Prevalence of Induced Abortion in Iran: A Comparison of Two Indirect Estimation Techniques

CONTEXT: *Surveys that use direct questions to ascertain women's history of induced abortion tend to underestimate abortion prevalence, especially in such contexts as Iran where the procedure is legally restricted and highly stigmatized. No previous study has compared two indirect techniques for estimating abortion prevalence.*

METHODS: *A sample of 708 married women were recruited from one public hospital in Tehran between August and December 2013. Participants completed a survey, which included induced abortion estimation using the randomized response technique (RRT) and the unmatched count technique (UCT), as well as questions about demographic characteristics, trust in direct questions about abortion, and comprehensibility of and trust in RRT and UCT. Prevalence of induced abortion was calculated for each technique. Spearman correlation was used to evaluate whether comprehensibility of and trust in estimation methods were associated with women's age and education.*

RESULTS: *The prevalence of induced abortion was estimated to be 14% using RRT and 12% using UCT; the estimates were not significantly different. Ninety-one percent of women reported that UCT was very easy to comprehend; the proportion for RRT was 78%. Sixty-three percent of women reported completely trusting in the confidentiality of UCT; the proportion for RRT was 50%. Age was inversely associated with comprehensibility for UCT (correlation coefficient, –0.13), and with trust for both RRT and UCT (–0.12 and –0.08, respectively); education was directly associated with trust for both methods (0.24 and 0.22).*

CONCLUSIONS: *Of the two indirect methods, UCT may be simpler and more dependable for the estimation of induced abortion prevalence in low-literacy, abortion-restricted settings.*

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By Marziyeh Ghofrani, Fariba Asghari, Maryam Kashanian, Hojat Zeraati and Akbar Fotouhi

At the time this research was conducted, Marziyeh Ghofrani was a master's student, Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Iran. Hojat Zeraati and Akbar Fotouhi are professors of epidemiology, Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences. Fariba Asghari is associate professor, Medical Ethics Research Center, Tehran University of Medical Sciences. Maryam Kashanian is professor of obstetrics and gynecology, Akbarabadi Hospital, Iran University of Medical Sciences, Tehran.

Induced abortion is used around the world to terminate unwanted pregnancies. In countries where the procedure is legal, women generally have access to safe services and appropriately trained providers;[1] however, in countries where induced abortion is restricted, some women have no recourse but to seek out an unsafe procedure. The World Health Organization defines unsafe abortion as a pregnancy termination performed by someone lacking the necessary skills, in an environment lacking the minimal medical standards, or both.[2] In 2008, an estimated 21.6 million unsafe abortions occurred worldwide—the vast majority (97%) of which took place in developing countries.[3] Such unsafe abortions often lead to short- and long-term complications, and result in an estimated 68,000 maternal deaths annually.[4]

In Iran, induced abortion is illegal, except when necessary to save the life of the woman and in cases of severe fetal abnormality; yet, some women who desire a nontherapeutic induced abortion find a way to terminate their pregnancy. A study by Erfani based on direct interview data from the Tehran Survey of Fertility estimated that the prevalence of abortion among married women aged 15–49 was about 6% in 2014.[5] A meta-analysis of 10 cross-sectional studies that directly asked married Iranian women aged 15–44 about their abortion history found the prevalence of induced abortion to be less than 1%;[6] however, one of the included studies reported a prevalence of 8% among women attending health centers in Ardebil in 2011.[7]

Previous research has shown that induced abortion is often underreported even in societies in which the procedure is not legally restricted,[8] which may be because some people are not comfortable with the subject and may not answer direct survey questions about it honestly. In addition, in Iran and other countries where abortion is severely legally restricted, hospital data are insufficient to provide a reliable estimation of the prevalence of the procedure. Thus, collecting data on sensitive matters such as abortion can be difficult, and indirect estimation methods may be necessary to overcome these problems.[9]

One such indirect estimation method, the randomized response technique (RRT), was first proposed by Warner as a way to increase the likelihood of honest response.[10] In this technique, respondents are asked a question—for example, whether they have ever engaged in a particular sensitive behavior. Before answering, they use a randomization tool (e.g., tossing a coin), which determines whether they answer truthfully or give a prescribed yes or no answer. Thus, the researcher does not know respondents' true

answers, but an estimate of the proportion of respondents who have engaged in the sensitive behavior can be calculated. Given that the RRT technique requires a high level of literacy to comprehend the instructions, Liu et al. proposed a specific randomization tool comprehensible even by individuals who are illiterate.[11] This tool has been used in Turkey[12] and rural areas of Ethiopia[13] to estimate the prevalence of abortion, and the obtained estimates have been much higher than estimates from direct questioning.

However, because RRT requires a randomization tool and the correct use of that tool, other methods have since been developed. The unmatched count technique (UCT) is a method in which some respondents are asked only nonsensitive yes or no questions, while other respondents are asked a sensitive question along with those same nonsensitive questions; respondents do not answer the questions, but instead report only their number of positive responses to those questions. The method—also known as the item-count technique or the list experiment—has been used in different subject areas, such as politics and social studies,[14–16] as well as for the estimation of the prevalence of abortion. According to a study in Liberia by Moseson et al., UCT resulted in an estimation of abortion that was five times higher than that from direct questioning.[17] In contrast, a pilot study conducted by Cowan et al. in the United States found no difference between estimates of abortion prevalence from UCT and direct questioning.[18]

To our knowledge, no study has compared two indirect methods of estimating induced abortion prevalence. In this study, we used both RRT and UCT to estimate the prevalence of induced abortion among a sample of married women in Tehran, Iran, and compared the methods' results and usability.

METHODS

Study Design

For this cross-sectional study, we used convenience sampling to recruit a sample of patients attending the perinatology and gynecology clinics of a public specialized women's hospital in Tehran between August and December 2013. All women presenting to the hospital's perinatology and gynecology clinics during the study period were approached, and those who were married were invited to participate. Overall, 756 women were approached, of whom 731 agreed to participate. Informed consent was obtained from all participants, and interviews were conducted in a private room by one interviewer. The study's protocol was approved by the Ethics Committee of Tehran University of Medical Sciences.

The survey instrument consisted of three sections. In the first, the interviewer verbally asked participants' their age and level of education, as well as a question to measure their level of trust in direct questions about abortion. Specifically, women were asked how many of their relatives and acquaintances who have had an induced abortion would tell the truth about it if asked directly; response options were "almost all," "most," "about half," "some" and "none."

The second and third sections of the questionnaire consisted of estimating participants' lifetime history of induced abortion using RRT and UCT, respectively. For each, the technique was first explained, and if the participant understood the instructions, the technique was conducted to elicit the participant's response. Twenty-three women did not understand either technique and were excluded—a response rate of 94%, which resulted in a sample of 708. Women who were excluded did not differ from women who completed the study in terms of age or education.

After participants completed each method, the interviewer asked them about its comprehensibility and their level of trust in the technique's confidentiality. Comprehensibility was measured by asking women if their relatives, neighbors or friends used the method, how easy would it be for them to understand; response options were "very easy," "easy," "difficult" and "very difficult." Trust was measured by asking participants if their relatives, neighbors or friends used the method, how sure would they be that it would not reveal whether they had had an abortion; response options were "completely," "somewhat" and "not at all."

- *RRT:* For this method, we had participants use the randomization tool designed by Liu.[10] The tool consists of a bottle with a thin neck and a closed orifice. All parts of the bottle except for the neck are covered in a dark cardboard. The bottle contains 50 beads—35 pink (indicating having had an induced abortion) and 15 white (indicating not having had an induced abortion). The body of the bottle is big enough for the beads to mix, but the neck is shaped so it allows only a row of five beads. All beads are the same shape, size and weight, and thus have the same odds of falling into the neck.

The interviewer asked participants to shake the bottle to mix the beads and then hold it upside down to allow five beads to fill the neck. Women were instructed to hold the bottle in such a way that the beads would only be visible to them, and then to say aloud only the number of beads corresponding to their induced abortion status. For example, if a participant had had an induced abortion, she would count the number of pink beads in the neck and report it (without mentioning the color). Therefore, participants would report only a number to the interviewer, and their abortion history—positive or negative—would remain concealed. Each participant repeated the procedure three times.

- *UCT:* Half of participants were randomly selected into the baseline group and were asked a set of three nonsensitive yes or no questions, and the other half were selected into the treatment group and were asked the same nonsensitive questions plus an extra question about whether they had ever had an induced abortion (Table 1). The interviewer read the questions aloud, and instructed participants to keep in mind their number of "yes" responses and report the total after all the questions had been asked.

Because, in this method, the sensitive question is not asked of half of respondents, the power of the study to

TABLE 1. Questions used for unmatched count technique estimation of induced abortion, Tehran, Iran, 2013

Group 1	Group 2
Baseline A	**Baseline B**
Is your house located on the second floor?	Do you have a computer at home?
Do you work?	Are you a housewife?
Do you usually watch TV in the morning?	Did you drink juice yesterday?
Treatment B	**Treatment A**
Do you have a computer at home?	Is your house located on the second floor?
Are you a housewife?	Do you work?
Did you drink juice yesterday?	Do you usually watch TV in the morning?
Have you ever had an induced abortion?	Have you ever had an induced abortion?

estimate the mean would be reduced. To overcome this problem, we used two sets of nonsensitive questions (A and B); women selected into the baseline group for list A were in the treatment group for list B, and vice versa. To account for low literacy among participants, we included only three short nonsensitive questions in each set. To reduce ceiling and floor effects, and to reduce the variance of the estimation, we chose nonsensitive questions in a way that negative correlation between two questions within each list and positive correlation between lists were considered. We conducted a pilot survey among a group of university students to ensure a good distribution of "yes" responses.

Data Analysis

We used descriptive statistics to analyze women's demographic characteristics, trust in direct questions about abortion, and comprehensibility of and trust in each of the estimation methods. Spearman correlation was used to evaluate whether comprehensibility and trust were associated with women's age and education; significance was set at $p<.05$. The calculations of the prevalence of induced abortion and its variance for the two techniques are shown in Appendix 1.

RESULTS

On average, participants were 30 years old; 33% of women were aged 16–25, 47% were 26–35, 15% were 36–45, and 6% were older than 45 (Table 2). Twenty-five percent of women had 1–5 years of education, 20% had 6–8 years, 43% had 9–12 years, and 10% had 13–16 years; about 1% each had zero and more than 16 years of education. Some 16% of participants believed that none of their relatives and acquaintances who have had an induced abortion would tell the truth about it if asked directly; trust in direct questions about abortion had an inverse correlation with age, although weak (correlation coefficient, −0.08; $p<.02$—not shown), and with education (−0.13; $p<.01$).

Of the 708 participants interviewed, 703 completed RRT and 703 completed UCT; 693 women completed both methods. The estimated prevalence of induced abortion among women was 14% using RRT and 12% using UCT (Table 3); the estimates did not differ significantly, although the confidence interval for UCT was somewhat narrower than that for RRT. Abortion prevalence as estimated by RRT generally increased with age, from 7% among 16–25-year-olds to 16–17% among women older than 35 (Table 4), and decreased with increased education, from 16% among those with 0–5 years of education to 11% among those with more than 12 years of education. In comparison, the prevalence of abortion as estimated by UCT also increased with age, although the figure was lowest among 16–25-year-olds (10%) and then fairly similar among all other women (13–15%); however, the UCT estimate tended to increase with increased education, from 6% among women in the two lower education groups to 26% among women in the highest education group. Estimates did not differ significantly by age or education, however, most likely because of the small sample sizes of subgroups.

Seventy-eight percent of women reported that RRT was very easy to comprehend, and another 15% said that it was easy to comprehend (Table 5); in comparison, 91% of women reported that UCT was very easy to comprehend,

TABLE 2. Selected characteristics of married women who participated in the survey, Tehran, Iran, 2013

Characteristic	% (n=708)
Age-group	
16–25	32.6
26–35	46.6
36–45	14.7
>45	6.1
Years of education	
0	1.4
1–5	24.9
6–8	20.6
9–12	42.5
13–16	9.7
>16	0.8
Trust in direct questions about induced abortion*	
Almost all	14.5
Most	21.0
About half	19.6
Some	25.3
None	15.8
No response	3.7
Total	100.0

*Participants were asked how many of their relatives and acquaintances who have had an induced abortion would tell the truth about it if asked directly.

TABLE 3. Estimated prevalence of induced abortion, by estimation method

Method	Trial/list			Mean	95% CI
	First	Second	Third		
RRT (n=703)	14.5 (1.9)	15.3 (1.9)	13.4 (1.9)	14.4 (1.1)	12.1–16.6
UCT (n=703)	14.6 (1.1)	9.1 (1.1)	na	11.9 (0.8)	10.3–13.4

Notes: RRT=randomized response technique. UCT=unmatched count technique. CI=confidence interval. na=not applicable. Figures in parentheses are standard errors.

TABLE 4. Estimated prevalence of induced abortion, by demographic characteristics, according to estimation method

Characteristic	n	RRT	UCT
Age-group			
16–25	231	7.2 (2.1)	9.6 (6.5)
26–35	330	11.1 (1.7)	14.2 (5.5)
36–45	104	16.5 (2.8)	14.8 (6.2)
>45	43	16.4 (4.2)	13.4 (6.7)
Years of education			
0–5	186	15.6 (2.2)	6.0 (6.0)
6–8	146	14.9 (2.2)	5.9 (5.6)
9–12	301	11.7 (1.7)	13.7 (6.0)
>12	75	10.5 (3.5)	25.6 (6.0)

Notes: RRT=randomized response technique. UCT=unmatched count technique. Figures in parentheses are standard errors.

TABLE 5. Percentage distribution of participants, by comprehensibility of and trust in estimation method

Measure	RRT		UCT	
	n	%	n	%
Comprehensibility*				
Very easy	548	78.2	637	91.3
Easy	105	15.0	50	7.2
Difficult	43	6.1	9	1.3
Very difficult	5	0.7	2	0.3
Total	701	100.0	698	100.0
Trust*				
Completely	342	49.3	436	63.2
Somewhat	217	31.3	170	24.6
Not at all	135	19.5	84	12.2
Total	694	100.0	690	100.0

*Distributions differ by method at p<.001. *Notes:* RRT=randomized response technique. UCT=unmatched count technique.

and another 7% said that it was easy to comprehend. Differences in comprehensibility were significant at p<.001. In addition, the proportion of women who reported completely trusting in the confidentiality of UCT was greater than the proportion who reported completely trusting in the confidentiality of RRT (63% vs. 50%). Both methods were significantly correlated with comprehensibility (correlation coefficient, 0.36; p<.001—not shown) and trust (0.47; p<.001). Age was not correlated with comprehensibility for RRT, but showed a significant inverse association with comprehensibility for UCT (−0.13; p<.001). Age was inversely correlated with trust for both RRT (−0.12; p<.01) and UCT (−0.08; p<.03). Education was not associated with comprehensibility for either RRT or UCT, but was correlated with trust for both methods (0.24 and 0.22, respectively; p<.001 for both).

DISCUSSION

To our knowledge, this is the first study to compare the use of RRT and UCT for the estimation of the prevalence of induced abortion. We did not find a statistical difference between the techniques in terms of estimated prevalence; however, the UCT estimate had a narrower confidence interval and, thus, may be more accurate. The methods did differ by comprehensibility and trust. Although almost all women reported that both methods were at least easy to comprehend, a significantly greater proportion reported that UCT was very easy to comprehend; UCT was also more comprehensible by younger women, who had low trust in the direct question method. In addition, women were more likely to completely trust in the confidentiality of UCT. Together, these findings suggests that UCT may be preferable to RRT for estimating abortion among low-literacy populations.

The estimates of the prevalence of induced abortion among Iranian women from the two indirect methods used in this study—14% from RRT and 12% from UCT—are substantially higher than previous estimates from direct questions, and provide more evidence that indirect methods may be superior to direct methods for the estimation of abortion in settings where the procedure is legally restricted. For example, the prevalence of abortion in rural Ethiopia was estimated to be 35% using RRT, compared with less than 1% using direct questioning.[13] Rajapaksa and Perera found that, in Sri Lanka, the direct method resulted in a 31% underreporting of the prevalence of induced abortion as compared with RRT;[19] similarly, Tezcan and Omran found that, in Turkey, direct questioning resulted in an underestimation of 60%.[12] Furthermore, Moseson et al. reported that the estimated prevalence of abortion in Liberia using UCT was five times higher than that using the direct method.[17] Because underreporting of abortion is known to be an issue, especially in countries where the procedure is legally restricted, we believe that abortion prevalence estimates that are higher than those obtained via direct questions are likely to be more valid.

Limitations

This study was limited to patients of one public hospital in Tehran, which hinders the generalizability of its findings in terms of the prevalence of abortion. Given that there are not enough public primary health care facilities to serve the population in Tehran, it is likely that most women who seek gynecological or perinatal care covered by insurance go to a public hospital; thus, women in our sample may have had a lower income than women in the general population. Also, the proportion of participants who were older than 45 years of age (6%) was much lower than this proportion among Tehrani women older than 15 in the National Population and Housing Census (29%).[20] However, our primary goal of the study was the comparison of techniques and not the generalizability of the abortion prevalence estimates.

In addition, the exclusion of women who understood neither of the estimation methods may have reduced the generalizability of findings regarding the comprehensibility of these methods. We did not evaluate the accuracy of participants' understanding of the estimation methods; thus, the responses of those participants who believed either of the methods was difficult might not be reliable. The large standard errors for estimates suggests that the sample size was not adequate to evaluate the correlation between induced abortion prevalence and age or education. Finally, for all participants, the RRT section of the survey preceded

the UCT section; it is possible that this order had a positive effect on the comprehensibility of UCT.

Conclusion

Because there are no direct methods to reach accurate estimates of the prevalence of induced abortion in such settings as Iran where the procedure is legally restricted and highly stigmatized, indirect methods are necessary. According to our comparison of the two indirect estimation techniques, women in our sample had more trust in the confidentiality of UCT, and considered UCT simpler and easier to comprehend. Both UCT and RRT resulted in higher estimates of the prevalence of induced abortion among women in Iran than previous estimates from direct questioning. In addition, the estimates from both were similar, which suggests that they are dependable. More research is needed, however, to assess and compare the accuracy of abortion prevalence estimates from indirect methods.

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RESUMEN

Contexto: *Las encuestas que utilizan preguntas directas para determinar el historial de abortos inducidos de las mujeres tienden a subestimar la prevalencia del aborto, especialmente en contextos como Irán, donde el procedimiento está legalmente restringido y está altamente estigmatizado. Ningún estudio previo ha comparado dos técnicas indirectas para estimar la prevalencia del aborto.*

Métodos: *Entre agosto y diciembre de 2013, en un hospital público en Teherán, se reclutó una muestra de 708 mujeres casadas. Las participantes completaron una encuesta, que incluyó la estimación del aborto inducido mediante la técnica de respuesta aleatoria (RRT) y la técnica de conteo no pareado (UCT), así como preguntas sobre características demográficas, nivel de confianza en preguntas directas sobre el aborto, así como comprensión y confianza en la RRT y la UCT. Se calculó la prevalencia del aborto inducido para cada técnica. Se usó la correlación de Spearman para evaluar si la comprensión y la confianza en los métodos de estimación estaban asociadas con la edad y escolaridad de las mujeres.*

Resultados: *Se estimó que la prevalencia de aborto inducido era del 14% con la RRT y del 12% con la UCT. Las estimaciones no fueron significativamente diferentes. El noventa y uno por ciento de las mujeres informaron que la UCT era muy fácil de comprender; la proporción para la RRT fue del 78%. El sesenta y tres por ciento de las mujeres reportaron confiar completamente en la confidencialidad de la UCT. La proporción para la RRT fue del 50%. La edad se asoció inversamente con la comprensibilidad para la UCT (coeficiente de correlación, −0.13) y con la confianza tanto para la RRT como para la UCT (−0.12 y −0.08, respectivamente); la escolaridad se asoció directamente con la confianza en ambos métodos (0.24 y 0.22).*

Conclusiones: *De los dos métodos indirectos, la UCT puede ser más simple y más confiable para la estimación de la prevalencia del aborto inducido en entornos de baja alfabetización y de aborto restringido.*

RÉSUMÉ

Contexte: *Les enquêtes faisant appel aux questions directes pour évaluer les antécédents d'avortement provoqué des femmes tendent à sous-estimer la prévalence de la pratique, en particulier dans les contextes tels que l'Iran où la procédure est limitée par la loi et fortement stigmatisée. Aucune étude antérieure n'a comparé deux techniques indirectes d'estimation de la prévalence de l'avortement.*

Méthodes: *Un échantillon de 708 femmes mariées a été recruté dans un hôpital public de Téhéran entre août et décembre 2013. Les participantes ont été invitées à répondre à un questionnaire, avec estimation de l'avortement provoqué selon la technique de la réponse aléatoire (RRT) et celle du dénombrement d'items (UCT). Le questionnaire couvrait aussi les caractéristiques démographiques, la confiance à l'égard des questions directes relatives à l'avortement, la compréhensibilité des méthodes RRT et UCT et la confiance à leur égard. La prévalence de l'avortement provoqué a été calculée pour chaque technique. La question de savoir si la compréhensibilité et la confiance relatives aux méthodes d'estimation étaient associées à l'âge et à l'éducation des femmes a été évaluée par corrélation de Spearman.*

Résultats: *La prévalence de l'avortement provoqué a été estimée à 14% selon la technique RRT et à 12% selon la méthode UCT, soit une différence non significative. Quatre-vingt-onze pour cent des femmes ont déclaré la technique UCT très facile à comprendre; la proportion correspondante était de 78% pour la technique RRT. Soixante-trois pour cent des femmes ont indiqué avoir pleine confiance en la confidentialité de la méthode UCT; cette proportion était de 50% pour la technique RRT. L'âge s'est avéré inversement associé à la compréhensibilité pour la technique UCT (coefficient de corrélation, −0,13) et à la confiance pour les deux techniques (−0,12 pour RRT et −0,08 pour UTC); l'éducation s'est révélée directement associée à la confiance pour les deux méthodes (0,24 et 0,22).*

Conclusions: *Des deux méthodes indirectes, la technique UCT peut être plus simple et plus fiable pour l'estimation de la prévalence de l'avortement provoqué dans les contextes à faible niveau d'alphabétisation sujets à restriction de l'avortement.*

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Author contact: *fasghari@tums.ac.ir*

APPENDIX 1. Calculations of the prevalence of induced abortion, by method

RANDOMIZED RESPONSE TECHNIQUE

To assess the mean prevalence of induced abortion and its variance, we used the following formula, for which π signifies the proportion of participants with a history of abortion, Z the mean reported number of beads, p the proportion of pink beads in bottle (0.7) and K the number of beads in bottleneck in each experiment (5):

$$\overline{\pi}_A = \frac{\hat{z} - (1 - \mathrm{p})}{(2p - 1)}$$

$$\hat{z} = \frac{z_1 + z_2 + z_3 + \ldots + z_n}{kn}$$

$$\overline{\pi}_A = (\overline{\pi}_{A1} + \overline{\pi}_{A2} + \overline{\pi}_{A3}) / 3$$

$$Var\left(\overline{\pi}_A\right) = \frac{P(1-p)}{3Kn(2p-1)^2}$$

Participants repeated the experiment three times, and the estimated prevalence was the average of the three.

UNMATCHED COUNT TECHNIQUE

The difference between baseline and treatment groups in the mean number of "yes" responses was used to estimate the prevalence of the sensitive question (i.e., abortion history). There were two baseline groups and two treatment groups (A and B), and the sensitive question was in one of the lists randomly for each person.

$$\tilde{y}_{Aik} = \begin{cases} 1 & \textit{if individual i would honestly say yes to item k on the A list} \\ 0 & \textit{if individual i would honestly say no to item k on the A list} \end{cases}$$

$$\tilde{y}_{Bik} = \begin{cases} 1 & \textit{if individual i would honestly say yes to item k on the B list} \\ 0 & \textit{if individual i would honestly say no to item k on the B list} \end{cases}$$

Because of the similar sample size for both groups and because the sensitive question was the same in both lists, $y_{Aik} = y_{Bik}$ for all participants, and the sum of sensitive and nonsensitive questions in both groups was as follows:

$$\tilde{y}^K_{Ai+} = \sum_{K=1}^{K} \tilde{y}_{Aik} \quad \tilde{y}^{K-1}_{Ai+} = \sum_{K=1}^{K-1} \tilde{y}_{Aik}$$

$$\tilde{y}^K_{Bi+} = \sum_{K=1}^{K} \tilde{y}_{Bik} \quad \tilde{y}^{K-1}_{Bi+} = \sum_{K=1}^{K-1} \tilde{y}_{Bik}$$

The prevalence of the abortion in each group was estimated as:

$$\hat{\pi}^A_K = \frac{1}{n_2} \sum_{i=n_1+1}^{n} \tilde{y}^K_{Ai+} - \frac{1}{n_1} \sum_{i=1}^{n_1} \tilde{y}^{K-1}_{Ai+}$$

$$\hat{\pi}^B_K = \frac{1}{n_1} \sum_{i=1}^{n_1} \tilde{y}^K_{Bi+} - \frac{1}{n_2} \sum_{i=1+n_1}^{n_2} \tilde{y}^{K-1}_{Bi+}$$

Since both groups answered the sensitive question, the estimated prevalence was the average of the two. The following formula was applied to calculate the variance of the estimate:

$$\mathrm{var}(\mathcal{P}) = \frac{1}{\mathrm{n}} \left\{ \begin{array}{c} \mathrm{V}\left[\tilde{y}^{K-1}_{Ai+}\right] + \mathrm{V}\left[\tilde{y}^{K-1}_{Bi+}\right] + \frac{1}{2}\left(\mathrm{V}\left[\tilde{y}_{Aik}\right] + \mathrm{V}\left[\tilde{y}_{Bik}\right]\right) \\ -2\ \mathrm{Cov}\left[\tilde{y}^{K-1}_{Ai+}, \tilde{y}^{K-1}_{Bi+}\right] \end{array} \right\}$$

$$+ \frac{1}{\mathrm{n}}\left(\mathrm{Cov}\left[\tilde{y}_{Aik}, \tilde{y}^{K-1}_{Ai+}\right] - \mathrm{Cov}\left[\tilde{y}_{Bik}, \tilde{y}^{K-1}_{Ai+}\right]\right)$$

$$+ \frac{1}{\mathrm{n}}\left(\mathrm{Cov}\left[\tilde{y}_{Bik}, \tilde{y}^{K-1}_{Bi+}\right] - \mathrm{Cov}\left[\tilde{y}_{Aik}, \tilde{y}^{K-1}_{Bi+}\right]\right)$$