# Estimating misreporting in condom use and its determinants among sex workers: Evidence from the list randomisation method

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Carole Treibich*and Aurélia Lépine†

**Abstract**

Social desirability bias, which is the tendency to under-report socially undesirable health behaviours, significantly distorts information on sensitive behaviours gained from self-reports. We designed a list randomisation method to indirectly elicit condom use among female sex workers and tested it among 651 female sex workers in Senegal, a country where sex workers face high social stigma and where the AIDS epidemic is mainly concentrated among this population. Based on our list randomisation, we found that the condom use rate in the last sexual intercourse with a client was 78%, which is significantly lower than the 97% obtained when asked directly in the survey. When estimating condom use among the subgroups, we found that female sex workers who are at a higher risk of infection are less likely to use condoms.

**Key words:** list randomisation, condom use, female sex workers, Senegal.

## 1 Introduction

Condom use is the main preventive tool available to limit the spread of sexually transmitted diseases (STIs) and human immunodeficiency virus infection/acquired immune deficiency

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syndrome (HIV/AIDS). Given that the consistent use of condoms is known as the most cost-effective way to prevent HIV transmission (Cohen et al., 2004; Creese et al., 2002), condom use is the pillar of any HIV prevention strategy in most countries. The promotion of condom use is often based on multiple interventions such as awareness campaigns and the free provision of condoms. However, the evaluation of the effects of such policies as well as their value for money is difficult to determine due to the impossibility to directly observe sexual behaviours adopted by targeted groups. Researchers and policy makers have no other choice than relying on individuals' declarations. As a matter of fact, in a systematic review looking at the effect of interventions involving condom promotion, Foss et al. (2007) found that most of the evidence published on the effect of such interventions is based on self-reported condom use, despite the inherent bias of such a measure. Indeed, one may wonder whether direct elicitation of condom use would provide an accurate estimate and could be used to measure the impact and monetary value of condom-based interventions. This may be even more of a concern when considering stigmatised groups highly targeted by preventive services, such as female sex workers (FSWs).

Our paper aims to measure misreporting in condom use among FSWs in Senegal, a country particularly interesting for the study of FSWs. First, while HIV prevalence is 0.7% in the general population, FSWs in Senegal are up to 9 times more likely to be infected, with HIV/AIDS with an HIV/AIDS prevalence of 6.6% in 2015 (APAPS and IRESSEF, 2015). Second, Senegal is the only African country where prostitution is legal and regulated by a public health policy. In 1969, the Government of Senegal legalised prostitution and introduced a compulsory registration programme for FSWs to monitor the prevalence of STIs, and later on, the spread of the HIV/AIDS epidemic. As a consequence of the close monitoring of this population, registered FSWs are aware of the benefits provided by the use of condoms and receive condoms for free at their monthly routine health visits. Third, Senegal is a Muslim-dominated country where a

woman's status is very low. As a result, despite having a legal status, FSWs face very high social stigma. In this context, we anticipate that condom use self-reported in face-to-face surveys is likely to be over-reported.

To estimate the amount of over-reporting and the determinants of condom use and of its over-reporting, we used list randomisation. The list randomisation method or item count technique provides privacy to respondents and thus limits dishonest answers caused by social desirability bias in face-to-face interviews (Holbrook and Krosnick, 2010). It has been applied to elicit vote preferences (Corstange, 2009; Gonzalez-Ocantos et al., 2012; Holbrook and Krosnick, 2010), illegal migration (McKenzie and Siegel, 2013), the use of micro finance loans (Karlan and Zinman, 2012) as well as opinions on topics such as same sex marriage (Lax et al., 2016) and racism (Blair and Kosuke, 2012; Kuklinski et al., 1997).

However, there are only a few studies that have applied the method in health research (Chong et al., 2013; Jamison et al., 2013; LaBrie and Earleywine, 2000; Walsh and Braithwaite, 2008), and the method has never been used to measure over-reporting in condom use among a low educated stigmatised group. We believe that it is important to assess whether list randomisation could be introduced into national surveys to obtain a less biased estimation of condom use among high-risk groups in low-income countries. In addition to providing a better estimate of condom use, list randomisation allows the identification of subgroups for which condom use rates are lower. We used the parameters from the model by Geoffard and Philipson (1996) to identify the main drivers of condom use. Finally, we compared the proportion of FSWs who openly declared using a condom with their last client with the proportion obtained through the indirect elicitation method to quantify the propensity to over-report condom use among subgroups. By doing so, we are able to test whether registered FSWs, who are by definition more exposed to HIV prevention services, are more likely to over-report condom use than their

non-registered counterparts.

We found that 22% of FSWs did not use a condom in their last sexual intercourse with a client, which is significantly greater than the 3% obtained when asked directly. Hence, our results confirm that list randomisation could be a promising indirect method to elicit condom use in low-income countries. When estimating condom use among subgroups, we found that FSWs at a higher risk of HIV are significantly less likely to have used a condom with their last client. The results also show that increasing the knowledge of FSWs regarding HIV and the consequences of STIs as well as increasing the links with health facilities would be useful policies to increase condom use. Finally, we did not find that FSWs receiving more HIV prevention services are more likely to over-report condom use.

# 2 Methodology

## 2.1 List randomisation method and underlying hypotheses

The principle of list randomisation is to allocate respondents randomly into the following two different groups: a "control" and a "treatment" group. Individuals allocated into the "control" group are presented with a number of non-sensitive statements. They are not asked to say whether they agree with each of the statements but only with how many of them they agree with. The same statements are presented to the "treated" group; the difference is that a sensitive statement is added to the series of non-sensitive statements. Assuming that the two groups agree on average with the same number of non-sensitive statements, one can deduce the share of individuals in the "treated" group who agreed with the sensitive item by comparing the average number of agreed statements in each group (see Glynn, 2013; Holbrook and Krosnick, 2010; Kuklinski et al., 1997).

The effectiveness of this methodology is based on the following three assumptions: (i) randomisation of the treatment, (ii) absence of any design effect, and (iii) honest answers. More precisely, individuals allocated to each group must be similar to ensure that they agree with the same number of non-sensitive items on average. Second, the addition of the sensitive item must not change the sum of the affirmative answers to the control items. Finally, as pointed out by Kuklinski et al. (1997), the choice of the non-key items needs to be such that individuals are not urged to provide false answers. There are two different types of dishonest answers: those who honestly would answer "yes" to all the non-sensitive items and hence would no longer benefit from any privacy if they agree with the sensitive item (ceiling effects) and those who honestly would answer "no" to all non-sensitive items and hence would no longer benefit from any privacy if they disagree with the sensitive item (floor effects).

### 2.2 List randomisation implemented among FSWs in the Dakar region

In 2015, we interviewed 651 FSWs in the Dakar suburbs, which represents 15% of the total estimated number of FSWs in the Dakar region (APAPS, 2011-2012). Ethical clearance was obtained from the London School of Hygiene & Tropical Medicine and from the national ethics committee in Senegal (reference number SEN15/15). Data were captured using electronic devices and all respondents were asked whether they used a condom with their last client. Then, we randomised the allocation of the participants into the "treatment" and "control" groups based on their identifying number to determine their elicited condom use.

In our survey, the "control" group was presented with the following question:

*I [the interviewer] will read three statements. I will then ask you how many of these statements you agree with. You should not tell me which specific statement you agree with but the*

*number of statements you agree with. I will give you three marbles, and you have to hold them in your right hand. Keep both of your hands on your back side. For each of the statements, if you agree with it, please transfer one marble from your right hand to your left hand behind you. If you do not agree with it, please do not transfer any marble. At the end, I would like to know the total number of statements you agreed with. This number should correspond to the number of marbles you have in your left hand. I will now read the statements.*

1. *It is safer to bring a client home than going to a hotel.*

2. *I prefer that the client pays me before intercourse.*

3. *Monday is the day I have the greatest number of clients.*

FSWs from the "treatment" group received an additional marble and were presented the same statements plus the sensitive item that relates to condom use. Note that this sensitive item was presented in the second position in the treatment group list:

4. *I used a condom during my last sexual intercourse with a client.*

## 3 Theoretical framework

In this section, we present a theoretical framework for the potential mechanisms at play in the decision to engage or not engage in unprotected sex. To do so, we adapted the model by Geoffard and Philipson (1996), which is a two-period model where individuals (in our case FSWs) decide whether to engage or not engage in an unprotected sex act in the period $t$ and face the costs of being infected in the period $t + 1$. We added interdependence to the utility functions of FSWs and their clients (Bergstrom, 1999) so that the utility function of (infected) FSWs $u$ depends on their sexual partner's utility level $v$.

As it is commonly done in the literature for the compensating differential for unprotected sex (Arunachalam and Shah, 2012; Gertler and Shah, 2011; Rao et al., 2003), it is assumed that clients bear disutility from using condom. FSWs choose their behaviours to maximise their utility given their health state. The health status $h$ of FSWs can take the following two values: susceptible ($h = s$) or infected with HIV ($h = i$). FSWs decide to adopt a behaviour $b$ that can also take the following two values: protection against risk ($b = p$) or exposure to risk ($b = e$). The utility derived by FSWs $u(h, b)$ is a function of one's health and behaviour.

Ceteris paribus, protective activity ($p$) and infection ($i$) are both assumed to be costly as follows:

$$u(h, e) > u(h, p) \text{ and } u(s, b) > u(i, b)$$

FSWs discount future utility at a discount rate $\delta(h)$, which is a function of their future health state, with $\delta(s) < \delta(i)$.

The transition rate from state $s$ to state $i$, which is conditional on exposure, is denoted as $\lambda = \pi \times P$ where $P$ is the probability that a susceptible FSW matches with an infected client and $\pi$ is the probability that an exposed activity between the FSW and her client will result in a new infection.

The underlying assumptions in the model are as follows:

$$P[h(t+1) = i | (h(t), b) = (s, e)] = \lambda \tag{1}$$

$$P[h(t+1) = i | (h(t), b) = (s, p)] = 0 \tag{2}$$

$$P[h(t+1) = i | (h(t), b) = i] = 1 \tag{3}$$

In other words, (1) the probability of getting infected if exposed for a susceptible FSW is $\lambda$; (2) the probability of being infected under protection is zero and (3) the probability of

remaining infected if already infected is one, whichever behaviour is adopted by the FSW.

FSWs engage in safe sex if and only if the cost of protection (the loss of current utility from protection) is below the expected future utility loss due to infection.

$$u(s,e) - u(s,p) \leq \pi \cdot P\left[\frac{u(s)}{\delta(s)} - \frac{u(i)}{\delta(i)}\right]$$

While in this model, infected FSWs have no reason to engage in safe sex as $u(i,p) < u(i,e)$; thus, we relax this assumption and assume interdependence in the utility functions of FSWs and their clients (Bergstrom, 1999) so that the utility function of (infected) FSWs $u$ depends on their sexual partner's utility level $v$, where

$$u(i,e) - u(i,p) \leq \pi[u(i,v(s)) - u(i,v(i))] \text{ with } v(s) > v(i)$$

# 4 Empirical strategy

Equation (4) shows that condom use estimated by list randomisation was estimated by regressing the number of statements the respondent agreed with ($Y_i$) on the allocation to the treatment group ($T_i$). The average condom use rate in the sample using list randomisation is then given by $\beta$ and corresponds to the average difference in the number of statements between the control and the treatment group in the sample. All estimations compute robust standard errors to account for the difference in the variance of error term $\varepsilon_i$ between the treatment and control groups.

$$Y_i = \beta T_i + \varepsilon_i \tag{4}$$

We use list randomisation to further investigate the characteristics of FSWs who did not use a condom during their last sexual intercourse.[1] Following Imai (2011), we investigated the relation between condom use and respondents' characteristics using a simple linear regression with the following interaction terms:

$$Y_i = \beta T_i + \gamma S_i + \alpha S_i \times T_i + \varepsilon_i \tag{5}$$

where $S_i$ is a characteristic of individual $i$ that may be correlated with condom use. $\beta$ precisely reports the condom use rate among the subgroup for which $S_i = 0$, while $\alpha$ is the difference in the condom use rate between the two subgroups ($S_i = 1$ and $S_i = 0$). The p-value of $\alpha$ indicates if the condom use rate is different between the subgroups.

To improve the statistical power, we added some variables that are assumed to be correlated with the non-sensitive statements:

$$Y_i = \beta T_i + \gamma S_i + \alpha S_i \times T_i + X_i + \varepsilon_i \tag{6}$$

where $X_i$ is a set of sex worker characteristics potentially influencing the answer to the non-sensitive items (i.e., FSW preferences regarding the place where the sex act occurred or the proportion of the last four sexual intercourses for which payment was made after the sex act). $X_i$ also includes age, whether the FSW is divorced, whether the FSW lives with or next to her parents, the type of client (regular versus occasional) and whether clients are usually approached in a night club.

[1] The advantage of the list randomisation methodology lies in the possibility of conducting subgroup analysis (see Appendix 1 for a comparison of different techniques eliciting sensitive items).

# 5 Data

Data were collected from 651 FSWs living in Dakar suburbs in June and July 2015, which represents 15% of the estimated total FSWs in the Dakar region (APAPS, 2011-2012). Our sample contains an equal share of registered and non-registered FSWs. Given that sexual health services are integrated with reproductive health in Senegal, registered FSWs were recruited by the midwife in charge of their medical follow-up. All active registered FSWs from four (Pikine, Rufisque, Mbao and Sebikotane) out of the five STI health centres located in Dakar were contacted to participate in our study. Unregistered FSWs were recruited by NGO staffs and by peer FSWs using snowball sampling. FSWs were asked to come to the health centre and were interviewed at the health facility in private dedicated rooms. Survey participants received a CFAF 3,000 show-up fee that aimed to cover transport cost and the time spent at the health facility.

As part of the questionnaire, information on socio-economic and intrinsic characteristics, preferences (time preferences, risk aversion and altruism) and sex work activity (revenue, type of clients and type of sex acts) was collected from the respondents. Table 1 shows the different parameters from the model with their measurements from the data set and presents descriptive statistics of these variables.

# 6 Validation of list randomisation

## 6.1 Verification of the randomisation

We noted that randomisation ensured balance between the two groups with respect to their observable characteristics (Table A2, Appendix 2). The only significant difference observed was in the type of the sex worker's last client (p=0.06). However, given that we tested approximately 60 different treatment-control differences in this table, this unique significant difference is no

Table 1: Determinants of condom use.

| Parameter | Description | Factors influencing the parameters | Expected effect | *Obs* | Mean |
|---|---|---|---|---|---|
| $u(s,e) - u(s,p)$ | Cost of protection | **Revenue loss:** | - | | |
| | | Earned more than 12,500 CFAF for the last intercourse | | *643* | 0.499 |
| | | Beauty ($\geq$ 5 out of 10) | | *651* | 0.776 |
| | | **Condom price:** | + | | |
| | | Received free condoms | | *641* | 0.671 |
| | | **Reduction in sexual pleasure:** | + | | |
| | | FSWs who declare having no reduction in sexual pleasure with condoms | | *640* | 0.195 |
| | | **Violence:** | - | | |
| | | The last client negotiated the price | | *605* | 0.534 |
| | | Violence from a client in the past year | | *648* | 0.255 |
| $P$ | Probability that a susceptible individual matched with an infected one | **Client at risk of HIV:** | + | | |
| | | Last client was at risk of HIV | | *593* | 0.73 |
| $\pi$ | Probability that an exposed activity between them will result in a new infection | **Risk taking:** | - | | |
| | | More than 3 clients a week | | *648* | 0.684 |
| | | Subjective risk taking in health domain ($\geq$ 8 out of 10) | | *651* | 0.054 |
| | | Last client was an occasional client | | *645* | 0.440 |
| | | Performed anal sex during last intercourse | | *645* | 0.023 |
| | | **HIV and STI knowledge:** | + | | |
| | | High HIV knowledge ($\geq$ 6 out of 8) | | *651* | 0.796 |
| | | **Poor trust towards the efficacy of condoms:** | - | | |
| | | Perceived condoms inefficacious to prevent HIV | | *606* | 0.254 |
| | | Agrees with 'One cannot avoid HIV by always using condoms' | | *643* | 0.171 |
| $u(i,e)$ | Utility in the case of infection | **Social exclusion:** | + | | |
| | | Was introduced to the sex business by another SW | | *651* | 0.267 |
| | | Thinks that all girls in the same location use condoms | | *364* | 0.522 |
| | | Would be ashamed if a neighbour learns about her sex work activity | | *648* | 0.844 |
| | | Fears that a neighbour who learns about her sex activity will repeat it to others | | *647* | 0.856 |
| | | **Medical and opportunity cost:** | + | | |
| | | Thinks that will lose more than 14 days of work if has an STI | | *648* | 0.486 |
| | | Expects to pay more than 15,000 CFAF in the case of a genital ulcer | | *634* | 0.364 |
| | | **Quality of life if infected:** | - | | |
| | | Knows ART | | *647* | 0.504 |
| $u(s)$ | Preference for health | **Legal status:** | + | | |
| | | Registered with authorities | | *650* | 0.500 |
| | | **Demand for prevention:** | + | | |
| | | Is affiliated with a health centre | | *648* | 0.731 |
| | | Does her monthly routine visit | | *269* | 0.729 |
| | | Visited a health centre in the last 6 months | | *651* | 0.750 |
| | | Had an HIV screening in the past year | | *651* | 0.806 |
| $\delta$ | Discount rate | **Preference for present:** | - | | |
| | | Agrees with 'Instead of saving, I prefer to spend my money today' | | *651* | 0.788 |
| | | Alcohol or drug consumption during last intercourse | | *640* | 0.077 |
| $u(i,p) < u(i,e)$ | Disutility in using condoms once infected | **HIV and STI status:** | - | | |
| | | HIV positive according to medical records (biological test) | | *219* | 0.059 |
| | | Subjective expectations about being HIV positive | | *582* | 0.065 |
| | | Subjective expectations about being STI positive | | *583* | 0.398 |
| $u(v(s))$ | Interdependent utilities | **Altruism:** | + | | |
| | | Gave more than 40% of the amount received in a dictator game | | *651* | 0.289 |

*Notes:* All listed variables are binary variables.

more than what would be expected by chance. This was confirmed by the joint significance tests for a large share of the set of variables presented in Table A2.[2]

### 6.2 Absence of ceiling, floor and design effects

We also needed to ensure that the list of non-sensitive items provided enough privacy to respondents in the treated group (hypothesis 2) and that the addition of the sensitive item did not modify the answers regarding the non-sensitive statements (hypothesis 3). In Table A3 (Appendix 2), we estimated the proportion of FSWs in the control group who did not agree with any statement and answered "0" to the item count list question. If this proportion was high, it would encourage respondents in the treated group to report a positive value since answering "0" would reveal that they had unprotected sex. Since the proportion of individuals answering "0" in the control group was less than 3%, we did not face this issue. We also avoided the issue of ceiling effects because the proportion of respondents in the control group who answered "3" to the non-sensitive items was also very low (9%). This absence of ceiling and floor effects has been ensured thanks to the negative correlation between items 2 and 3. Some protection for the respondents is therefore built-in to allow them to honestly report their true behaviours towards condom use. Finally, the difference (Row 5) between the proportion of individuals in the treated group (Row 2) and in the control group (Row 4) who agree with at least $j$ statements ($j = 1, 2, 3, \text{and} 4$) is always positive, which provides evidence of the absence of design effects.

[2]More precisely, two tests of joint significance were performed and provided similar results. While the first one aimed to maximise the size of the sample considered (645 observations and 32 variables), the second one increased the number of variables included in the model (621 observations and 39 variables).

# 7 Results

## 7.1 Measuring misreporting in condom use

Using self-reported information, we found that 97.2% of FSWs declared to have used a condom with their last client. Table 2 presents the results from the list randomisation exercise. It appears that based on list randomisation, the condom use rate is equal to 79.7% when considering all female sex workers (Panel A) and 77.7% versus 97.2% when self-reported if we consider the sample of FSWs who answered to the self-declared question (Panel B). As a result, the self-reported condom use is overestimated by 19.5% points (95% CI [7.5; 31.6]).

The difference between self-reported condom use and the condom use elicited by list randomisation is statistically significant ($p < 0.01$). For the entire sample, i.e., when including the 10.6% who did not answer the direct question, the elicited condom use rate using list randomisation is 2 percentage points higher. This is an interesting result because it means that respondents who did not answer the self-reported question report slightly higher condom use (see Panel C).

Table 2: Condom use with the last client estimated with the list experiment.

| | **Average number of agreed statements** | | **Estimated** | |
|---|---|---|---|---|
| | **Control** | **Treatment** | **condom use** | **CI 95%** |
| ***Panel A:*** *All female sex workers (n=651)* | | | | |
| | 1.700 | 2.497 | 0.797 | [68.52, 90.93] |
| ***Panel B:*** *Restricted to individuals who answered the self-declared question (n=582)* | | | | |
| | 1.685 | 2.462 | 0.777 | [65.67, 89.75] |
| ***Panel C:*** *Restricted to individuals who did not answered the self-declared question (n=69)* | | | | |
| | 1.839 | 2.763 | 0.924 | [64.10, 120.78] |

*Notes:* The proportion who used a condom is obtained by taking the difference between the "control" and "treated" means.

## 7.2 Measuring misreporting in condom use for subgroups

Table 3 displays the results obtained when performing the subgroup analysis based on the variables presented in Table 1.

***Factors affecting the costs of protection*** We found that having high earnings[3] is negatively correlated with the likelihood of using a condom (68.4% vs. 89.4%, p-value=0.07). Nevertheless, FSWs who received free condoms are not more likely to use condoms than those who have to pay for condoms. In addition to these financial costs, FSWs were asked to compare their sexual pleasure with and without condoms. Those who declared that the use of condom does not decrease their sexual pleasure showed greater condom use, although the difference is not statistically significant (94.7% vs. 76.2%, p-value=0.17). No information regarding the type of violence experienced during the last sexual intercourse was collected. We attempted to overcome this issue (i) by comparing FSWs who suffered from violence by an occasional client in the last twelve months with those who did not and (ii) by looking at whether the last client negotiated the price of intercourse as a proxy for a FSW's low bargaining power. However, we did not find any significant differences in condom use between these subgroups.

***Factors affecting the probability that a susceptible FSW matches with an infected client*** FSWs were asked about their last client characteristics. We found that FSWs are more likely to use a condom with clients perceived to be at high risk of HIV (90.4% vs. 77.4%), though this difference was not statistically significant.

***Factors affecting the probability that an exposed activity between a FSW and a client will result in a new infection*** Having an occasional client reduces the probability of engaging in safe sex even if this difference is not statistically significant. FSWs who have more than three clients per week are significantly less likely to have used a condom (73.3% vs. 95.0%, p-value=0.08). FSWs who declare to be willing to take risks with their health tend to be less likely to use condoms, though the sample size of this subgroup does not enable us to detect a statistically significant difference. FSWs who have a better knowledge regarding

[3]More than 12,500 CFAF for the sexual act, which corresponds to the median in our sample

HIV transmission modes are more likely to have used a condom with their last client (85.2% vs. 58.5%, p-value=0.06). For FSWs who think that condoms will not prevent against HIV infection, they have a lower condom use, but this difference is not statistically significant (62.0% vs. 82.9%, p-value=0.14).

***Factors affecting the utility in the case of an infection*** We found that peer effects and social norms play a role in condom use. FSWs who declare that all the girls working in their area use condoms are more likely to have used a condom with their last client (98.8% vs. 63.2%, p-value=0.02). This is also the case for FSWs who entered sex work thanks to another sex worker (97.4% vs. 73.9%, p-value=0.06). Furthermore, we investigated the impact of fear of social stigma on condom use by looking at the following two different variables: those who would be ashamed if a neighbour learns about their sex work activity and those who fear the neighbour would repeat this to others. Both subgroups are more likely to use condoms (85.2% vs. 47.2%, p-value=0.02 and 84.6% vs. 42.7%, p-value=0.02 respectively).

As expected, perceived high STI consequences are positively associated with the decision to engage in safe sex. On one hand, FSWs who think they will lose more than 14 days of work in the case of an STI are more likely to have used a condom during their last paid intercourse (92.9% vs. 66.6%, p-value=0.02). Likewise, FSWs who expect to pay more than 15,000 CFAF in medical expenses in the case of a genital ulcer are more likely to have used a condom with their last client (85.2% vs. 65.7%, p-value=0.10). FSWs who are aware of the existence of antiretroviral treatment (ART) also displayed lower rate of condom use than FSWs who had never heard about ART, but this difference was not statistically significant (71.5% vs. 88.9%, p-value=0.13).

***Factors reflecting the preference for health*** FSWs who visited a health centre in the past six months are more likely to have used a condom (86.0% vs. 60.9%, p-value=0.07). However,

being a registered FSW and adhering to medical visits is not correlated with condom use.

***Factors affecting the discount rate*** FSWs who declared that they have consumed alcohol or drugs before their last paid sexual intercourse are significantly less likely to have used a condom (40.7% vs. 81.4%, p-value=0.06).

***Testing the disutility in using condoms once infected*** HIV positive FSWs (estimated via biological markers) are less likely to have used a condom than HIV negative FSWs (5.0% vs 80.0%, p-value=0.05). This negative relationship between HIV status and condom use was somehow confirmed for the entire sample when considering subjective expectations regarding HIV status. Additionally, FSWs who believe that they have another STI than HIV (also estimated via subjective expectations) are significantly less likely to have used a condom with their last client (57.1% vs 89.4%, p-value=0.01).

***Interdependent utilities*** We found that altruistic FSWs are more likely to have used a condom (97.2% vs. 72.6%, p-value=0.05).

Table A4 (Appendix 3) shows that very similar results were found when introducing the set of covariates aiming at controlling for any sex worker's characteristics, which could influence the answers to the non-sensitive items or when restricting the sample to FSWs who answered the self-declared condom use question.

Table 3: Condom use by subgroups.

| | | Self-declared condom use | | | | | | List randomisation ‡ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Obs* | *Obs if Yes* | Yes | No | Difference | SE | *Obs* | *Obs if Yes* | Yes | No | Difference | SE |
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| $u(s,e)-u(s,p)$ | **Revenue loss:** | | | | | | | | | | | | |
| | Earned more than 12,500 CFAF in the last intercourse | *582* | *293* | 0.956 | 0.990 | -0.034** | 0.013 | *643* | *321* | 0.684 | 0.894 | -0.210* | 0.114 |
| | Beauty ($\geq$ 5 out of 10) | *582* | *461* | 0.972 | 0.975 | -0.003 | 0.016 | *651* | *505* | 0.745 | 0.974 | -0.230* | 0.131 |
| | **Condom price:** | | | | | | | | | | | | |
| | Received free condoms | *573* | *371* | 0.987 | 0.970 | 0.016 | 0.013 | *641* | *430* | 0.791 | 0.849 | -0.058 | 0.124 |
| | **Reduction in sexual pleasure:** | | | | | | | | | | | | |
| | FSWs who declare having no reduction in sexual pleasure with condoms | *572* | *111* | 0.982 | 0.980 | 0.002 | 0.014 | *640* | *125* | 0.947 | 0.762 | 0.186 | 0.135 |
| | **Violence:** | | | | | | | | | | | | |
| | The client negotiated the price | *576* | *309* | 0.981 | 0.966 | 0.014 | 0.014 | *605* | *323* | 0.780 | 0.821 | -0.041 | 0.120 |
| | Violence from a client in the past year | *581* | *150* | 0.980 | 0.970 | 0.010 | 0.014 | *648* | *165* | 0.843 | 0.782 | 0.061 | 0.122 |
| $P$ | **Client at risk of HIV:** | | | | | | | | | | | | |
| | Last client was at risk of HIV | *543* | *39* | 0.923 | 0.974 | -0.051 | 0.043 | *593* | *43* | 0.904 | 0.774 | 0.129 | 0.213 |
| $\pi$ | **Risk taking:** | | | | | | | | | | | | |
| | More than 3 clients a week | *581* | *397* | 0.970 | 0.978 | -0.008 | 0.014 | *648* | *443* | 0.733 | 0.950 | -0.217 | 0.122 |
| | Subjective risk taking in health domain ($\geq$ 8 out of 10) | *582* | *33* | 0.939 | 0.974 | -0.035 | 0.042 | *651* | *35* | 0.500 | 0.812 | -0.312 | 0.230 |
| | Last client was an occasional client | *582* | *266* | 0.981 | 0.965 | 0.016 | 0.013 | *645* | *284* | 0.711 | 0.860 | -0.148 | 0.115 |
| | **HIV and STI knowledge:** | | | | | | | | | | | | |
| | High HIV knowledge ($\geq$ 6 out of 8) | *582* | *460* | 0.980 | 0.943 | 0.038* | 0.022 | *651* | *518* | 0.852 | 0.585 | 0.266* | 0.144 |
| | **Poor trust towards the efficacy of condoms:** | | | | | | | | | | | | |
| | Perceived condoms inefficacious to prevent HIV † | *543* | *125* | 0.992 | 0.967 | 0.025** | 0.012 | *606* | *154* | 0.620 | 0.829 | -0.209 | 0.142 |
| | Agrees with 'One cannot avoid HIV by always using condoms' | *576* | *101* | 0.960 | 0.979 | -0.019 | 0.021 | *640* | *110* | 0.618 | 0.830 | -0.212 | 0.150 |
| $u(i,e)$ | **Social exclusion:** | | | | | | | | | | | | |
| | Was introduced to the sex business by another sex worker | *582* | *165* | 0.982 | 0.969 | 0.013 | 0.013 | *651* | *174* | 0.974 | 0.739 | 0.234* | 0.122 |
| | Thinks that all girls in the same location use condoms | *322* | *163* | 1.000 | 0.975 | 0.025** | 0.012 | *364* | *190* | 0.988 | 0.632 | 0.356** | 0.151 |
| | Would be ashamed if a neighbour learns about her sex work activity | *579* | *485* | 0.975 | 0.957 | 0.018 | 0.022 | *648* | *547* | 0.852 | 0.472 | 0.380** | 0.160 |
| | Fears that a neighbour who learns about her sex activity will repeat it to others | *578* | *493* | 0.976 | 0.953 | 0.023 | 0.024 | *647* | *554* | 0.846 | 0.427 | 0.419** | 0.181 |
| | **Medical and opportunity cost:** | | | | | | | | | | | | |
| | Thinks that will lose more than 14 days of work if has an STI | *581* | *283* | 0.968 | 0.977 | -0.008 | 0.014 | *648* | *315* | 0.929 | 0.666 | 0.263** | 0.114 |
| | Expects to pay more than 15,000 CFAF in the case of a genital ulcer | *568* | *368* | 0.965 | 0.985 | -0.020 | 0.013 | *634* | *403* | 0.852 | 0.657 | 0.195 | 0.119 |
| | **Quality of life if infected:** | | | | | | | | | | | | |
| | Know ART | *581* | *290* | 0.983 | 0.962 | 0.021 | 0.014 | *647* | *326* | 0.715 | 0.889 | -0.173 | 0.114 |

Table 3: Condom use by subgroups (continued).

| | | Self-declared condom use | | | | | | List randomisation ‡ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Obs* | *Obs if Yes* | Yes | No | Difference | SE | *Obs* | *Obs if Yes* | Yes | No | Difference | SE |
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| $u(s)$ | **Legal status:** | | | | | | | | | | | | |
| | Registered with authorities | *582* | *271* | 0.985 | 0.961 | 0.024$^{\star}$ | 0.013 | *650* | *325* | 0.848 | 0.749 | 0.100 | 0.115 |
| | **Demand for prevention:** | | | | | | | | | | | | |
| | Is affiliated with health centre | *580* | *416* | 0.978 | 0.957 | 0.021 | 0.017 | *648* | *474* | 0.843 | 0.680 | 0.163 | 0.133 |
| | Does her monthly routine visit | *224* | *156* | 0.993 | 1.000 | -0.006 | 0.006 | *269* | *196* | 0.841 | 0.711 | 0.130 | 0.190 |
| | Visited a health centre in the last 6 months | *582* | *427* | 0.981 | 0.948 | 0.033$^{\star}$ | 0.019 | *651* | *488* | 0.860 | 0.609 | 0.251$^{\star}$ | 0.137 |
| | Had an HIV screening in the past year | *582* | *464* | 0.983 | 0.932 | 0.051$^{\star\star}$ | 0.024 | *651* | *525* | 0.803 | 0.774 | 0.029 | 0.153 |
| $\delta$ | **Preference for present:** | | | | | | | | | | | | |
| | Agrees with 'Instead of saving I prefer spending my money today' | *582* | *472* | 0.972 | 0.973 | -0.001 | 0.017 | *651* | *513* | 0.791 | 0.809 | -0.018 | 0.138 |
| | Alcohol or drug consumption during last intercourse | *579* | *41* | 1.000 | 0.970 | 0.030$^{\star\star\star}$ | 0.007 | *640* | *49* | 0.407 | 0.814 | -0.407$^{\star}$ | 0.218 |
| $u(i,p) < u(i,e)$ | **HIV and STI status:** | | | | | | | | | | | | |
| | HIV positive according to medical records (biological test) | *185* | *10* | 1.000 | 0.994 | 0.006 | 0.006 | *219* | *13* | 0.050 | 0.800 | -0.750$^{\star}$ | 0.384 |
| | Subjective expectations about being HIV positive $^{\diamond}$ | *521* | *32* | 0.969 | 0.973 | -0.005 | 0.032 | *582* | *38* | 0.421 | 0.787 | -0.366 | 0.278 |
| | Subjective expectations about being STI positive $^{\diamond}$ | *521* | *207* | 0.966 | 0.978 | -0.012 | 0.015 | *583* | *232* | 0.571 | 0.894 | -0.323$^{\star\star\star}$ | 0.124 |
| $u(v(s))$ | **Altruism:** | | | | | | | | | | | | |
| | Gave more than 40% of the amount received in the dictator game | *582* | *170* | 0.976 | 0.971 | 0.006 | 0.014 | *651* | *188* | 0.972 | 0.726 | 0.245$^{\star\star}$ | 0.125 |

*Notes:* $^{\dagger}$ Condom inefficacy refers to a subjective probability higher than 80% of being infected after 100 protected intercourses. $^{\diamond}$ Sample is restricted to individuals who understood the subjective probabilities. "*Obs*" reports the total number of respondents for whom we have information on the variable. "*Obs if Yes*" presents the number of respondents who answered "Yes" to the related question. Columns (3) and (9) [Columns (4) and (10), respectively] display the proportion of FSWs who answered "Yes" ["No"] and who used a condom in their last sexual act.
*Reading note:* For the variable 'Registered with authorities', columns (7) to (10) can be read as follows : Among the 650 respondents, 325 of them are registered, 84.8% of legal sex workers used a condom with their last client, and 74.9% of illegal sex workers used a condom with their last client.
Columns (5) and (11) correspond to the difference between (3) and (4) and between (9) and (10), respectively. Columns (6) and (12) give the robust standard errors of the estimated difference.
‡ List randomisation - estimation: equation (5): $Y_i = \beta T_i + \gamma S_i + \alpha S_i \times T_i + \varepsilon_i$. Reported levels of significance are $^{\star}$ p<0.1, $^{\star\star}$ p<0.05 and $^{\star\star\star}$ p<0.01.

### 7.3 The role of prevention on condom use over-reporting

An important concern is whether high-risk populations who are more exposed to intensive HIV prevention services tend to over-report more condom use. To measure the role of prevention on condom use over-reporting, we perform the following procedure. First, we computed the proportion of FSWs who declared using a condom with their last client depending on their registration status, assuming that registered FSWs are more exposed to HIV prevention than non-registered FSWs. Then, we estimated condom use for those groups using the list randomisation results presented in Table 3. Finally, we computed the difference in condom use obtained with the two methods as well as its associated standard error. Table 4 reports the propensity to over-report condom use depending on HIV prevention exposure. Overall, there is no evidence that FSWs receiving intensive HIV prevention services are more likely to over-report condom use. Conversely, we found that FSWs who have not visited a health centre in the last six months tend to be more likely to over-report their condom use when compared to FSWs who recently attended a health centre, though this result is not statistically significant.

Table 4: Social desirability bias.

| | | | **Over-reporting estimation** | | | |
|---|---|---|---|---|---|---|
| | *Obs* | *Obs if Yes* | Yes (1) | No (2) | Difference (3) | SE (4) |
| ***Legal status*** | | | | | | |
| Registered with authorities | *650* | *325* | 0.137 | 0.213 | -0.076 | 0.122 |
| Is affiliated with a health centre | *648* | *474* | 0.135 | 0.277 | -0.142 | 0.129 |
| ***Access to HIV prevention and linked to the health system*** | | | | | | |
| Visited a health centre in the past 6 months | *651* | *488* | 0.121 | 0.339 | -0.218 | 0.144 |
| Visited a health centre less than a month ago | *651* | *368* | 0.122 | 0.246 | -0.124 | 0.112 |
| Does her monthly visits | *269* | *196* | 0.152 | 0.289 | -0.136 | 0.185 |
| Received free condoms | *641* | *430* | 0.196 | 0.122 | 0.074 | 0.125 |
| Had an HIV screening in the past year | *651* | *525* | 0.179 | 0.158 | 0.021 | 0.161 |

*Notes:* (1) and (2) correspond to the difference in condom use with the direct and indirect measures for the control group and the treated group, respectively. (3) is the difference between (1) and (2). (4) is the standard error of (3) and is equal to the square root of the sum of the squared standard errors of (1) and (2) (not reported in this table). The p-value indicates whether the difference is significantly different from zero and has been computed as follows: p-value = 2×normal(-abs((3)/(4)). None of the differences are statistically significant at the 10% level or lower. "*Obs*" reports the total number of respondents for whom we have information, i.e., 650 respondents. "*Obs if Yes*" presents the number of respondents who answered "Yes" to the question, i.e., 325 respondents are registered.

# 8 Discussion

Using list randomisation, we found that FSWs in Dakar over-report condom use by 19.5 points. The misreporting in condom use is higher than previously reported in the literature. Previous studies concluded that condom use was overestimated by 11 points among college students in the United States (LaBrie and Earleywine, 2000) and by 14 points among young men in Uganda, but condom use was neither overestimated among young women (Jamison et al., 2013) nor among teenagers in Colombia (Chong et al., 2013). The high misreporting in our study is likely to be explained by the characteristics of the targeted population; given that sex work is morally condemned by the Senegalese society, FSWs fear to be looked down upon when disclosing socially unacceptable behaviours in a face-to-face survey. Hence, by guaranteeing anonymity, the list randomisation method seems particularly suited to this population. Nonetheless, we acknowledge that condom use may still be overestimated. While list randomisation guarantees privacy in response to survey participants, it cannot help with participants who do not want to reveal their true behaviours. For example, we found that among the respondents who did not answer the self-declared condom use question, only 8% did not use condoms with their last client according to list randomisation, which may indicate that condom use is still overestimated in this sub-sample (see Table 2, Panel C).

We empirically tested the role of the main parameters from Geoffard and Philipson (1996)'s model. We found that one of the main reasons for not using condom comes from the existence of a premium for unprotected sex (Gertler et al., 2005; Rao et al., 2003). By showing that more expensive sex acts were more likely to be unprotected, our results confirm the important role of clients in the AIDS epidemic. Policies that would aim to reduce the strong preference of clients for unprotected sex could be effective in limiting HIV transmission. While a main barrier to

condom use is the fact that condom use is under the client's control (Wojcicki and Malala, 2001), our data show that only 7% of the 1,629 protected sexual intercourses contained in our data set were protected using a female condom. This suggests that the low bargaining power of FSWs may not be the main reason for not using condoms and justifies why FSWs with a lower bargaining power or FSWs exposed to physical violence from a client are not less likely to use condoms in our data set.

Our results provide some evidence on the role of factors affecting the utility in the case of infection upon condom use. First, we showed that FSWs who fear social stigma are more likely to use condoms. This indicates that while stigma reduction policies will certainly reduce social exclusion of FSWs, the absence of social sanctions could lead to greater risk-taking. Second, we found that condom use is significantly higher for FSWs who anticipate that infection will lead to important direct and indirect costs and a lower quality of life. For example, we found that women who have heard about ART are less likely to use condoms. There is some evidence in the literature that ART roll out is associated with greater risk taking (Geoffard and Méchoulan, 2004; Gray et al., 2003). However, the negative relationship between ART knowledge and condom use could also come from the fact that FSWs on ART have a lower incentive to use protection, ceteris paribus. To test this, we excluded FSWs who believed that they were infected with HIV from our sample, which reinforced the negative relationship between ART knowledge and condom use. FSWs who knew about ART had a lower condom use by 25 points and this difference was statistically significant at 5%.

The model by Geoffard and Philipson (1996) predicts that once infected, FSWs should stop using condoms because the benefits provided from protection is nil; this was confirmed empirically. This result is particularly alarming because it shows that the riskiest sexual intercourses

are more likely to be unprotected compared with safer ones. In fact, we estimate that among the 4,225 sexual intercourses that occur weekly in our sample, 8% involved HIV positive FSWs. This is because HIV positive FSWs have on average 7 weekly clients (compared to 6.5 for HIV negative ones). Among those 329 sexual intercourses that are particularly at risk of infection, only 16 were protected according to the list randomisation results. However, the increased likelihood of adopting risky sexual behaviours once infected can be mitigated if we assume interdependent utilities. When testing this empirically, we find that altruistic HIV positive FSWs have a condom use rate that is 85 points greater than non-altruistic HIV positive FSWs, although the difference was not statistically significant given the small sample (p-value=0.12).

While our results are novel and in line with economic theory predictions, our study has several limitations. First, the small size of our sample prevents us from detecting moderate differences in condom use for a few subgroups. In addition to the issue of low statistical power, the small sample size also leads to higher uncertainty in the estimated proportion of condom use for several subgroups. For instance, while we estimate that the condom use by HIV positive FSWs (according to biological markers) is only 5%; this result may be attributable to the small HIV prevalence in our sample. In the treated group of HIV positive FSWs, the average number of true statements was 2.2, while it was 1.7 in the total sample, leading to an underestimation of condom use for this subgroup. When considering the number of true statements in the total sample, list randomisation concludes that condom use is 20 points lower for HIV positive FSWs. Despite the impossibility to investigate the causal effect of HIV status on condom use, our findings confirm that FSWs are an important vector of HIV transmission in Senegal. An important limitation however is that while we assume that clients bear disutility from using condoms, the data did not allow us to investigate the role of client preferences on condom use.

Future research on the use of the list randomisation method to elicit sexual behaviours could be conducted along three axes. First, additional methodological research that would provide guidance regarding the optimal design of list randomisation is required. While the number and choices of non-key items should not affect the results in theory, there is some empirical evidence that the choice of non-key items does matter (Droitcour et al., 1991). Unlike previous papers using list randomisation to elicit condom use (Chong et al., 2013; Jamison et al., 2013; LaBrie and Earleywine, 2000; Walsh and Braithwaite, 2008) and building on the agreement in the recent literature that it is better to select non-key items that relate to the topic of interest (see Imai et al., 2015; Karlan and Zinman, 2012; Wolter and Laier, 2014), our non-key items are related to sex work activity. Second, we showed that results obtained from list randomisation are to some extent imprecise, and, given the implementation challenges when performing a list randomisation, the method is often applied to small samples. When the length of the survey allows it, a double list randomisation where each group serves once as the control group and once as the treated group can increase precision (Glynn, 2013). Finally, future research on condom use measurements should aim to test the validity of the results obtained with list randomisation. This could be performed by asking condom use question to clients in addition to FSWs since clients are less likely to over-report condom use (Wilson et al., 1989) or to compare the results obtained with the list randomisation to results obtained with another indirect elicitation method.

# 9 Conclusion

We implemented list randomisation on FSWs to test if condom use was over-reported. Our results are consistent with the fact that self-reported condom use leads to a large overestimation of condom use, which has direct implications when this measure is used to assess the impact

and the value for money of condom-based interventions. When analysing the determinants of condom use, we provide some alarming evidence on the fact that sexual intercourses most at risk of infection are more likely to be unprotected than safer ones. We also highlight some important factors that affect the decision to engage in unprotected sex. While many of those factors have something to do with a FSW's personality and social norms, and hence are hardly changeable, our results also suggest that a mix of policies that consist of both educating FSWs and clients on the benefits of protected sex and reducing the costs associated with protected sex could be effective to increase condom use.

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# Appendices

## Appendix 1 Techniques eliciting sensitive items

Table A1 presents several techniques aiming at ensuring confidentiality and summarizes the strengths and weaknesses of each of them. We believe that given the low-literacy level of FSWs and the policy relevance of performing a sub-group analysis, the list randomisation methodology was the most appropriate method to estimate misreporting in condom use.

Table A1: Strengths and weaknesses of measurement techniques eliciting sensitive items.

| **Methodology** | **Description** | **Strengths** | **Weaknesses** |
|---|---|---|---|
| List randomisation | Respondents are allocated randomly to two different groups. They are asked on how many of $j$ non-sensitive items (plus one sensitive item) they agree on if they belong to the control group (to the treated group). | - Enumerators do not know with which items respondents agree on<br>- Can be implemented in low-literacy settings<br>- Allows sub-group analysis | - Imprecise results, hence requires large sample<br>- Success depends on the design and on enumerators understanding of the method |
| Ballot box | Respondents fill in a form with no identifier which is then put in a sealed envelope | - Enumerators never ask directly the sensitive question | - Population under study must be literate<br>- Impossibility to perform sub-group analyses |
| Randomised response technique | Respondents use a participant-controlled randomised device not seen by the interviewer. Depending on the outcome of the device, the respondent provides an automatic response or a truthful response | - Enumerators do not know if the response is true or automatic | - Population under study must be literate |
| Diaries | Respondents complete digital diaries on a daily basis about their daily activities including potentially the sensitive behaviour | - No recall bias issue<br>- No face-to-face interview<br>- Insights into event level factors impacting the adoption of the sensitive behaviour | - Population under study must be literate<br>- Need a safe place to hide the diary |
| Qualitative approach | Enumerators spend time with respondents and report the respondent's admission of adopting the sensitive behaviour | - Trust building and time invested by validators should reduce the under-reporting of the sensitive behaviour | - Need to recruit enumerators who can approach respondents and spend time with them without modifying their habits |
| Nominative technique | Respondents are asked to report (i) how many of their close friends adopt the sensitive behaviour of interest, (ii) how many of other close friends of each reported individual who adopt the sensitive behaviour also know about it. This allows calculation of weights that correct for multiple reports of one particular individual. | - Enumerators do not know about whom the incriminated information is being provided | - Response accuracy for the second question is questionable |

## Appendix 2 Verification of the list randomisation hypothesis

Table A2: Tests of randomisation.

| **Variables** | *Observations* | **Control** | **Treated** | **p-value** |
|---|---|---|---|---|
| | *651* | *323* | *328* | |
| ***Socio-demographic characteristics*** | | | | |
| Age (in years) ⋆ | *651* | 35.58 | 36.16 | 0.421 |
| Has the legal age (above 21) | *651* | 96.28 | 97.56 | 0.346 |
| Is divorced ⋆ | *651* | 67.80 | 70.73 | 0.419 |
| Never married ⋆ | *651* | 25.70 | 23.17 | 0.454 |
| Has at least one child | *651* | 86.38 | 89.63 | 0.201 |
| Number of children ⋆ | *651* | 2.53 | 2.50 | 0.813 |
| Age of first child | *573* | 19.16 | 19.12 | 0.905 |
| Menopausal | *642* | 21.70 | 25.62 | 0.244 |
| Use contraceptive methods | *495* | 86.96 | 86.78 | 0.953 |
| Use condoms as contraceptive method | *495* | 52.57 | 49.17 | 0.451 |
| Went to koranic school | *646* | 8.46 | 7.65 | 0.703 |
| Highest level of education achieved ⋆ | *650* | 1.07 | 1.01 | 0.446 |
| Has a regular partner ⋆ | *651* | 46.13 | 41.16 | 0.202 |
| Lives alone | *647* | 16.56 | 16.21 | 0.903 |
| Household size ⋆ | *651* | 6.26 | 6.24 | 0.957 |
| Number of moving out in the past year ⋆ | *651* | 0.235 | 0.332 | 0.392 |
| Dead mother ⋆ | *651* | 30.96 | 36.28 | 0.151 |
| Dead father | *649* | 65.84 | 65.14 | 0.851 |
| Mother lives in Dakar ⋆ | *651* | 52.01 | 49.70 | 0.555 |
| Father lives in Dakar ⋆ | *651* | 19.81 | 22.56 | 0.392 |
| HH monthly expenditures ⋆ | *651* | 358,017 | 349,909 | 0.757 |
| Monthly sex revenues (CFAF) | *649* | 134,498 | 132,299 | 0.821 |
| Perceived wealth (1 to 10) ⋆ | *651* | 3.82 | 3.90 | 0.675 |
| HH members received transfers in the past year | *649* | 27.73 | 25.00 | 0.431 |
| HH members sent transfers in the past year | *647* | 38.87 | 38.11 | 0.843 |
| Altruism for talibe (CFAF) ⋆ | *651* | 266 | 278 | 0.537 |
| Altruism for sex worker (CFAF) ⋆ | *651* | 140 | 131 | 0.601 |
| Risk aversion in general (1 to 10) ⋆ | *651* | 6.31 | 6.19 | 0.579 |
| Risk aversion in sex (1 to 10) ⋆ | *651* | 7.76 | 7.64 | 0.567 |
| Preferences for future (1 to 10) ⋆ | *651* | 6.69 | 6.88 | 0.457 |
| Trust in others | *648* | 82.19 | 81.10 | 0.721 |
| Life satisfaction (1 to 4) ⋆ | *650* | 2.20 | 2.25 | 0.470 |
| Beauty (1 to 10) ⋆ | *651* | 5.81 | 5.80 | 0.930 |
| Health status (0 to 100) ⋆ | *651* | 73.92 | 73.21 | 0.677 |
| Feelings of helplessness (1 to 4) ⋆ | *651* | 3.23 | 3.18 | 0.529 |
| Fear of discrimination due to HIV | *614* | 67.43 | 71.61 | 0.261 |
| Fear of discrimination due to sex work | *633* | 74.52 | 73.67 | 0.807 |
| Family knows about sex work | *641* | 28.39 | 26.85 | 0.664 |
| Feel respected (1 to 10) ⋆ | *651* | 7.63 | 7.37 | 0.148 |
| HIV knowledge (score 0-8) ⋆ | *651* | 6.32 | 6.45 | 0.186 |

Table A2: Tests of randomisation (continued).

| **Variables** | *Observations* | **Control** | **Treated** | **p-value** |
|---|---|---|---|---|
| | *651* | *323* | *328* | |
| ***Sex work activity*** | | | | |
| Work mostly in bars or brothels ⋆ | *651* | 23.84 | 26.83 | 0.381 |
| Work mostly at home ⋆ | *651* | 28.48 | 29.57 | 0.760 |
| Experience in sex work ‡ (in years) | *650* | 7.64 | 8.51 | 0.147 |
| Age at first sexual intercourse ⋆ | *650* | 17.24 | 17.28 | 0.891 |
| Age at first paid sexual intercourse ⋆ | *650* | 27.94 | 27.61 | 0.594 |
| Has only occasional clients ◇ | *645* | 11.32 | 14.98 | 0.170 |
| Has only regular clients ◇ | *645* | 33.02 | 32.42 | 0.871 |
| Last client was occasional ◇ | *645* | 40.37 | 47.68 | 0.062 |
| Declared use of condom with last client | *582* | 97.60 | 96.90 | 0.603 |
| Number of clients within a week ◇ | *648* | 6.49 | 6.56 | 0.893 |
| ***Link with the authorities and the health system*** | | | | |
| Legal sex worker (LSW) ⋆ | *650* | 47.68 | 52.29 | 0.240 |
| LSW since more than one year | *650* | 37.46 | 38.53 | 0.779 |
| Thinks sex work is legal | *610* | 60.30 | 64.22 | 0.315 |
| Police violence in the last 12 months ⋆ | *651* | 6.81 | 7.93 | 0.587 |
| LSW who go to her monthly visits | *269* | 72.87 | 72.86 | 0.998 |
| Has received free condoms ◇ | *641* | 65.41 | 68.73 | 0.372 |
| Is affiliated with a STD centre ◇ | *648* | 72.36 | 74.01 | 0.637 |
| Came to a STD centre in the last month ⋆ | *651* | 56.97 | 56.10 | 0.824 |
| Had an HIV screeng in the past year ⋆ | *651* | 81.11 | 80.18 | 0.764 |
| HIV positive according to medical records | *219* | 4.90 | 6.84 | 0.548 |
| Has got STI symptoms in the last month ◇ | *646* | 20.67 | 23.55 | 0.383 |
| **Test of joint significance** (when considering the variables indicated by ⋆): F(32,612) = 0.63, p-value = 0.947 | | | | |
| **Test of joint significance** (when considering the variables indicated by ⋆ and ◇): F(39,581) = 0.76, p-value = 0.855 | | | | |

*Notes:* ‡ Experience in sex work = age - age at first paid sexual intercourse.

Table A3: Checking floor, ceiling and design effects.

| Estimated Proportions | Source | *Obs.* | Number of reported items 0 | 1 | 2 | 3 | 4 | Sum |
|---|---|---|---|---|---|---|---|---|
| Row 1 | Treatment list | *328* | 0.006 | 0.079 | 0.409 | 0.424 | 0.082 | 1.000 |
| Row 2 | Proportion at least | | 1 | 0.994 | 0.915 | 0.506 | 0.082 | - |
| Row 3 | Control list | *323* | 0.028 | 0.334 | 0.548 | 0.090 | 0 | 1.000 |
| Row 4 | Proportion at least | | 1 | 0.972 | 0.638 | 0.090 | 0 | - |
| Row 5 | Row2 - Row 4 | | 0 | 0.022 | 0.0277 | 0.416 | 0.082 | 0.796 |

*Remark:* The Row 5 = Row 2 - Row 4 gives estimates of the population proportion that would honestly say 'yes' to the sensitive item and 'yes' to exactly $(j-1)$ non sensitive items. The sum of the difference between Row 2 and Row 4 gives the difference-in-means estimator.

## Appendix 3 Robustness checks

Table A4: Robustness checks - Condom use by subgroups.

| | | List randomisation (Panel B) ‡ | | | | | | List randomisation (Panel A) ∓ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Obs* | *Obs if Yes* | Yes | No | Difference | SE | *Obs* | *Obs if Yes* | Yes | No | Difference | SE |
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| $u(s,e)-u(s,p)$ | **Revenue loss:** | | | | | | | | | | | | |
| | Earned more than 12,500 CFAF for the last intercourse | *582* | *293* | 0.668 | 0.890 | -0.221⋆ | 0.122 | *642* | *321* | 0.635 | 0.952 | -0.317⋆⋆⋆ | 0.110 |
| | Beauty ($\geq$ 5 out of 10) | *582* | *461* | 0.726 | 0.970 | -0.244⋆ | 0.147 | *644* | *500* | 0.737 | 0.977 | -0.240⋆ | 0.129 |
| | **Condom price:** | | | | | | | | | | | | |
| | Received free condoms | *573* | *371* | 0.785 | 0.801 | -0.016 | 0.131 | *634* | *424* | 0.776 | 0.850 | -0.074 | 0.119 |
| | **Reduction in sexual pleasure:** | | | | | | | | | | | | |
| | FSWs who declare having no reduction in sexual pleasure with condoms | *572* | *111* | 0.981 | 0.729 | 0.251⋆ | 0.149 | *633* | *124* | 0.919 | 0.759 | 0.160 | 0.132 |
| | **Violence:** | | | | | | | | | | | | |
| | The client negotiated the price | *576* | *309* | 0.768 | 0.815 | -0.047 | 0.123 | *605* | *323* | 0.804 | 0.795 | 0.009 | 0.116 |
| | Violence from a client in the past year | *581* | *150* | 0.844 | 0.751 | 0.093 | 0.127 | *643* | *164* | 0.851 | 0.765 | 0.086 | 0.117 |
| $P$ | **Client at risk of HIV:** | | | | | | | | | | | | |
| | Last client was at risk of HIV | *543* | *39* | 0.888 | 0.747 | 0.140 | 0.233 | *592* | *43* | 0.931 | 0.777 | 0.154 | 0.230 |
| $\pi$ | **Risk taking:** | | | | | | | | | | | | |
| | More than 3 clients a week | *581* | *397* | 0.712 | 0.945 | -0.234⋆ | 0.131 | *642* | *440* | 0.733 | 0.944 | -0.212⋆ | 0.117 |
| | Subjective risk taking in health domain ($\geq$ 8 out of 10) | *582* | *33* | 0.474 | 0.792 | -0.318 | 0.243 | *644* | *35* | 0.583 | 0.801 | -0.218 | 0.210 |
| | Last client was an occasional client | *582* | *266* | 0.717 | 0.838 | -0.121 | 0.123 | *644* | *284* | 0.717 | 0.849 | -0.131 | 0.112 |
| | **HIV and STI knowledge:** | | | | | | | | | | | | |
| | High HIV knowledge ($\geq$ 6 out of 8) | *582* | *460* | 0.831 | 0.574 | 0.257⋆ | 0.151 | *644* | *512* | 0.841 | 0.602 | 0.239⋆ | 0.134 |
| | **Poor trust towards the efficacy of condoms:** | | | | | | | | | | | | |
| | Perceived condoms inefficacious to prevent HIV † | *543* | *125* | 0.495 | 0.829 | -0.334⋆⋆ | 0.162 | *599* | *152* | 0.611 | 0.819 | -0.208 | 0.137 |
| | Agrees with 'One cannot avoid HIV by always using condoms' | *576* | *101* | 0.591 | 0.811 | -0.220 | 0.152 | *633* | *110* | 0.617 | 0.823 | -0.206 | 0.146 |
| $u(i,e)$ | **Social exclusion:** | | | | | | | | | | | | |
| | Was introduced to the sex business by another SW | *582* | *165* | 0.981 | 0.701 | 0.279⋆⋆ | 0.129 | *644* | *172* | 0.959 | 0.735 | 0.224⋆ | 0.119 |
| | Thinks that all girls in the same location use condoms | *322* | *163* | 0.899 | 0.655 | 0.244 | 0.160 | *360* | *189* | 0.955 | 0.673 | 0.282⋆ | 0.148 |
| | Would be ashamed if a neighbour learns about her sex work activity | *579* | *485* | 0.836 | 0.440 | 0.396⋆⋆ | 0.171 | *641* | *540* | 0.848 | 0.468 | 0.380⋆⋆ | 0.153 |
| | Fears that a neighbour who learns about her sex activity will repeat it to others | *578* | *493* | 0.825 | 0.410 | 0.415⋆⋆ | 0.194 | *640* | *547* | 0.837 | 0.469 | 0.367⋆⋆ | 0.174 |
| | **Medical and opportunity cost:** | | | | | | | | | | | | |
| | Thinks that will lose more than 14 days of work if has an STI | *581* | *283* | 0.911 | 0.639 | 0.272⋆⋆ | 0.122 | *641* | *313* | 0.937 | 0.649 | 0.288⋆⋆⋆ | 0.110 |
| | Expects to pay more than 15,000 CFAF in the case of a genital ulcer | *568* | *368* | 0.841 | 0.612 | 0.229⋆ | 0.129 | *627* | *401* | 0.840 | 0.656 | 0.184 | 0.117 |
| | **Quality of life if infected:** | | | | | | | | | | | | |
| | Know ART | *581* | *290* | 0.686 | 0.870 | -0.184 | 0.123 | *640* | *325* | 0.702 | 0.890 | -0.188⋆ | 0.110 |

Table A4: Robustness checks - Condom use by subgroups (continued).

| | | List randomisation (Panel B) ‡ | | | | | | List randomisation (Panel A) ∓ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Obs* | *Obs if Yes* | Yes | No | Difference | SE | *Obs* | *Obs if Yes* | Yes | No | Difference | SE |
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | ((8) | (9) | (10) | (11) | (12) |
| $u(s)$ | **Legal status:** | | | | | | | | | | | | |
| | Registered with authorities | *582* | *271* | 0.846 | 0.723 | 0.123 | 0.122 | *643* | *322* | 0.821 | 0.762 | 0.059 | 0.111 |
| | **Demand for prevention:** | | | | | | | | | | | | |
| | Is affiliated with a health centre | *580* | *416* | 0.830 | 0.649 | 0.181 | 0.141 | *641* | *470* | 0.834 | 0.686 | 0.148 | 0.128 |
| | Does her monthly routine visit | *224* | *156* | 0.871 | 0.705 | 0.166 | 0.204 | *266* | *193* | 0.826 | 0.693 | 0.133 | 0.186 |
| | Visited a health centre in the last 6 months | *582* | *427* | 0.845 | 0.592 | 0.253⋆ | 0.143 | *644* | *484* | 0.842 | 0.638 | 0.204 | 0.129 |
| | Had an HIV screening in the past year | *582* | *464* | 0.786 | 0.745 | 0.041 | 0.161 | *644* | *521* | 0.794 | 0.776 | 0.019 | 0.147 |
| $\delta$ | **Preference for present:** | | | | | | | | | | | | |
| | Agrees with 'Instead of saving I prefer to spend my money today' | *582* | *472* | 0.760 | 0.822 | -0.062 | 0.159 | *644* | *507* | 0.789 | 0.782 | 0.007 | 0.134 |
| | Alcohol or drug consumption during last intercourse | *579* | *41* | 0.400 | 0.804 | -0.405 | 0.248 | *639* | *49* | 0.348 | 0.822 | -0.474⋆⋆ | 0.208 |
| $u(i,p) < u(i,e)$ | **HIV and STI status:** | | | | | | | | | | | | |
| | HIV positive according to medical records (biological test) | *185* | *10* | 0.167 | 0.808 | -0.641 | 0.404 | *216* | *13* | 0.221 | 0.765 | -0.543⋆ | 0.287 |
| | Subjective expectations about being HIV positive ◇ | *521* | *32* | 0.375 | 0.761 | -0.386 | 0.291 | *575* | *38* | 0.479 | 0.769 | -0.290 | 0.267 |
| | Subjective expectations about being STI positive ◇ | *521* | *207* | 0.525 | 0.877 | -0.352⋆⋆⋆ | 0.132 | *576* | *231* | 0.621 | 0.843 | -0.221⋆ | 0.122 |
| $u(v(s))$ | **Altruism:** | | | | | | | | | | | | |
| | Gave more than 40% of the amount received in the dictator game | *582* | *170* | 0.927 | 0.715 | 0.213 | 0.133 | *644* | *187* | 0.954 | 0.723 | 0.231⋆ | 0.124 |

*Notes:* Panel B corresponds to the restricted sample i.e. to respondents who answered to the self-declared condom use question (582 out of 650 FSWs) and Panel A to the full sample.
† Condom inefficacy refers to a subjective probability higher than 80% to be infected after 100 protected intercourses. ◇ Sample is restricted to individuals who understood the subjective probabilities. "*Obs*" reports the total number of respondents for whom we have information on the variable. "*Obs if Yes*" presents the number of respondents who answered "Yes" to the related question. Columns (3) and (9) [Columns (4) and (10)] display the proportion of FSWs who answered "Yes" ["No"] and who used a condom in their last sexual act.
*Reading note:* For the variable 'Registered with authorities', columns (7) to (10) can be read as follows: Among the 643 respondents, 322 of them are registered, 82.1% of legal sex workers used a condom with their last client, 76.2% of illegal sex workers did so.
Columns (5) and (11) correspond to the difference between (3) and (4) and between (9) and (10) respectively. Columns (6) and (12) give the robust standard errors of the estimated difference.
‡ Equation (5): $Y_i = \beta T_i + \gamma S_i + \alpha S_i \times T_i + \varepsilon_i$.
∓ Equation (6): $Y_i = \beta T_i + \gamma S_i + \alpha S_i \times T_i + X_i + \varepsilon_i$. $X_i$ include age, whether the FSW is divorced, whether the FSW lives with or next to her parents, whether last client was an occasional client, whether clients are usually approached in a night club, whether she had last paid sexual intercourse at home, proportion of the last four sexual intercourses for which payment was made after the sex act.
Reported levels of significance are ⋆ p<0.1, ⋆⋆ p<0.05 and ⋆⋆⋆ p<0.01.