely to admit unprotected sex if the interviewer bias had been removed. In religious communities or where condom use is associated with risky behaviour, condom promotion might be frowned upon and it would be 'desirable' to deny condom use. Such as circumstance was not addressed in any of the papers in the review so we assume condom use is socially desirable.
- 3) **'Ever been forced to have sex'**: since this outcome was expected to have strong negative connotations, it was expected that in a more private interview setting an increased number of respondents would report forced sex in the alternative interview tool.
- 4) **Number of partners**: time over which partner numbers are elicited and the cut-off points between the categories for the number of partners categorical variable varied across studies. It was assumed that it would be socially undesirable to report a higher number of partners, independently of the categorisation used. In order to assess the impact of these variations, timeframe and partner cut-off points were included in the subgroup analyses.

Analysis

We hypothesised that innovative methods that bypass the interviewer will be more successful than FTFI in achieving self-reports of risky behaviour as the impact of interviewer bias has been removed. For this reason a comparison was made between alternative interviewing tools (mostly ACASI) and FTFI.

Sample size was defined as the number of people that took part in the questionnaire because the denominator for each of the four outcomes varied within and between papers. Crude odds ratios and the 95% confidence intervals (CIs) were calculated for each study and outcome using FTFI as the comparative group. We assume that if one interview method was really superior the direction of the

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3 association of most included studies would be in the same direction, thus relatively homogeneous even
4 though the magnitude of the effect could vary by study characteristics (e.g. gender, region). The Cochran
5 Q test and I-squared were used to assess heterogeneity across studies [47]. If there was significant
6 heterogeneity and the studies were not considered combinable, no overall pooled estimate was provided,
7 and sub-group analyses based on study or population characteristics such as gender, education, locale
8 (urban/rural), region (Africa/South America/Europe/Asia) and study design (randomised control trials
9 (RCTs)/cross-sectional) was undertaken to explore potential causes of heterogeneity.
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17 Surveys that interviewed both male and female respondents were considered independent and treated as
18 two separate studies in the meta-analysis, in order to examine the impact of gender. For instance it was
19 anticipated that girls, for whom secrecy about sexual activity is the norm, would be particularly
20 susceptible to report more premarital sex in a more private interview setting [22]. However, boys may
21 exaggerate their level of sexual activity in the FTFI. Regarding education level of the participants in the
22 studies, we created an aggregate study-level variable: over or under 60% of the sample having received
23 secondary school education. As a range of education levels had been reported across studies, a cut-off
24 had to be determined that maximised the number of studies in two comparable groups for analysis.
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33 Summary estimates in the subgroup analyses were calculated using random effects models [49], which
34 take into account the within and between-study variance across studies. Forest plots were used to
35 explore graphically the heterogeneity found between the studies and between the pooled estimates by
36 subgroups [50].
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42 The systematic review was undertaken following MOOSE guidelines for reviews of observational
43 studies since all studies were not randomised trials [48].
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47 **Results**

48 Nearly 1700 articles were identified. Of these, 105 were selected to be reviewed in full. Twenty-one
49 references satisfied the primary selection criteria, examining interviewing techniques in resource-poor
50 settings. Eight additional papers were identified from the references. Of these 29 references, five were
51 excluded because they did not contain quantitative results and four studies compared interviewing tools
52 with SAQ only (the search results are summarised in Table S1). Of the remaining 20 references, five
53 reported results from the same dataset and were combined together. As a result there were a final total of
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3 15 studies, with a total of 20 references as some articles described the same study. The final 15 studies
4 were divided by gender, interview mode and district to create 25 independent datasets to be included in
5 the meta-analysis, the characteristics of which are described in Table 1. The flow chart summarising the
6 results of the search on self-reported HIV and STI associated behaviour in low- and middle-income
7 countries, by interview mode, is shown in Figure S1 (see Appendix).
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13 Figures 1 to 4 show OR and 95% CI for reporting HIV risk behaviour by interview mode. An OR>1
14 meant respondents were more likely to report a risk behaviour using an alternative interview mode than
15 by FTFI. The funnel plots in S2-S5 are reasonably symmetrical therefore we can be reasonably
16 confident in assuming there is no publication bias for these outcomes.
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22 **Description of the characteristics of the studies included:** Out of the total of 15 studies; six studies
23 were carried out in Asia and Africa, two in South America and one in Europe. Among these, eight
24 interviewed adolescents; three the general population; and two among IDU and sex workers. Most of the
25 studies compared FTFI with ACASI (11 studies) and there was one study comparing with PASI, tape-
26 recorded interviews, ICVI, PBS, and ASCQ.
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33 Since potential biases are likely to occur for non-randomised studies compared with randomised trials,
34 the heterogeneity of the included studies by study design was investigated (see Figures S6-S9 in
35 Appendix). Since the meta-analysis demonstrated no difference by study design, the results from the
36 different study types were grouped together in the analysis. Study population, study design, gender,
37 interviewing tool, age, study outcomes and total sample size are summarised in Table 1.
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43 **‘Ever had sex’:** There were a total of 17 studies reporting ‘ever had sex’. As shown in Figure 1, there is
44 significant heterogeneity between studies ($I^2=93.4\%$, $p<0.001$) preventing a summary estimate to be
45 interpreted. However, in the subgroup analysis presented in Figure 2A, studies with a higher proportion
46 of participants having finished secondary education had a significantly higher pooled estimate of
47 reporting sex in non-FTFI methods. There were trends observed between region, locale and study
48 design, with studies from Asia, those sampled in urban areas and through cross-sectional studies
49 presenting significantly higher pooled OR. However, despite the fact that the CIs overlap for these
50 subgroups and the difference in reporting was therefore not statistically significant, there is indication
51 that the new tool elicited a greater risk-behaviour reporting in non-FTFI for the outcome ‘ever had sex’.
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5 As a result of the distinctions emerging in Figure 2A, ‘ever had sex’ by study design, region, education,
6 and locale were explored to examine heterogeneity between studies, as shown in Figures S6 and S10-
7 S12 respectively. Reporting ever had sex was higher in all studies carried out in Asia and urban areas,
8 with the exception of boys recruited in slums of India which is likely to be confounded by lack of
9 education [25].
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15 **‘Non-condom use’:** There were 21 studies that reported on ‘non-condom use’. As shown in the bottom
16 part of Figure 1, there is also significant heterogeneity present across all studies for non-condom use
17 ($I^2=89.3\%$, $p<0.001$) preventing us to quote a summary statistic. Subgroup analysis to explore the source
18 of variation is included in Figure 2B. In contrast to ‘ever had sex’, there were fewer clear distinctions
19 emerging. There was a trend to an increased reporting of non-condom use among non-FTFI participants
20 in all regions except Africa. This effect was particularly pronounced regarding South America. We also
21 observed a trend in urban areas towards a higher effect estimate, which supported the findings of ‘ever
22 had sex’. However, the CIs are large and overlap for these subgroups. ‘Last sex act’ seemed to show a
23 greater increase in reporting of non-condom use with respect to questions asked with a longer time
24 frame. In contrast to ‘ever had sex’, those sampled through RCTs presented with higher pooled OR and
25 as a result this outcome was explore to examine heterogeneity between studies, as shown in Figure S7.
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37 **‘Ever forced to have sex’:** There were a total of 10 studies reporting ‘ever been forced to have sex’.
38 There was consistent increased reporting of coerced sex among non-FTFI participants in all studies with
39 no significant heterogeneity between them (Figure 3: $I^2=0\%$ $p=0.55$). Contrary to expectation, Figure
40 4A shows a trend towards less educated respondents as well as rural, African studies presenting a
41 slightly higher pooled estimate of reporting forced sex in non-FTFI method, although the CIs overlap for
42 these subgroups.
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50 **‘Number of sexual partners’:** There were a total of 12 studies reporting ‘number of partners’. Nearly
51 all studies demonstrated increased reporting of a higher number of sexual partners among non-FTFI
52 participants (Figure 3), with significant heterogeneity observed between them ($p<0.01$). Figure 4B
53 shows a higher reporting in non-FTFI among more educated respondents but contrary to the trends
54 observed for ‘ever had sex’ and non-condom use, studies from rural areas presented the highest pooled
55 OR in non-FTFI. We also observed a similar trend regarding studies in the African region and RCTs, but
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3 in these subgroup analyses CIs overlap. Figure 4B also shows studies with a shorter reporting timeframe
4 (last month) report higher numbers of partners in the non-FTFI. Furthermore, as the number of partner
5 threshold increases (i.e. more stigmatised behaviour) the difference between the FTFI and alternative
6 tool also tends to increase. As a result of the distinctions emerging in Figure 4B, the number of partners
7 by region and timeframe were explored to examine heterogeneity between studies, as shown in Figure
8 S13 and S14 respectively.
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15 A comparison was also made between innovative interview tools and paper-based SAQ. Although the
16 results have not been analysed in detail, the summary Table S1 outlines the similar estimates and lack of
17 difference between SAQ and alternative interview methods for the outcome ‘ever had sex’ (OR: 1.07;
18 95% C.I 0.91, 1.25) and non-condom use (OR: 0.87; 95% C.I 0.67, 1.12). Although forced sex also
19 demonstrated increased reporting in the non-FTFI/SAQ method, the difference was not as significant.
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26 Discussion

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28 This review evaluates the impact of innovative modes of data collection in low- and middle-income
29 countries by collating studies that compare two or more interview tools on one population in reporting
30 HIV-risk behaviour. The purpose of this meta-analysis was to identify patterns and sources of
31 disagreement among the results. With no gold standard in sexual behaviour research it is difficult to
32 determine whether modification of interview mode (e.g. self-administered vs. interviewer-administered)
33 increases the accuracy of reporting sensitive behaviour. However, the results showed that alternatives to
34 FTFIs do not always yield higher estimates of risky behaviour.
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42 Our hypothesis was based upon previous research indicating that a method providing greater anonymity
43 and privacy than conventional interviewer-administered methods was more likely to yield higher
44 affirmative response rates to sensitive questions [35]. This theory was based upon the assumption that a
45 respondents’ perception of social norms, and their own notions of acceptable behaviour, influence their
46 willingness to respond truthfully to interview questions. It was further believed that differences in
47 reporting would be greater among females and those with higher education.
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54 This hypothesis was not confirmed for the reporting of ‘ever had sex’, where there was no significant
55 difference between FTFI and non-interviewer administered tools, and little difference between gender.
56 However, more educated respondents did have a higher pooled estimate for reporting sex in the non-
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3 FTFI methods. Moreover a trend was observed in Asian, urban and cross-sectional studies suggesting an
4 increase for reporting 'ever had sex' in the non-FTFI method, although the summary effect did not reach
5 statistical significance. Overall, the results imply that FTFI may not be inferior to innovative interview
6 tools in eliciting this behaviour. One possibility is that having started sexual intercourse was not
7 perceived as particularly stigmatised. A second reason is that respondents had become more comfortable
8 in the presence of an interviewer, or in the case of computerised methods inhibited by the technology.
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15 There was no significant difference by interview tool in the reporting of non-condom use. However,
16 higher levels of non-condom use were reported in non-FTFI studies in South America, and a similar
17 trend was observed for studies in Asia, urban areas, those sampled through RCTs, and, unexpectedly,
18 among respondents with less than 60% education. As mentioned previously, the variability of the results
19 may be attributed to the impact of stigma in (religious) communities where condom use is associated
20 with risky behaviour and therefore it would be 'desirable' to deny condom use. The timeframe of the
21 question seems to have been important, with questions using a shorter recall period such as "condom use
22 at last sex" resulting in increased reporting of non-condom use.
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29 There was a significant increase in the reporting of forced sex in the non-interviewer administered tools.
30 Rural and African studies as well as those less educated reported more forced sex by non-FTFI, although
31 the effect was not significant. Subgroup analysis for number of partners also showed that studies in
32 Africa and rural areas were higher in non-FTFI. However, participants with a secondary education and
33 asking the question within a recent timeframe showed an increase in the reporting of higher number of
34 sexual partners in the non-interviewer administered tools.
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42 There are limitations to the results of the meta-analysis. Firstly, not all of the studies identified asked
43 about every behaviour, for example those sampling adult sex workers did not ask if the respondents
44 had ever had sex. Secondly, question phrasing did vary across studies for example the time frame for
45 non-condom use and the number of sexual partners. A third reason points to bias that could not be
46 attenuated even with increased privacy and anonymity. For example Hewett *et al* suggested STI positive
47 participants were more likely than STI negative participants to misreport their behaviour in the FTFI
48 [18]. Finally the response rate was not available for all studies so it was difficult to know if it was a
49 factor influencing the performance of the different methods [36].
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3 Any interpretation of these results is based on two sets of assumptions. Firstly, as outlined above, no
4 self-report tool can be proven to be more accurate than another given no gold standard exists with which
5 to compare alternative methods. Secondly, many assumptions are made about people's social desires
6 when answering questions which may not always go in the direction expected.
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11 In further developing methods for collecting HIV and STI risk behaviour data, multiple methods
12 assessing self-reported behavioural risks should be complemented with the appropriate biological
13 markers of sexual activity, as appropriate depending on the type of study. Although these tests may
14 provide evidence of the validity of self-reported behaviours, their application is limited because the
15 exposure period captured by a biomarker may not be the relevant exposure period for the study.
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17 Moreover, infection probabilities are moderated by other factors irrelevant to the particular risk
18 behaviour, including prevalence in the general population, partner status, biological susceptibility of the
19 respondents, and availability of STI testing and treatment [18]. Only a few studies have attempted to
20 validate the reporting of behaviour with STI biological markers within an interview mode experiment in
21 a resource-poor setting [18][20][23].
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31 In conclusion, the findings of the review have important implications for research design and data
32 interpretation. The results of this review show that the relationship and success of novel interviewing
33 methods has proved complex in a low- and middle-income country context. The results suggest that
34 strongly stigmatised behaviour such as forced sex was significantly more likely to be reported in a non-
35 FTFI setting, whereas other outcomes such as 'ever had sex' and non-condom use did not vary by
36 interview mode. Further research efforts to understand factors affecting the degree of measurement error
37 obtained with different interview methods are required, as different tools may generate very different
38 conclusions about what should constitute essential elements of HIV prevention programmes.
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Competing Interests

All authors declare no conflicts of interest exist.

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Contributors

AE Phillips, MC Boily and GB Gomez designed the study; AE Phillips and GB Gomez performed the searches, data extraction and analysis. All authors contributed to the interpretation of results and write up.

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Table 1: Summary of selected studies comparing alternative quantitative interview tools with FTFI in low-middle income countries

Study population (grey) and reporting estimates (white)	Design	Gender	Tool	ΣN	Age	Ever had sex n (N-n)**	Non Condom n (N-n)**	Timeframe of Non- Condom use question	Forced Sex n (N-n)**	Number of partners n (N-n)**	No. of partners cut-off	Timeframe number of partners
Simoes ¹⁴⁻¹⁵ , Urban Brazil, Injecting Drug Users 2003												
Simoes (2005) ¹⁴⁻¹⁵	RCT	C	ACASI	367	18+	260 (35)	279 (88)	<i>Inconsistent***</i>		67 (300)	2+	<i>6 months</i>
			FTFI	368		338 (30)	260 (108)			40 (328)	2+	
LeLC ¹⁶ , Urban Vietnam, Adolescents												
LeLC (2006) ¹⁶	RCT	M	ACASI	378	15-24	69 (309)	50 (22)	<i>Last sex act</i>	1 (375)	3.46 §	[Mean]	<i>Lifetime</i>
		M	FTFI	356		54 (302)	47 (14)		0 (352)	1.46 §		
		F	ACASI	393		29 (364)	50 (22)		2 (385)	1.92 §		
		F	FTFI	465		24 (441)	47 (14)		0 (461)	1.06 §		
Hewett ¹⁸ and Mensch ¹⁹ , Urban Brazil, Adolescents												
Hewett ¹⁸ (2004)	RCT	F	ACASI	409	15-21		243 (68)	<i>Last sex act (vaginal sex)</i>		1.6 §	[Mean]	<i>Last 6 months</i>
			FTFI	409			254 (94)			1.3 §		
Van Griensven ²⁰ , Urban Thailand, Adolescents												
Van Griensven (2005) ²⁰	RCT	C	PASI	328	15-21	192 (136)	238 (90)	<i>Last sex act</i>				
			FTFI	317		180 (137)	184 (133)					
			ACASI	325		183 (142)	259 (66)					
			FTFI	317		180 (137)	184 (133)					
Mensch ²² & Hewett ²³⁻²⁴ , Rural Kenya, Adolescents – data taken from												
Mensch (2003) ²²	RCT	M (K)	ACASI	405	15-21	193 (212)	250 (109)	<i>Lifetime</i>	17 (83)	45 (55) ‡	1+	<i>Lifetime</i>
& Hewett (2004) ²³⁻²⁴		M (K)	FTFI	361		217 (142)	262 (99)		9 (91)	41 (59) ‡	1+	
		F (K)	ACASI	343		146 (197)	256 (69)		31 (69)	35 (65) ‡	1+	
		F (K)	FTFI	349		168 (180)	275 (74)		13 (87)	21 (79) ‡	1+	
		M (N)	ACASI	688		271 (417)	111 (160)					
		M (N)	FTFI	821		548 (273)	182 (365)					
		F (N)	ACASI	603		138 (465)	79 (48)					
		F (N)	FTFI	721		335 (386)	178 (155)					

Potdar ²⁵ , Urban India, College students and Slum dwelling adolescents												
Potdar (2005) ²⁵	RCT	M (C)	ACASI	300	18-22	18 (282) ‡	205 (95) ‡	<i>Lifetime</i>	19(281)‡	25 (275) ‡	2+	<i>Lifetime</i>
		M (C)	FTFI	300		11 (289) ‡	243 (57) ‡		2 (298)‡	13 (287) ‡	2+	
		M (S)	ACASI	300		33 (267) ‡	134 (166)‡		24(276)‡	143 (157)‡	2+	
		M (S)	FTFI	300		105 (195)‡	174 (126)‡		13(287)‡	143 (157)‡	2+	
Edwards ²⁶ , Urban Russia, Drug Addiction patients												
Edwards (2008) ²⁶	XSect	C	ACASI	180	18+		79 (101) ‡	<i>Last 6 months</i>		47 (133) ‡	4+	<i>Last 6 months</i>
			FTFI	180			72 (108) ‡			50 (130) ‡	4+	
Minnis ²⁷ , Urban Zimbabwe, General (adult) population												
Minnis (2007) ²⁷	RCT	F	ACASI	338	18-35		122 (216)	<i>Lifetime</i>		76 (262)	1+	<i>Lifetime</i>
			FTFI	315			106 (209)			77 (238)	1+	
Jaya ²⁸ , Urban India, Adolescents												
Jaya (2008) ²⁸	XSect	M	ACASI	290	15-19	78 (212)			33 (257)			
		M	FTFI	293		62 (228)			23 (267)			
		F	ACASI	233		8 (225)			8 (225)			
		F	FTFI	242		3 (230)			3 (230)			
Mensch ³⁰ , Rural Malawi, Adolescents												
Mensch (2008) ³⁰	RCT	F	ACASI	226	15-21	79 (147)				27 (73) ‡	1+	<i>Lifetime</i>
			FTFI	275		132 (143)				17 (84) ‡	1+	
Van der Elst ³¹ , Urban Kenya, Sex workers												
Van der Elst (2009) ³¹	XSect	M	ACASI	259	18+		75 (36)	<i>Inconsistent with regular partner***</i>	23 (236)	2	[Median]	<i>Last month</i>
		M	FTFI	259			72 (67)		10 (249)	1		
		F	ACASI	139			213 (46)		9 (129)	2		
		F	FTFI	139			230 (29)		3 (132)	1		
Xia ³⁴ , Rural China, General population												
Xia (2004) ³⁴	RCT	F	Tape	287	18-49	41 (246)						
			FTFI	305		46 (259)						
Gregson ³⁵⁻³⁶ , Rural Zimbabwe, General population												
Gregson (2004) ³⁵⁻³⁶	RCT	M	ICVI	1351	15-54		999 (353)	<i>Last 2 weeks</i>		112 (1239)	1+	<i>Last month</i>
		M	FTFI	418			311 (107)			21 (398)	1+	
		F	ICVI	1511			1304 (207)			35 (1476)	1+	
		F	FTFI	691			624 (67)			8 (683)	1+	

Hanck ³⁸ , Rural India, Female Sex Workers												
Hanck (2008) ³⁸	XSect	F	PBS	269	18+			55 (164)	<i>Last sex act</i>			
			FTFI	812				81 (322)				
Plummer ³⁹⁻⁴⁰ , Rural Tanzania, Adolescents												
Plummer (2004) ³⁹⁻⁴⁰	RCT	M	ASCQ	1430	15-21	1430 (1142)	1986 (68)	<i>Lifetime</i>	149 (2423)	240 (1055)	2+	<i>Last month</i>
										53 (1242)	4+	
		M	FTFI	1343		1327 (1245)	2024 (30)		3 (2569)	105 (1238)	2+	
										7 (1336)	4+	
		F	ASCQ	449		481 (1684)	2225 (172)		266 (1899)	48 (401)	2+	
										4 (445)	4+	
		F	FTFI	502		489 (1676)	2348 (49)		4 (2161)	32 (470)	2+	
										2 (500)	4+	

Study population: ∝ Gregson *et al* Round 1 data has been analysed only. **Design of sampling method:** RCT: randomised control trial (i.e. respondents were randomly allocated to either innovative interview tool or FTFI), XSect: Cross-sectional survey where respondents answered both interview tools; Male and female results were combined together and it was not possible to analyse separately; **Gender:** C; Combined male and female studies; M: Male data was reported and analysed independently; F: Female data was reported and analysed independently; Mensch²³ (2003) & Hewett²⁴⁻²⁵ (2004) have been divided by gender and location of study – Kisumu and Nyeri districts (K) and (N) respectively; Potdar (2005)²⁶ has been divided by population type College students (C) and slum swelling adolescents (S); **Outcome:** n: the number of respondents who answered positively to the question in each interview tool and N-n: the number of respondents who answered negatively to the question in each interview tool, **n and N-n may not always add up to the total sample population as some respondents may not have answered the outcome question, OR were then derived by [Odds of reporting behaviour in non-FTFI]/[Odds of reporting behaviour in FTFI]; ‡ the results in these papers were given as percentages, these were then re-calculated using the total sample size to calculate absolute numbers; § The mean number of partners were given by interview type in this study, as a result they were not included in the meta-analysis. Note: Some outcomes are blank as not every question was asked in each paper. **Non-condom use:** ***These papers did not report a time-frame of condom use but whether the respondent reported “inconsistent” condom use. We assume therefore that it is not desirable to deny condom use. **Number of partners:** The threshold of partner number varied across the studies, the odds ratio was calculated as above using the absolute number of respondents that had reported above the threshold in the non-FTFI method/the number of respondents that had reported over the threshold in the FTFI. * Plummer et al reported number of partners for several thresholds, those reporting over 2 and 4 partners have been included in the meta analysis for ASCQ data in 1998 only. ΣN = number of subjects that participated in the study by interview tool. Please note that the number of respondents answering each question may vary for example those that had never had sex would not answer a question on non-condom use. The total number of respondents answering each question can be calculated by adding together the number answering by alternative interview type plus FTFI

Figure Legend [note all figures are on a log scale]

Figure 1: Figure 1 summarises the 17 studies that report ‘ever had sex’, where the summary effect was more favourable for the FTFI than the alternative interview mode ($I^2=93.4\%$ $p<0.001$). Figure 1 also summarised the 21 studies that reported on ‘non-condom use’, some of which were included in the ‘ever had sex’ analysis. Respondents were more likely to report non-condom use in the FTFI, although the difference was not statistically significant ($I^2=89.3\%$ $p<0.001$).

Figure 2A: Since there is significant heterogeneity across all studies for ever had sex ($I^2=93.4\%$ $p<0.001$), the source of variation was explored by grouping the studies according to study level characteristics. Figure 2A shows more educated respondents had a significantly higher pooled estimate of reporting sex in non-FTFI methods as well as studies from Asia and those sampled in urban areas presenting higher pooled OR.

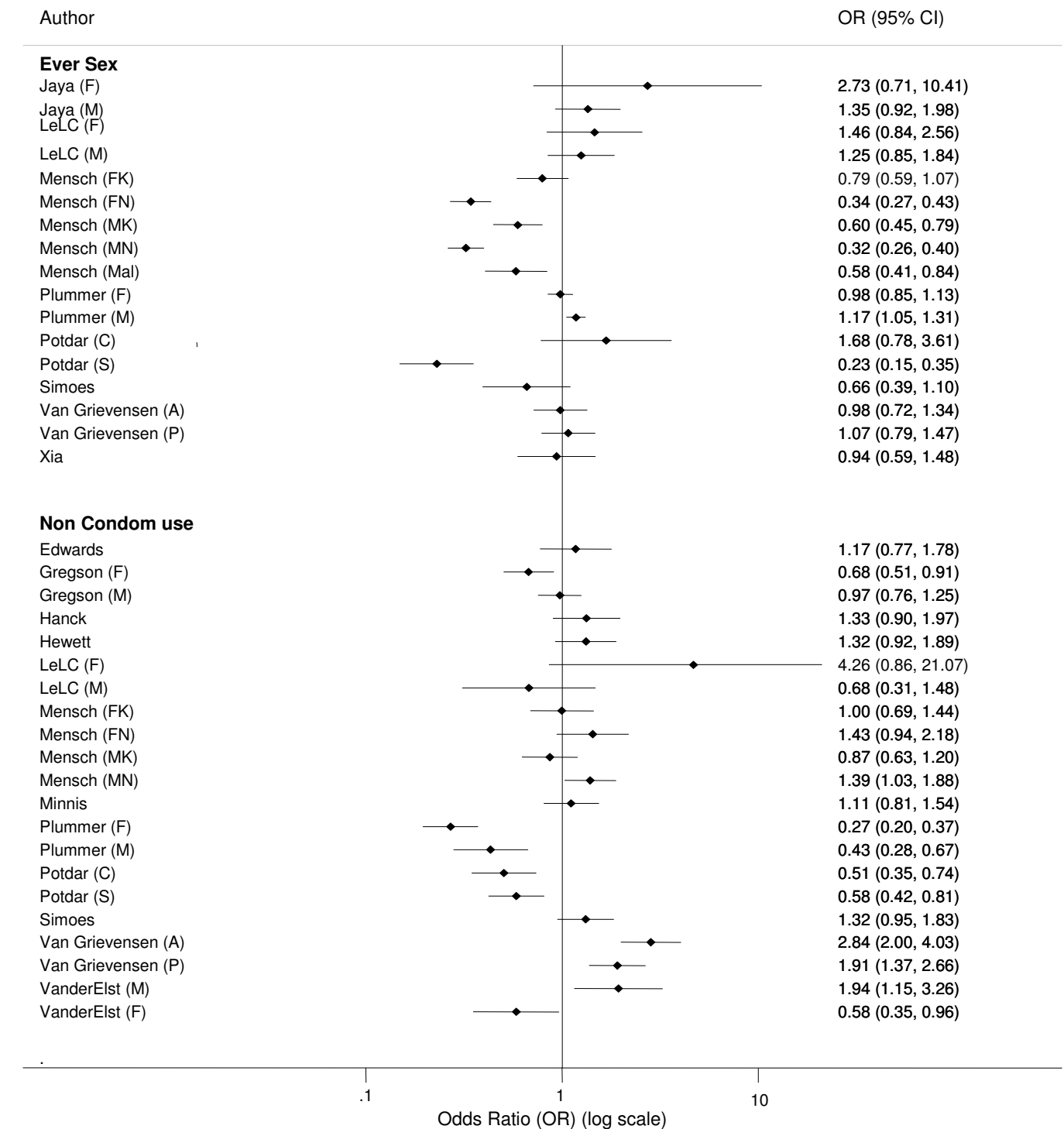
Figure 2B: Since there is significant heterogeneity across all studies for non-condom use ($I^2=89.3\%$ $p<0.001$), pooled estimates were calculated. Figure 2B no statistically significant differences by study characteristics for reporting non-condom use by interview mode.

Figure 3: Figure 2 summarises the 12 studies reporting ‘ever been forced to have sex’ and 12 studies (not identical) reporting ‘number of partners’. There was statistically significant and consistent increased reporting of coerced sex ($I^2=0\%$ $p=0.55$) and higher number of partners ($I^2=75.3\%$ $p<0.001$) among non-FTFI participants.

Figure 4A: Although there is homogeneity across all studies for forced sex ($I^2=0\%$ $p=0.972$), pooled estimates were calculated to examine trends in reported forced sex by study characteristics. Figure 4A shows those sampled in African, rural areas and studies where less than 60% of the sample had secondary education presented higher pooled OR. The difference between subgroups, however, was not significant.

Figure 4B: Since there is significant heterogeneity across all studies for number of partners ($I^2=78.8\%$ $p<0.001$), pooled estimates were calculated. Figure 4B shows those sampled in rural areas presented higher pooled OR. There was also a significant difference in the time frame of the question, with a higher number of partners reported in the last month compared with the last six months or over a lifetime.

Figure 1* : Odds Ratio for 'Ever had sex' and 'Non-condom use' (reference group: FTFI)



* Four papers were divided into separate studies by gender (M) =Male and (F)=Female as the data was reported by individual sex. Potdar & Koenig analysed slum-dwelling (S) and college (C) youth individually and so have been divided into two separate studies. Van Grievensen reported individual comparisons between ACASI (A) and PASI (P) with FTFI. Mensch sampled into two regions in Kenya (Kisumu and Nyeri) where samples were further divided by gender, therefore the data has been split into four: Kisumu Female (FK) and male (MK) and Nyeri Female (FN) and male (MN).

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2
3 **Figure 2A: Pooled estimates for subgroup analysis for ‘Ever had sex’ (reference group: FTFI)**
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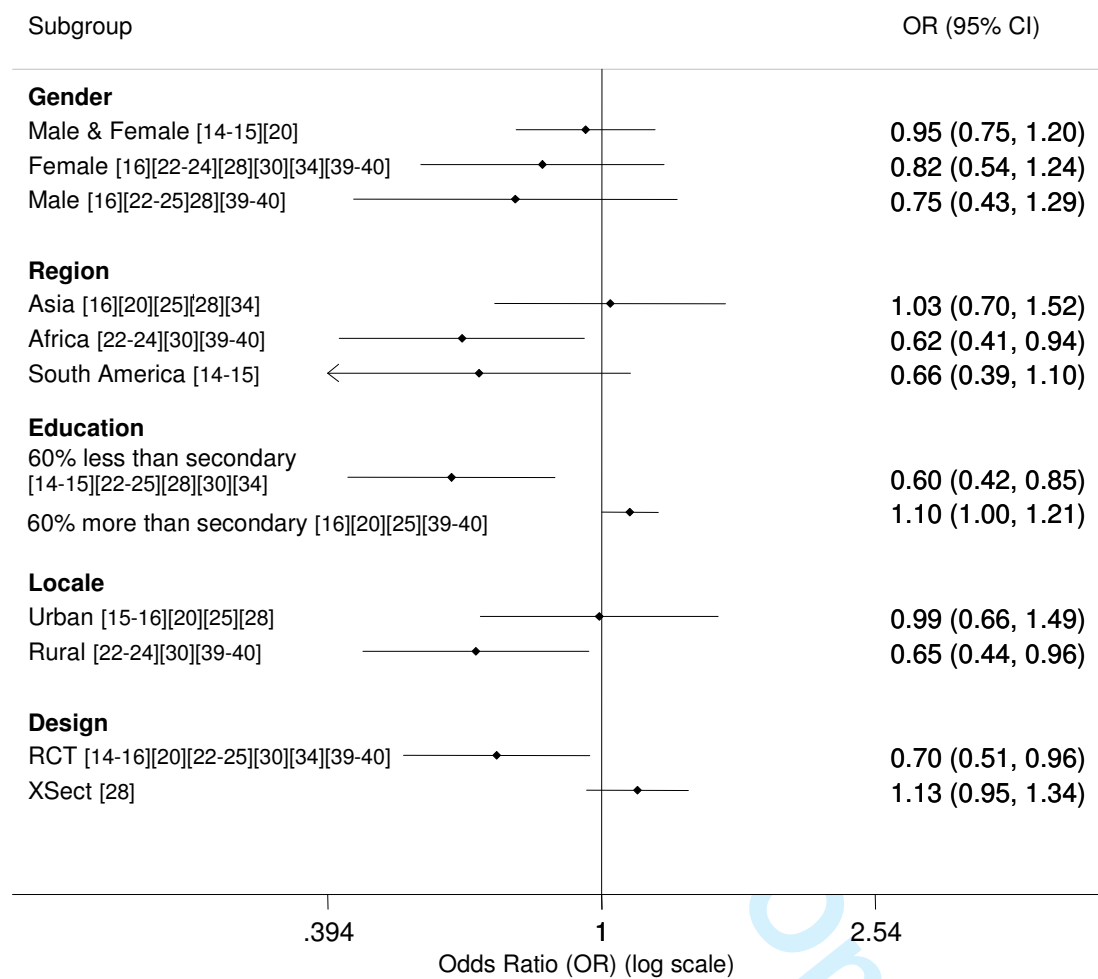


Figure 2B: Pooled estimates for subgroup analysis for ‘Non-condom use’ (reference group: FTFI)

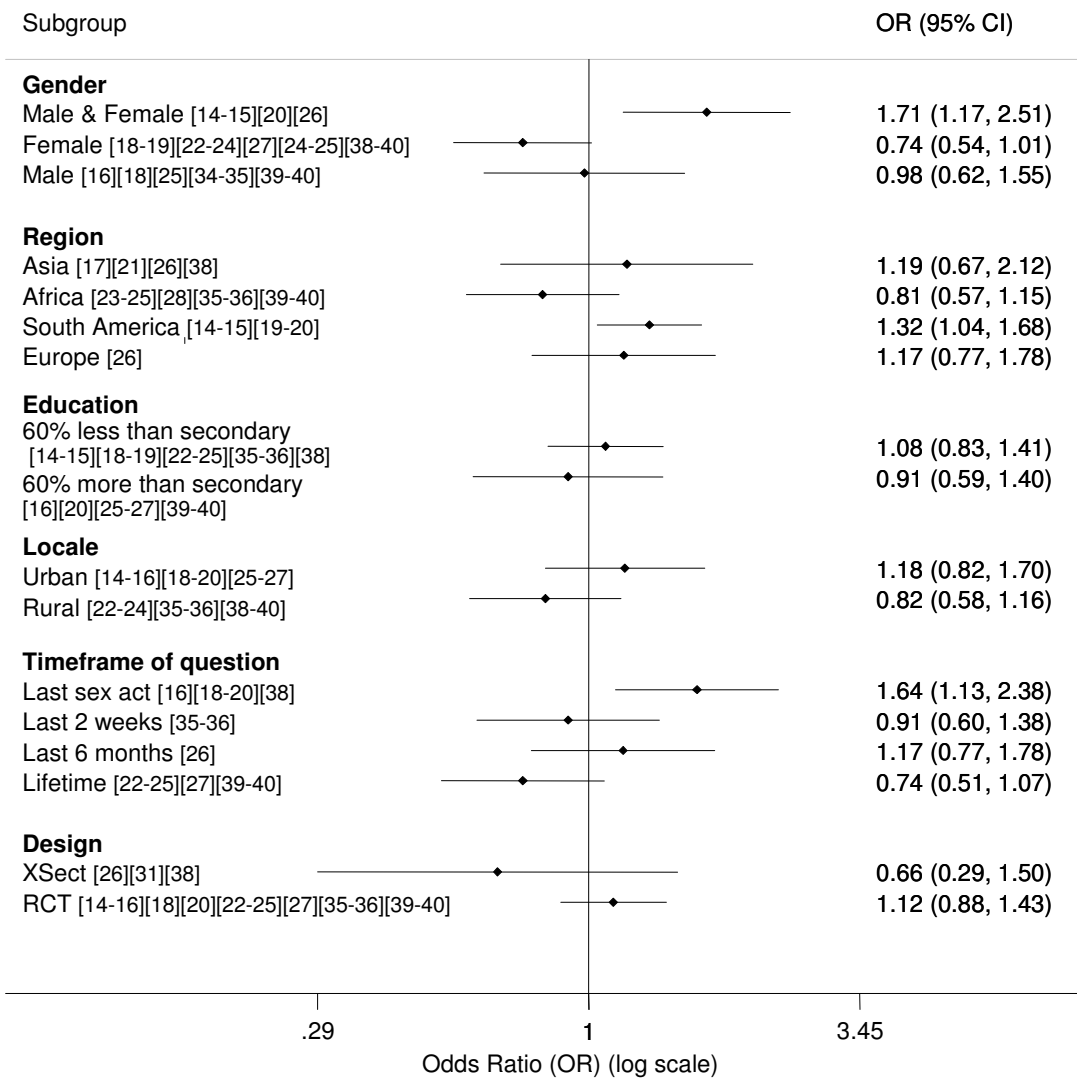


Figure 3: Odds Ratio estimates for ‘Forced sex’ and ‘Number of partners’ (reference group: FTFI)

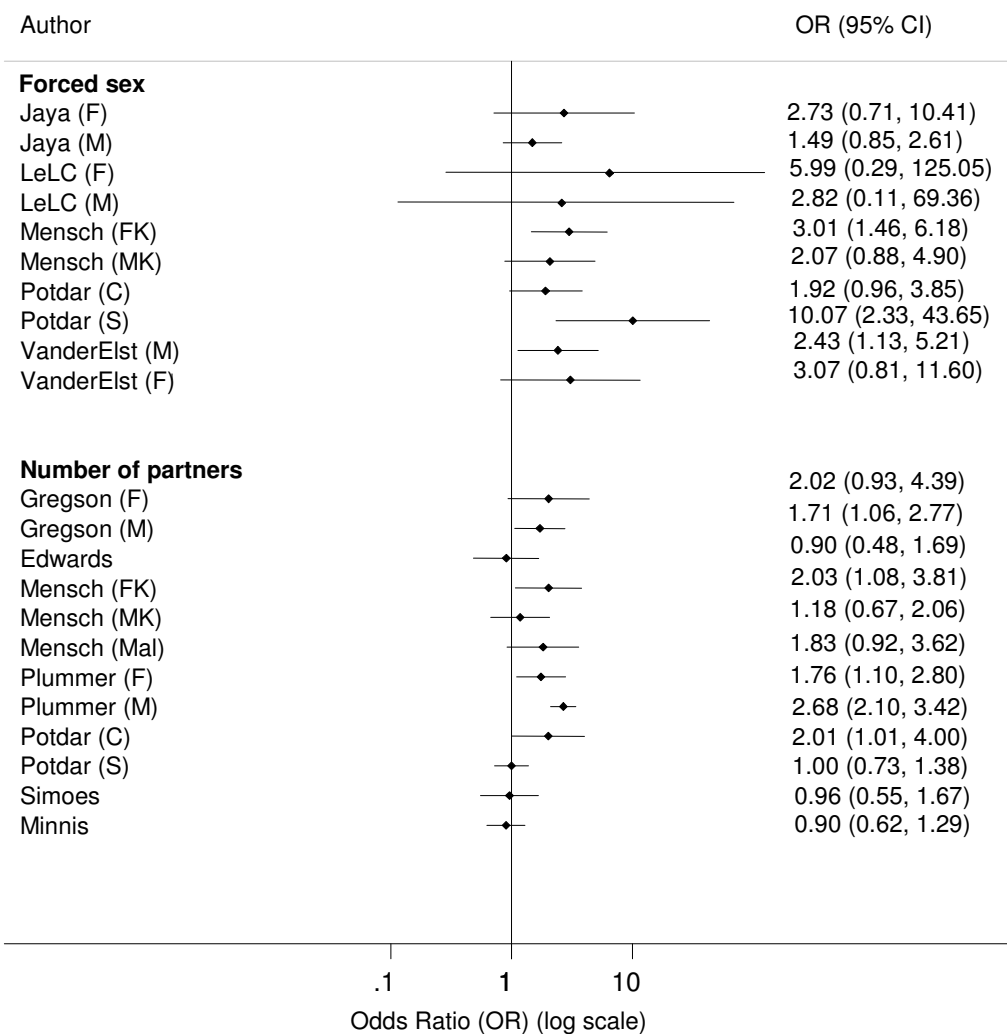


Figure 4A: Pooled estimates for subgroup analysis for ‘Ever forced to have sex’ (reference group: FTFI)

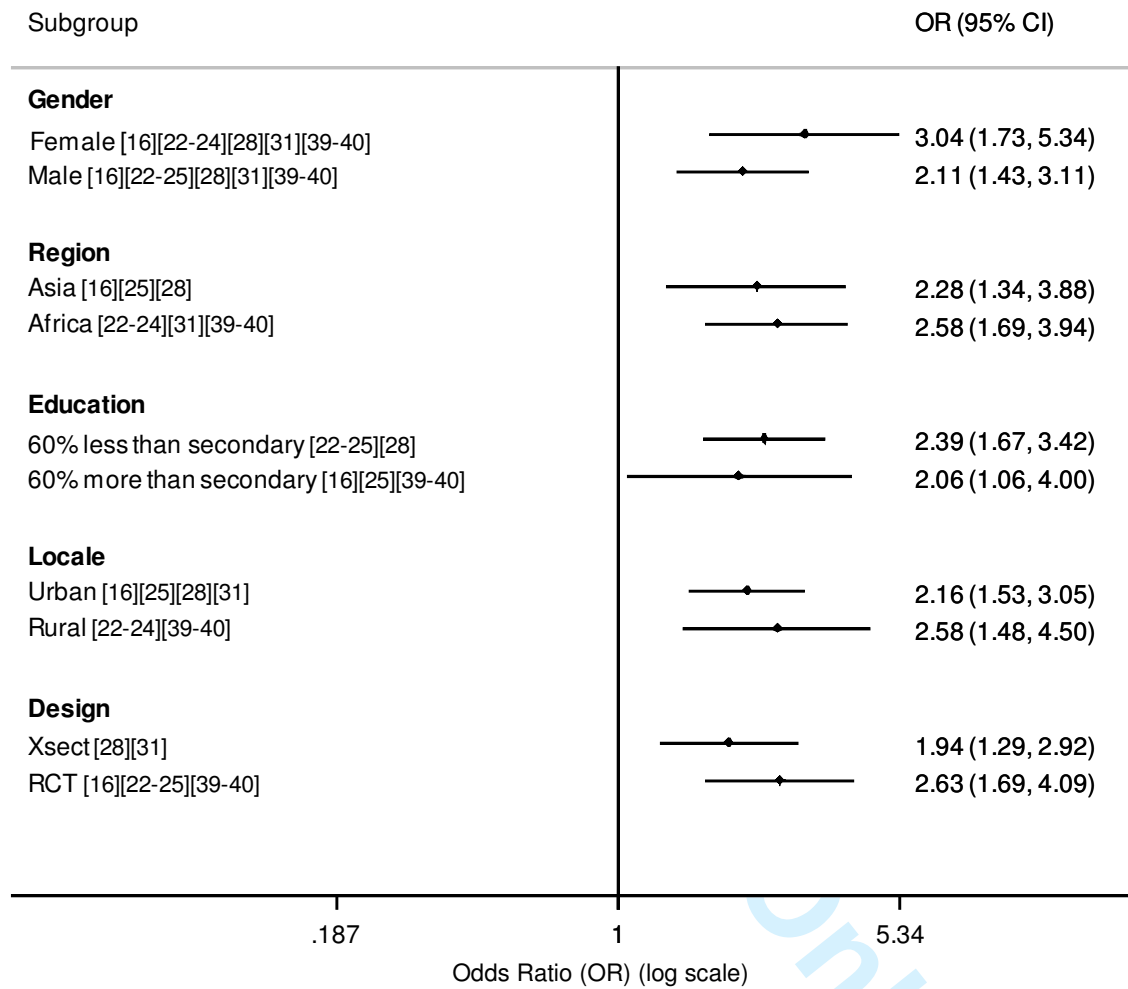
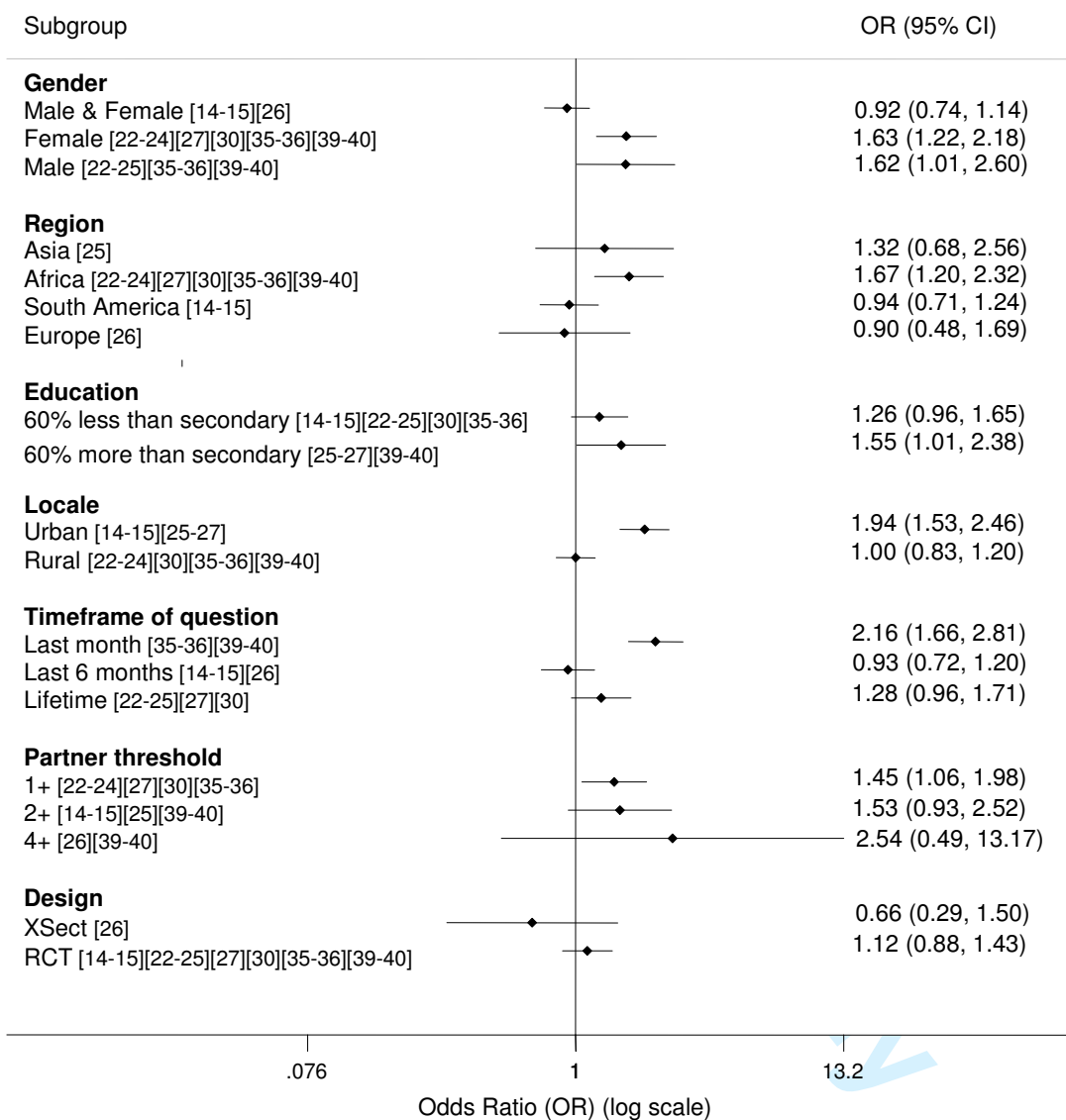


Figure 4B: Pooled estimates for subgroup analysis for ‘Number of partners’[†] (reference group: FTFI)



[†] Note Plummer *et al* have reported number of partners over +2 and +4 threshold, therefore the sample was divided into two in order to explore the sensitivity of the two cut-off points. It is important to note that the same individuals were not included in both the 2+ and 4+ groups. Given the small sample size in the Plummer analysis, the OR was calculated without the Plummer *et al* results included and were as follows: **Gender:** Female 1.63 (1.22-2.18) and Male 1.33 (0.96-1.85); **Region:** Africa 1.49 (1.13-1.94); **Education:** 60% more than secondary 1.34 (0.95-1.91); **Locale:** Rural 1.69 (1.34-2.13); **Timeframe of question:** Last month 1.78 (1.31-2.42).

Appendix: Supplementary information

Search strategy

The literature search to June 2008 was conducted using the following search terms and Boolean operators, for matches under any field: ((“HIV risk behaviour” OR “Sexual*” OR “Injecting drug use”) AND terms associated with different interviewing tools (Self-administered questionnaire OR SAQ; Assisted self-administered questionnaire OR ASCQ; Audio computer-assisted self-interview OR ACASI; Computer-assisted personal interview OR CAPI; Handheld OR Pocket PC OR Pocket-PC; Palm-top OR Palmtop; Personal digital assistant OR PDA; Palm assisted self-interview OR PASI; Informal confidential voting interview OR ICVI; Polling (booth OR box) survey OR PBS; Coital diaries)).

Figure Legends

Figure S1 Flowchart summarising the results of the search on alternative quantitative interviewing tools to investigate HIV risk behaviour up to April 2009.

Figure S2-5 The funnel plot in Figure S2-5 show the interview mode effect from individual studies (horizontal axis) against measure of study size (vertical axis). A funnel plot is a scatter plot which reflects how the estimates of the interview tool vary as sample size increases. In the absence of bias therefore, results from small studies are expected to scatter widely at the bottom of the graph, with the spread narrowing among larger studies. Publication bias (the association of publication probability with the statistical significance of the results), the use of the wrong measure of association, etc, may lead to asymmetrical funnel plots. The funnel plots in Figure S2-5 are reasonably symmetrical so we can assume that there is no publication bias for these variables.

Figure S6-9 The forest plots in Figures S6-9 show crude OR and 95% CI for reporting HIV risk behaviour for each study by study design, using FTFI as the comparative group. The Cochran Q test and I-squared were used to assess heterogeneity across studies. Figure S6-9 show significant heterogeneity between studies for all for outcomes preventing a summary estimate to be interpreted. As a result study design has been added to all subgroup analysis in the main text of the paper.

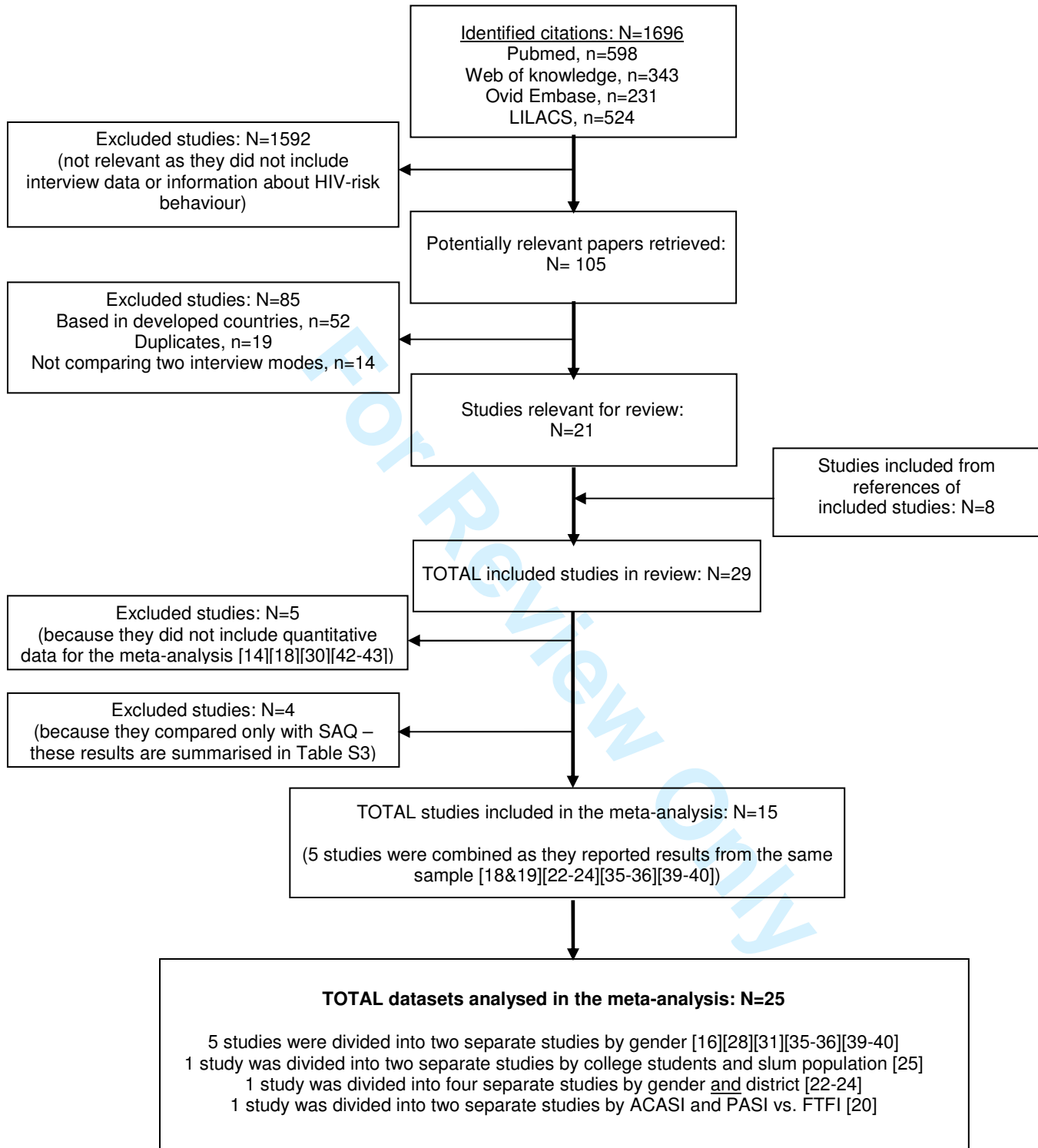
Figure S10-12 The forest plots in Figures S10, S11 and S12 examine heterogeneity between individual studies for reporting ‘ever had sex’ by region, education and locale respectively. Reporting ever had sex was higher in

1 nearly all studies carried out in Asia and urban areas, with the exception of boys recruited in slums of India
2 which was likely to be confounded by lack of education.
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5 **Figure S13-14** The forest plots in Figures S13 and S14 examine heterogeneity between individual studies for
6 reporting number of partners by region and timeframe. A higher number of partners was more likely to be
7 reported in Africa and if the question was asked over a shorter time frame, although this difference was not
8 significant.
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14 **Table S1** A comparison was also made between innovative interview tools and paper-based SAQ. Table
15 S1 summarises the similar estimates and lack of difference between SAQ and alternative interview methods for
16 the outcome 'ever had sex' (OR: 1.07; 95% C.I 0.91, 1.25); non-condom use (OR: 0.87; 95% C.I 0.67, 1.12);
17 and forced sex (OR: 1.31; 95% C.I 0.84, 2.06).
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Figure S1: Systematic review search results



Alternative interview methods compared to face-to-face interviews (FTFI)

Figure S2 Funnel plot, with pseudo 95% confidence limits, investigating publication bias for ‘Ever had sex’

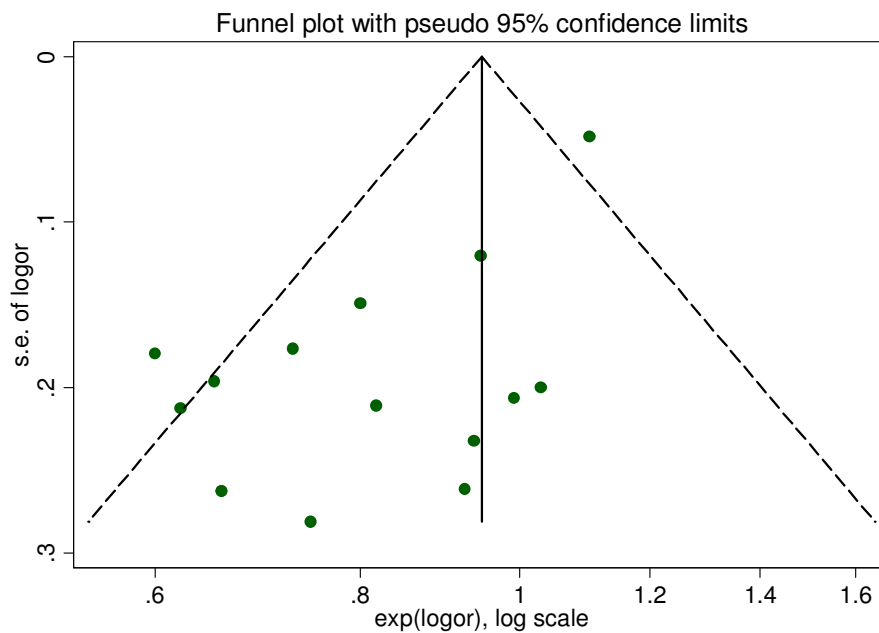


Figure S3: Funnel plot for investigating publication bias in meta-analysis for ‘Non-condom use’

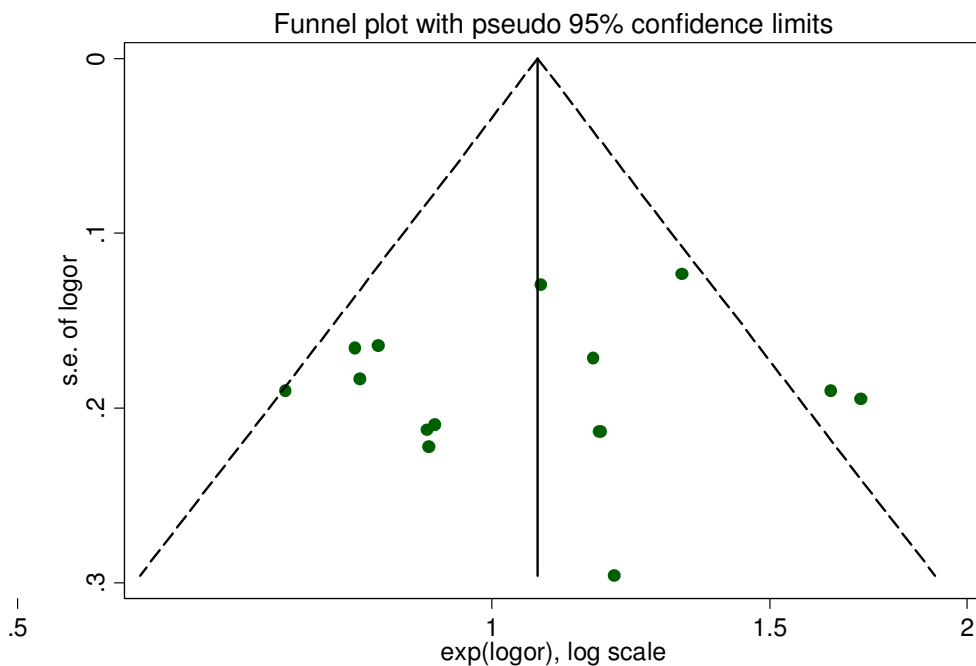


Figure S4: Funnel plot for investigating publication bias in meta-analysis for 'Ever forced to have sex'

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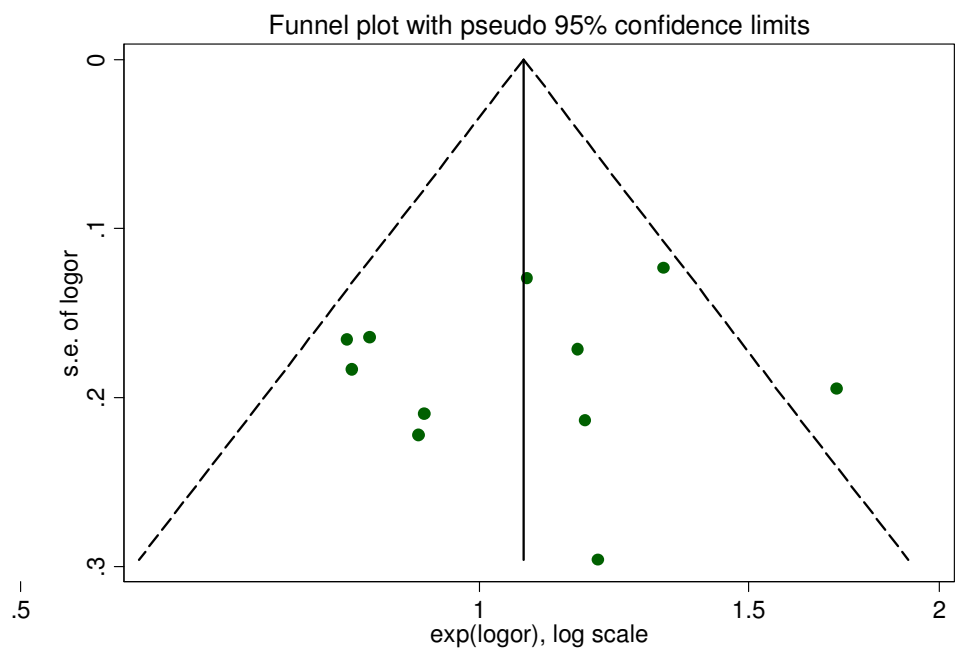


Figure S5: Funnel plot for investigating publication bias in meta-analysis for 'Number of partner'

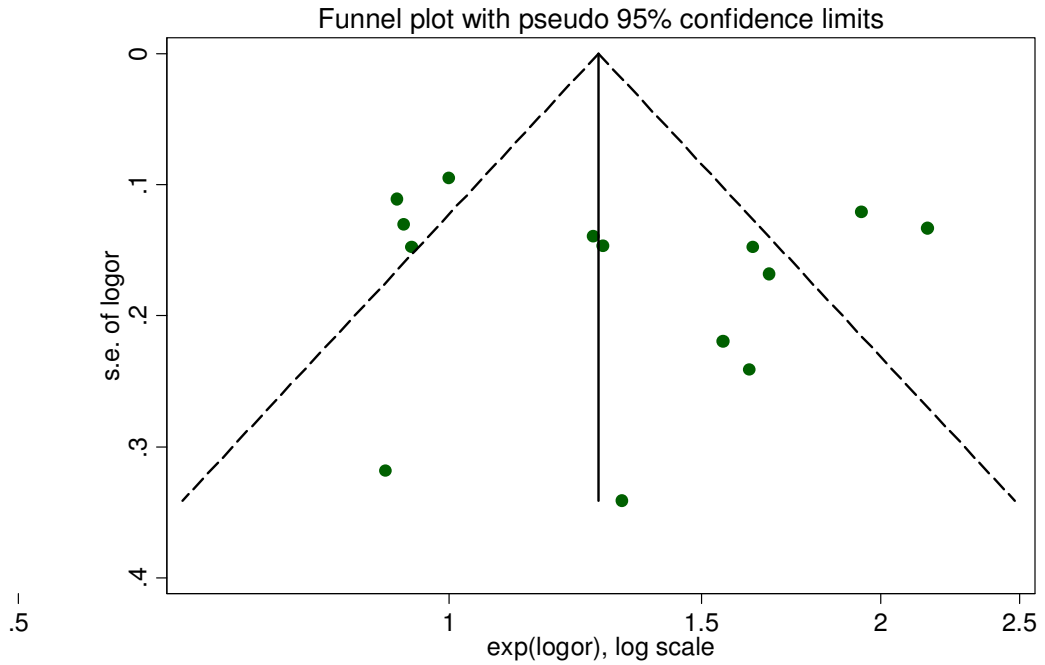
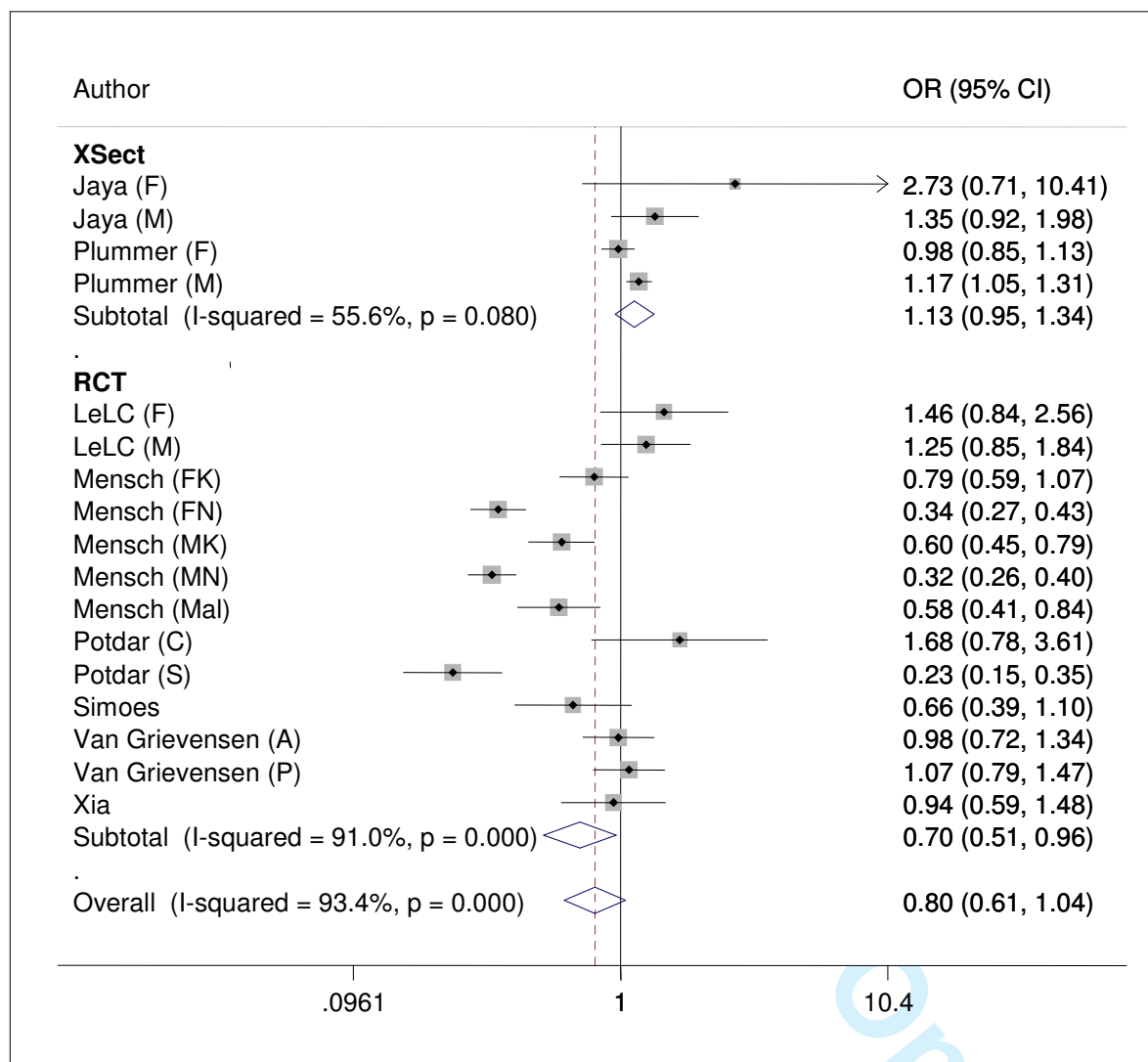
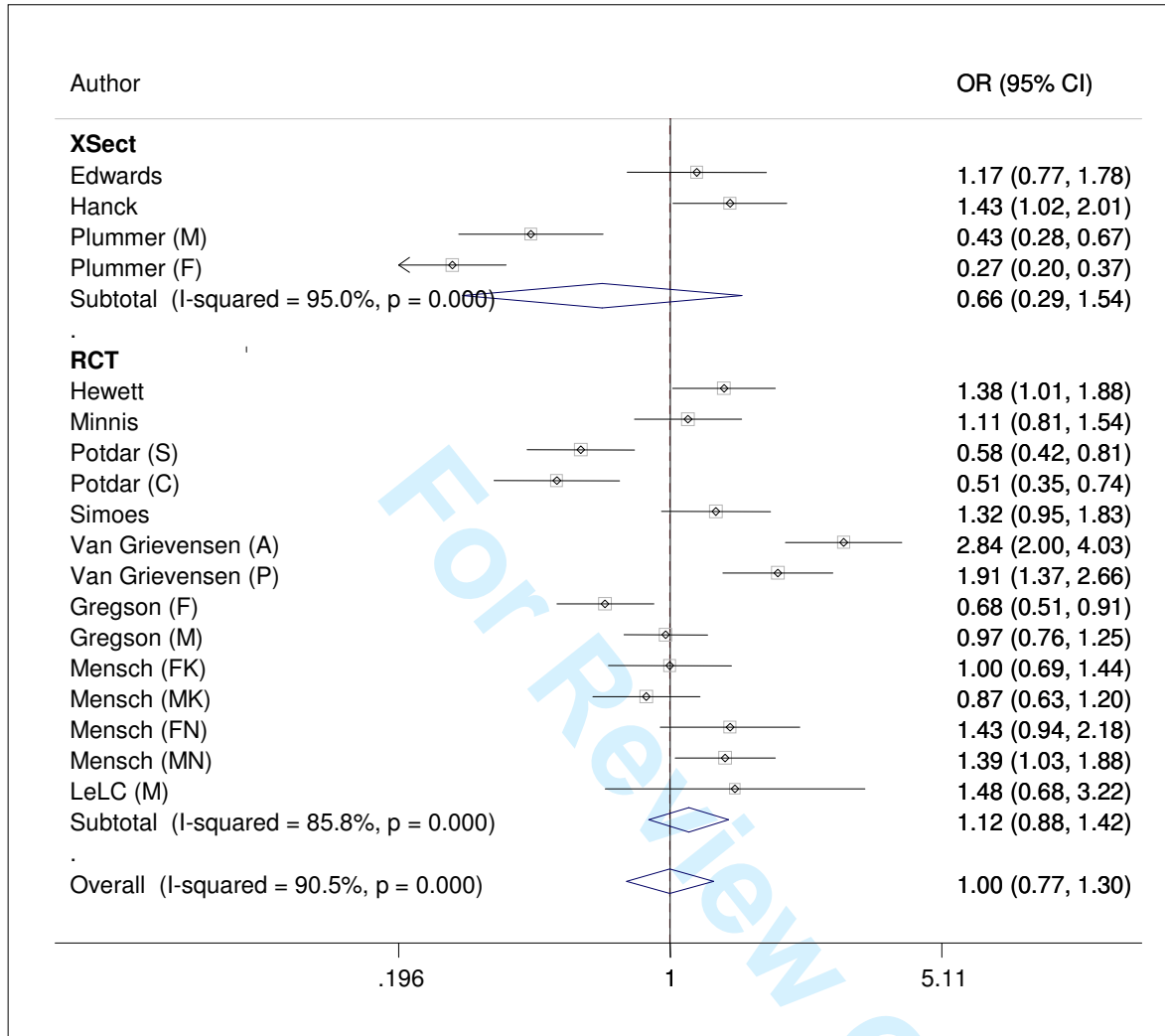


Figure S6: Heterogeneity (homogeneity for Xsect) for “ever had sex” by study design (reference group: FTFI)



'Ever had sex' by study design

Figure S7: Heterogeneity for “non condom use” by study design (reference group: FTFI)



'Non condom use' by study design

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Figure S8: Heterogeneity (homogeneity for Xsect) for “forced sex” by study design (reference group: FTFI)

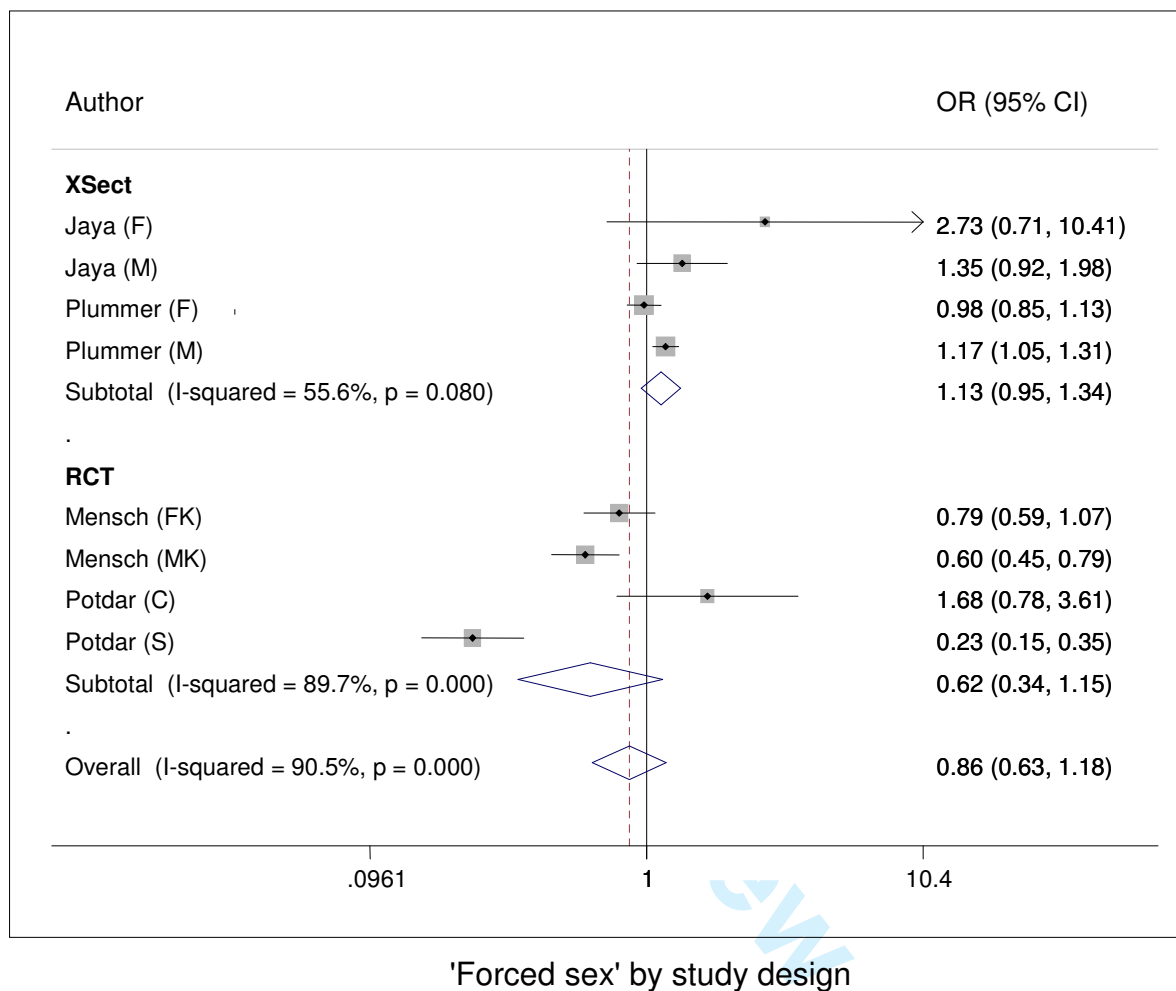
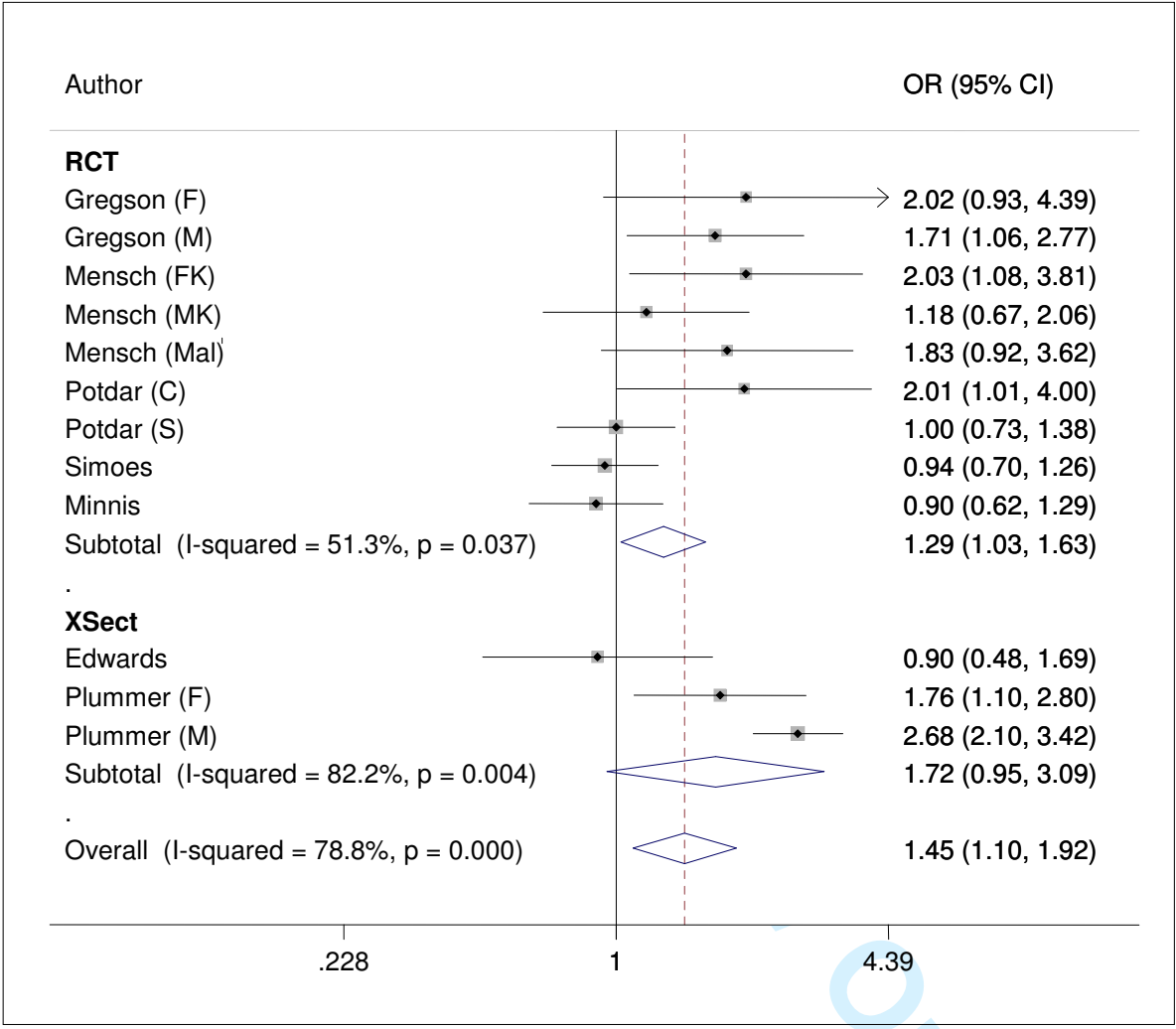


Figure S9: Heterogeneity for “number of partners” by study design (reference group: FTFI)



'Number of partners' by study design

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Figure S10: Heterogeneity for 'ever had sex' by region (reference group: FTFI)

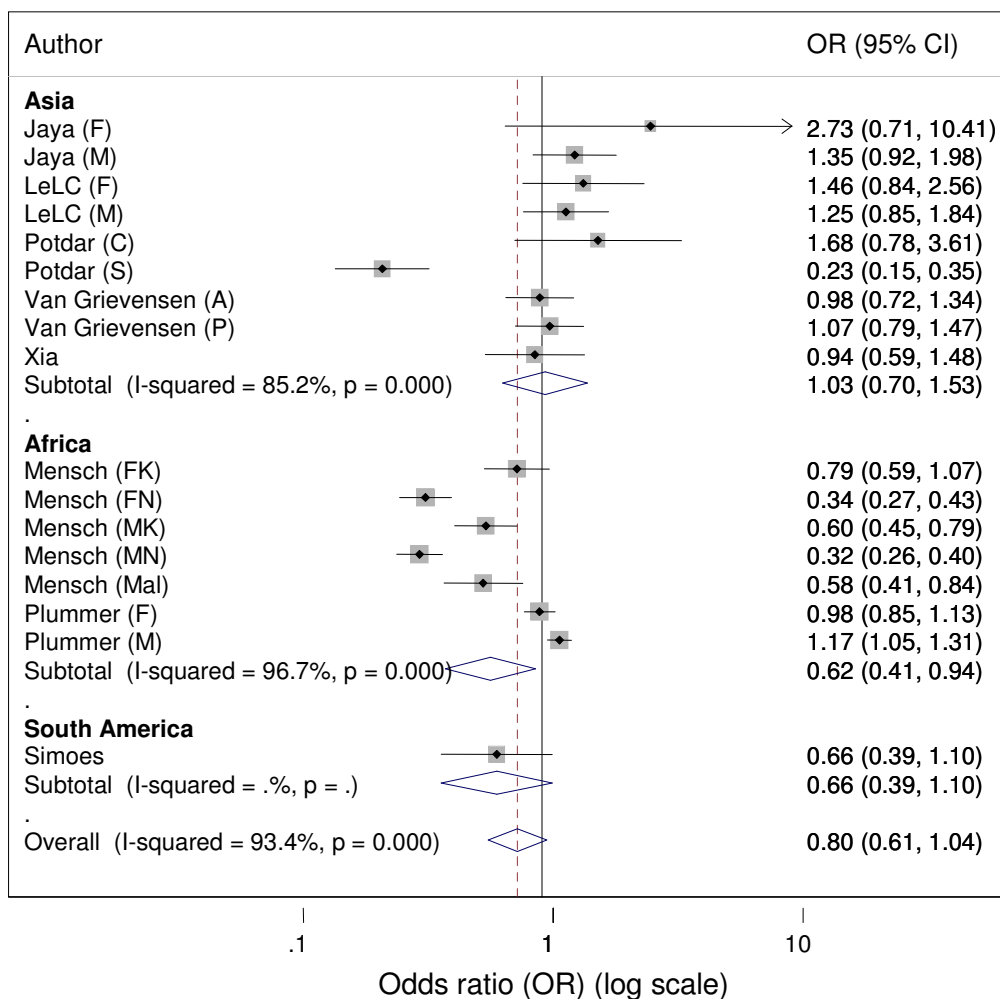
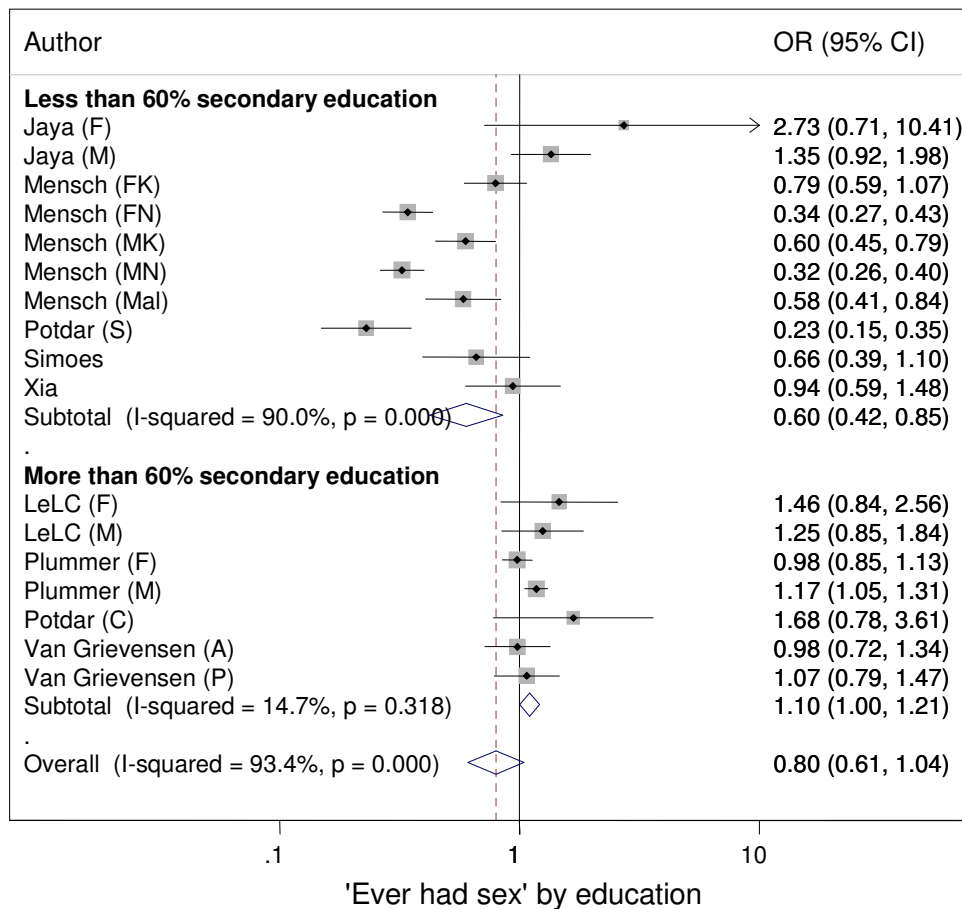


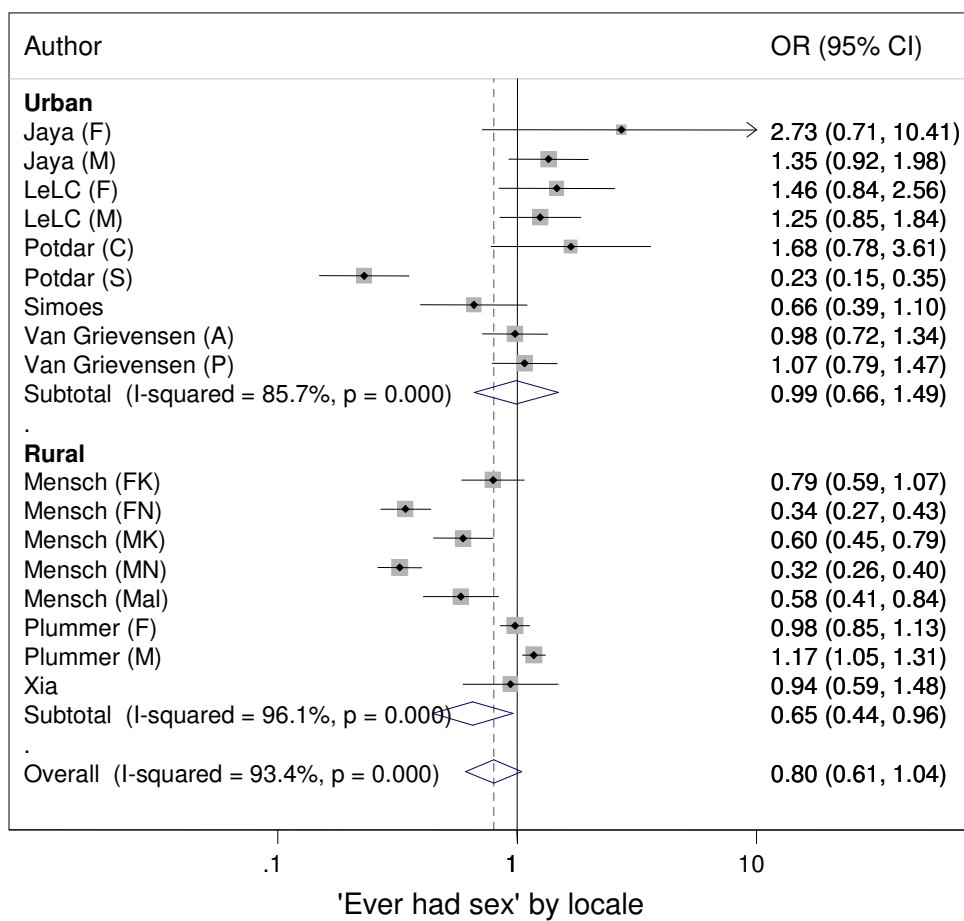
Figure S11: Heterogeneity & homogeneity for 'ever had sex' by education (reference group: FTFI)



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Figure S12: Heterogeneity for 'ever had sex' by locale (reference group: FTFI)



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Figure S13: Heterogeneity for 'number of sexual partners' by region (reference group: FTFI)

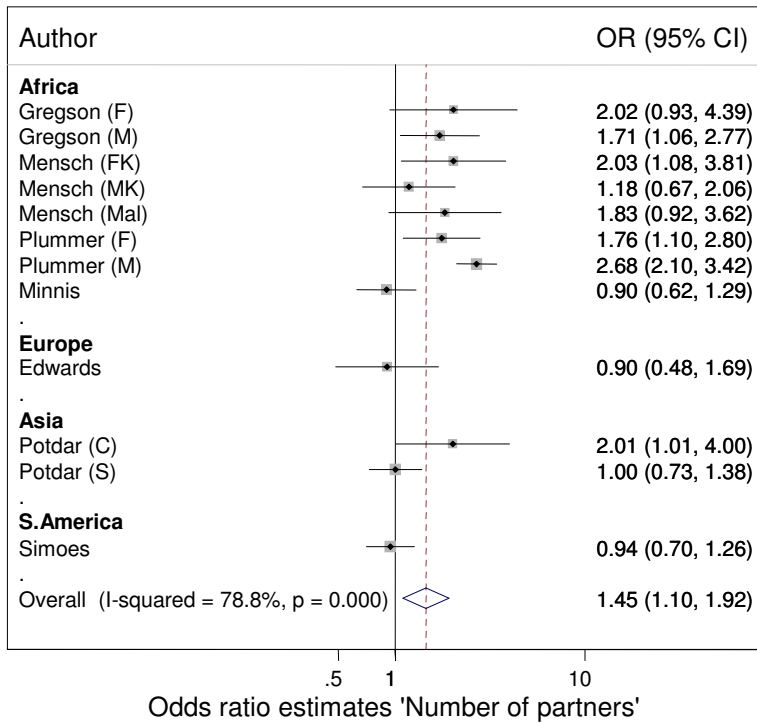
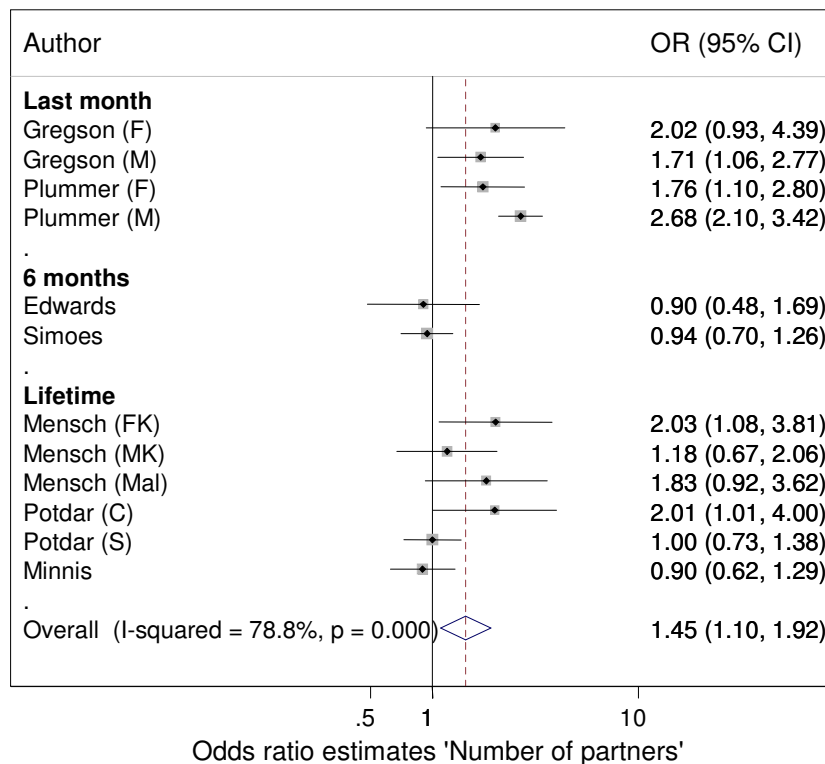


Figure S14: Heterogeneity for 'number of sexual partners' by timeframe (reference group: FTFI)



Alternative interview methods compared to self-administered questionnaire (SAQ)

Table S1: Summary odd ratios by outcome for meta-analyses of SAQ versus alternative interview tool (reference group: SAQ)

Outcome	Subgroup		Random effects estimate, Odds Ratio	95% CI	Q	P	N	References
Ever had sex	Gender	Combined	1.10	0.83, 1.46	10.7	.03	5	[21][33-34][50]
		Male	1.04	0.76, 1.42	7.94	.09	5	[17][22-26]
		Female	1.08	0.82, 1.42	17.8	<.001	5	[17][22-25]
	Region	Asia	1.24	1.04, 1.47	12.2	.	10	[17][21-22][26][50]
		Africa	0.85	0.71, 1.02	8.28	.08	5	[23-25][34]
		S.America	1.69	0.85, 3.34	0.00	.20	1	[33]
	Education	Less 60%	0.93	0.75, 1.15	10.0	.04	5	[23-25][33]
		More 60%	1.15	0.94, 1.41	20.6	.02	11	[17][21-22][34][50]
	Locale	Urban	1.23	0.96, 1.57	17.5	.02	8	[17][21][26][33][50]
		Rural	0.92	0.78, 1.08	11.0	.14	6	[22-25]
	Summary estimate		1.07	0.91, 1.25	39.2	<.001	16	
Non-condom use	Gender	Combined	0.93	0.69, 1.25	2.60	.27	3	[21][34]
		Male	0.77	0.54, 1.11	19.3	<.001	6	[17][23-25]
		Female	1.41	0.51, 3.90	16.7	.01	3	[17][22-26]
	Region	Asia	0.96	0.67, 1.37	16.2	.01	7	[17][21-22][26]
		Africa	0.79	0.52, 1.19	21.0	<.001	5	[23-25][34]
	Education	Less 60%	0.80	0.50, 1.27	20.9	.02	4	[23-25]
		More 60%	0.93	0.67, 1.29	16.7	<.001	8	[17][21-22][26]
	Locale	Urban	1.01	0.68, 1.49	14.9	0.01	6	[17][21][26]
		Rural	0.78	0.54, 1.12	21.5	<.001	6	[22-25]
		Summary estimate		0.87	0.67, 1.13	39.7	<.001	12
Ever forced to have sex*	Gender	Combined	1.54	0.38, 6.27	0.00	.	1	[34]
		Male	1.11	0.56, 2.19	0.16	0.98	4	[17][22][26]
		Female	1.49	0.76, 2.92	1.78	0.41	3	[17][22]
	Region	Asia	1.29	0.80, 2.08	2.32	0.89	7	[17][22][26]
		Africa	1.54	0.38, 6.27	0.00	.	1	[34]
	Locale	Urban	1.22	0.51, 2.93	0.52	0.92	4	[17][26][34]
		Rural	1.35	0.80, 2.29	1.82	0.61	4	[22]
		Summary		1.31	0.84, 2.06	2.38	0.94	8

Q –heterogeneity statistic; P – p-value; N- number of study estimates

* All respondents in studies reporting 'Ever forced to have sex' had more than 60% of the sample with secondary education