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Exploring the determinants of unsafe abortion: improving the evidence base in Mexico

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Background Despite the realized importance of unsafe abortion as a global health problem, reliable data are difficult to obtain, especially in countries where abortion is illegal. Estimates for most developing countries are based on limited and incomplete sources of data. In Mexico, studies have been undertaken to improve estimates of induced abortion but the determinants of unsafe abortion have not been explored.

Methods We analysed data from the 2006 Mexican National Demographic Survey. The sample comprises 14 859 reported pregnancies in women between 15 and 55 years old, of which 966 report having had an abortion in the 5 years preceding the survey. We use logistic regression to explore the relationship between unsafe abortion and various socio-economic and demographic characteristics.

Findings We estimate that 44% of abortions have been induced and 16.5% of those were unsafe. We find three variables to be positively and significantly associated with the probability of having an induced abortion: (1) whether the woman reported that the pregnancy was mistimed (OR = 4.5, 95% CI = 1.95–10.95); (2) whether the woman reported that the pregnancy was unwanted (OR = 2.86, 95% CI = −1.40–5.88); and (3) if the woman had three or more children at the time of the abortion (OR = 3.73, 95% CI = 1.20–11.65). There is a steep socio-economic gradient in the probability of having an unsafe abortion: poorer women are more likely to have an unsafe abortion than richer women (OR = 2.48, 95% CI = 1.09–5.63); women with 6–9 years of education (OR = 0.30, 95% CI = 0.11–0.81) and with more than 13 years of education are less likely to have an unsafe abortion (OR = 0.065, 95% CI = 0.01–0.43), and women with indigenous origin are more likely to have an unsafe abortion (OR = 5.44, 95% CI = 1.91–15.51). Thus, the probability for poor women with less than 5 years of education and indigenous origin is nine times higher compared with rich, educated and not indigenous women. We also find marked geographical inequities as women living in the poorest states have a higher risk of having an unsafe abortion.

Interpretation This analysis has explored the determinants of unsafe abortion and has demonstrated that there are large socio-economic and geographical inequities in unsafe abortions in Mexico. Further efforts are required to improve the measurement and monitoring of trends in unsafe abortions in developing countries.

Keywords Unsafe abortion, socio-economic inequalities, inequities, maternal health, Mexico

KEY MESSAGES

- This paper quantifies for the first time the large socio-economic and geographical inequities in unsafe abortions in Mexico.
- The burden of unsafe abortions is disproportionately born by poor, less educated and indigenous women. Women living in the poorest states have a higher risk of having an unsafe abortion.

Background

The critical relationship between unsafe abortion and the attainment of the Millenium Development Goals (MDGs) has been highlighted in recent studies (Fathalla *et al*. 2006; Glasier *et al*. 2006; Grimes *et al*. 2006; Ronsmans and Graham 2006). Reducing unsafe abortions and the complications resulting from them is not only closely linked to the health-related MDGs, such as the reduction of maternal mortality, but also to the MDGs related to other aspects of development, including poverty reduction, gender equality and women's empowerment. Monitoring trends in unsafe abortion practices as well as sharing countries' experience on policies and interventions that have been successful in reducing unsafe abortions is crucial, as the half-way point towards achieving the MDGs has been reached.

It is estimated that 22% of all pregnancies worldwide end in an induced abortion—approximately 50 million each year around the year 2000 (Guttmacher Institute 1999). About 20 million of these abortions are estimated to be performed in unsafe conditions, and almost all of them (97%) take place in developing countries (Henshaw *et al*. 1999). The number of women who die from an unsafe abortion each year is estimated to be 68 000, accounting for 13% of all maternal deaths around the world, and 17% in Latin America (World Health Organization 2004; Khan 2005), with a median unsafe abortion mortality ratio of 34 per 100 000 live births in countries where abortion is illegal (Berer 2004).

In Mexico, induced abortion is illegal. In some states abortion is legal when a woman has been raped, her life or health are in danger, or when there are foetal defects, and under request within the first 12 weeks of pregnancy in the Federal District (where abortion was recently legalized) (GIRE 2005; Organo del Gobierno del Distrito Federal 2007). However, even in those circumstances, access to safe abortion is not guaranteed, as doctors in public facilities can refuse to perform the procedure (Human Rights Watch 2006). According to government statistics, abortion-related complications in public hospitals are the third most common cause of hospitalization among women of reproductive age and account for 7.3% of all maternal deaths (Secretaria de Salud 2002b; Secretaria de Salud 2004).

Reducing maternal mortality and morbidity in Mexico has been a priority for the government in recent years. Unsafe abortion and its complications have been acknowledged as an important public health problem, but reliable data to monitor and evaluate its effects are difficult to obtain. Previous studies in Mexico used indirect methods to estimate the number of abortions, varying between 110 000 (CONAPO 1996) and 533 000 in 1990 (Henshaw *et al*. 1999). However, such indirect methods have been criticized for suffering from measurement error (Reinis 1992). Other studies in Mexico using population-based surveys (Nunez and Palma 1994; Lara *et al*. 2006a) are considered as a better source of information to study the incidence and prevalence of induced abortion (Lara *et al*. 2004; Lara *et al*. 2006a). The most recent study estimated a prevalence rate of induced abortion of 16.3% for women between 15 and 55 years old for 2005 (Lara *et al*. 2006a). Although these studies further explore and identify the characteristics of women who have had an induced abortion in Mexico, they do not provide information on the place and safety of the procedure or on the characteristics of women who had unsafe abortions.

In 2006, the National Demographic Survey (ENADID) included questions on abortions as part of the pregnancy calendar. This is the first time that a population-based survey in Mexico has included direct questions about abortion. Information was collected for the most recent abortion reported for each respondent on the type of provider, facility and technique, and whether the pregnancy was wanted or not. Information was also collected on the socio-economic and demographic characteristics of the respondent. In this paper we explore the ENADID survey to identify the determinants of unsafe abortion.

Methods

Data

Data for this study come from the ENADID survey (*Encuesta Nacional de Dinamica Demografica* which was conducted in 2006 (INEGI 2006). ENADID is an interviewer-administered household survey which is representative at state level. It is designed to collect detailed information on women aged between 15 and 55 years on social and demographic characteristics, child health and a range of reproductive health issues, including family planning, fertility, contraceptive knowledge and use. In addition, it collects information on household characteristics, including ownership of consumer goods, household services and place of residence.

In the women's questionnaire, respondents who have ever been pregnant were asked to report on all their pregnancies. For each pregnancy, women were asked to provide information on whether it ended in an abortion (defined in this survey as pregnancy termination up to 5 months of gestation), the date of abortion and the gestational age at the time of the abortion. Women who reported having had an abortion were asked more detailed questions on the most recent abortion. Respondents were asked: (1) if the abortion was a mistimed or unwanted birth, (2) whether the abortion was spontaneous, induced by medication, induced by injection or other procedure, (3) the

type of provider who performed the abortion (doctor, nurse, auxiliary worker, traditional birth attendant, the respondent herself or other) and (4) the facility where the abortion was performed (social security, public or private clinic or hospital, traditional birth attendant's residence or in the respondent's home). The survey did not collect information on the reason for the termination of the pregnancy or on the use of contraception methods during the cycle of conception.

The total sample is 38 661 women between 15 and 55 years old. We limited the analysis to women who reported having an abortion during the 5 years preceding the survey to avoid recall bias problems with reporting on events that happened in the distant past.

Of the 14 859 reported pregnancies in the last 5 years in women 15–55 years old, 999 ended in abortion and had complete information on the socio-economic and demographic characteristics used in the analysis. Among these 999 abortions, 966 were identified as the most recent abortion, which entails that the difference (of 33 abortions) represents women with more than one abortion. Figure 1 shows the flow diagram of information.

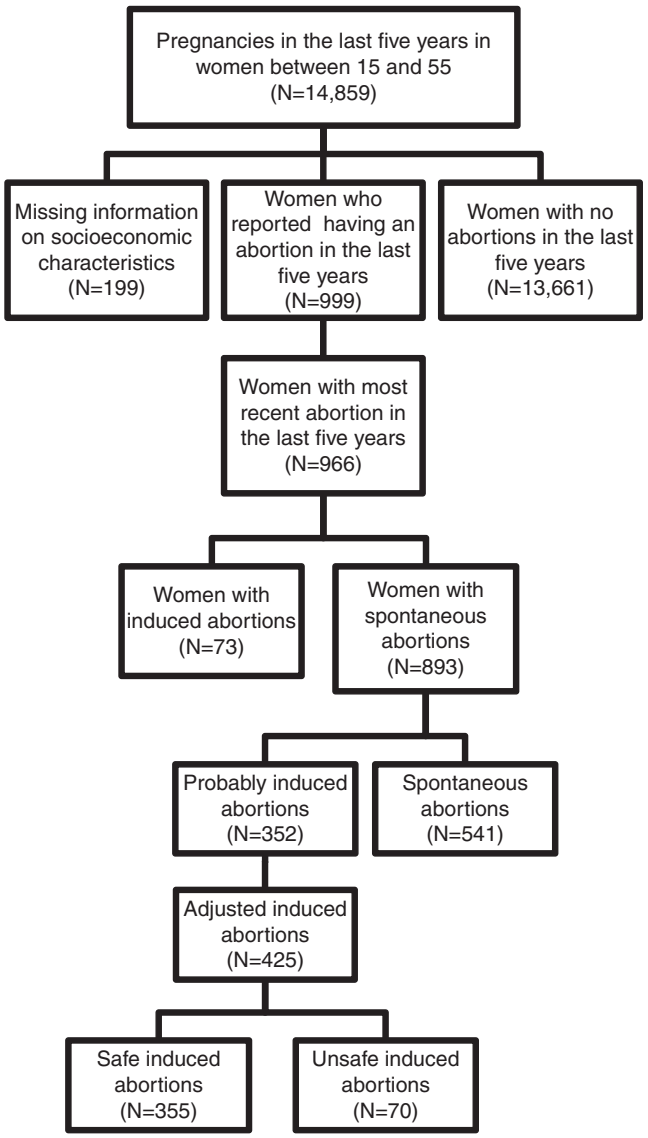

Figure 1 Flow diagram of information.

Definition of unsafe abortions

Unsafe abortions are characterized by the lack or inadequacy of skills of the provider, hazardous techniques and/or unsanitary facilities (World Health Organization 1994). WHO defines an unsafe abortion as a 'procedure for terminating an unintended/unwanted pregnancy either by individuals without the necessary skills or in an environment that does not conform to minimum medical standards, or both' (World Health Organization 1992). The types of health worker that have the necessary skills vary according to the medical and legal standards of each country. In Mexico only doctors are formally trained to perform abortions and to deal with the complications of incomplete abortions.

Using the WHO definition, we classified an induced abortion as unsafe if it was performed by an unskilled provider (the woman herself, a traditional birth attendant, an auxiliary worker, nurse or provider other than a doctor) and/or if it was performed in an unsanitary facility (the woman's home, the traditional birth attendant's home or other) and/or if it was performed using a hazardous technique (caused by an ingestion of a harmful substance, voluntary trauma or injury by fall) (Guttmacher Institute 1999). Induced abortions performed in public facilities were classified as safe as there is no information to verify if these were abortions attempted elsewhere in which complications ensued and which then ended up being treated in public facilities.

Analysis

We compared the distribution of pregnancy losses by gestation age at termination of pregnancy in our sample with the distribution in the study by Shapiro and colleagues (Shapiro *et al*. 1962). They found, as did several other studies, that most of the intrauterine mortality happened in the first weeks of gestation (Shapiro *et al*. 1962; Leridon 1977; Wilcox *et al*. 1981). In general, we found in our sample a larger concentration of abortions in the third and fourth month of gestation, between 7% and 12% more abortions than Shapiro *et al*. We argue that these differences are probably due to misreporting of induced abortions.

Under-reporting and misreporting of induced abortions is common in countries where abortion is illegal. In a study of 118 women who reported a spontaneous abortion in Merida, Mexico, 77% later admitted that the abortion had been induced (Canto de Cetina *et al*. 1985). Several strategies have been used in previous studies to identify abortions that have likely been induced, although there is no gold standard method (Talamanca and Repetto 1988; Magnani *et al*. 1996; World Health Organization 1996; Rasch *et al*. 2000). WHO proposed a classification scheme for categorizing hospitalized cases of abortion (World Health Organization 1996) and Magnani *et al*. proposed a scheme for classifying abortions that are reported in DHS calendar information (Magnani *et al*. 1996). According to the WHO classification, certainly induced abortions are those the woman herself reports having been induced (World Health Organization 1996). The corrected number of

induced abortion is the sum of the certain cases of induced abortions plus the cases considered to be probably induced.

In this analysis we used two logistic regression models. The first model was used to identify the suspected cases of induced abortions that were reported as spontaneous abortions. The second model was used to estimate the probability of having an unsafe abortion among the adjusted number of induced abortions.

In the first model, we explored the probability of having an induced abortion among all abortions (spontaneous and induced) using a logistic regression. The explanatory variables were age at the time of the abortion, number of children at the time of the abortion, whether the pregnancy was wanted, mistimed or unwanted, whether this abortion was the first one the woman had ever had, gestational age and marital status. We additionally considered as covariates in our analysis whether the household was poor or not (defined through a measurement of household wealth explained in the Appendix), urban or rural residence, years of education and indigenous origin.

We used the variables that were significantly positively associated with the probability of having an induced abortion in the first model to reclassify some of the reported spontaneous abortions as probably induced abortions. The adjusted numbers of induced abortions is therefore the sum of the reported cases of induced abortions and the probably induced abortions (identified in the first regression model).

In a second model, we explored the determinants of unsafe abortion among the adjusted number of induced abortions also using logistic regression. The explanatory variables in the model were whether the household was poor or not, urban/rural residence, years of education, indigenous origin, age at the time of the abortion, marital status, number of children at the time of the abortion and whether this abortion was the first one the woman had ever had. Based on the results of this logistic regression model and using Clarify (a software program for data simulation), we predicted the probability of having an unsafe abortion and the uncertainty around it, and examined trends among determinants of interest (King *et al*. 2000; Tomz *et al*. 2003).

Table 1 shows the indicators used in this analysis, the corresponding sample sizes from the ENADID (see also Figure 1 for a flow diagram of information) and the survey questions used.

The analyses in this paper were conducted using STATA (version 9.2) (StataCorp. 2005) and are presented in the following section.

Results

Table 2 shows the numbers and percentages of women aged 15–55 with pregnancies in the last 5 years, women who reported an abortion in the last 5 years, women who reported a most recent abortion in the last 5 years, women who reported an induced abortion and the adjusted number of induced abortions by socio-economic and demographic characteristics.

Table 1 Indicators of abortion, induced abortion and unsafe abortion as used in this study. The survey questions used as well as the sample sizes are shown

Term	Survey questions	Population	Population 'at risk'
Abortion	5.4. Have you ever been pregnant? (1) yes, (2) no. *If 'yes':* 5.17 Have you ever had an abortion? (1) yes, (2) no.	999 women who report having an abortion in the 5 years preceding the survey.	14 859 pregnant women 15–55 years old.
Reported induced abortions	6.8 Was the most recent abortion: (1) spontaneous, (2) induced by medication, (3) induced by injection, or (4) induced by other procedure, such as curettage, injury, voluntary trauma, ingestion of a harmful substance.	73 women reported having an induced abortion (response 2, 3 or 4 to question 6.8).	966 most recent abortions in the 5 years preceding the survey.
Corrected induced abortion	6.8 Was the abortion: (1) spontaneous, (2) induced by medication, (3) induced by injection, or (4) induced by other procedure, such as curettage, injury, voluntary trauma, ingestion of a harmful substance. 6.7 Was the terminated pregnancy: (1) planned, (2) mistimed or (3) unwanted.	425 women—sum of the reported induced abortions (response 2, 3 or 4 to question 6.8) plus the probably induced abortions, which are all those spontaneous abortions for which the pregnancy is reported as mistimed or unwanted (response 2 or 3 to question 6.7) or the women had more than three children at the time of the abortion.	966 most recent abortions in the 5 years preceding the survey.
Unsafe abortion	6.9. Who attended the abortion: (1) doctor, (2) nurse, (3) auxiliary worker, (4) traditional birth attendants, (5) yourself, or (6) other. 6.10. What type of facility was the abortion performed in: (1) social security hospital or clinic, (2) public hospital or clinic, (3) private hospital or clinic, (4) traditional birth atendant's home, (5) woman's home, or (6) other. 6.8 Was the abortion: (1) spontaneous, (2) induced by medication, (3) induced by injection, or (4) induced by other procedure, such as curettage, injury, voluntary trauma, ingestion of a harmful substance.	70 women with induced abortion (corrected estimate) who had an unsafe abortion. Unsafe is defined as: abortions performed by unskilled providers (response 2, 3, 4, 5 or 6 to question 6.9); and/or abortions performed in unsanitary facilities (response 4, 5 or 6 to question 6.10.); and/or using hazardous techniques (response 4 to question 6.8).	425 induced abortions (adjusted estimate).

Table 2 Numbers and percentages of all women aged 15–55 years with pregnancies in the last 5 years, women who reported an abortion in the last 5 years, women who reported an induced abortion, and adjusted women with induced abortion by socio-economic and demographic characteristics

Variable name	Pregnancies in last 5 years in women aged 15–55[a]		Women who reported having an abortion in last 5 years		Women who reported having most recent abortion in last 5 years		Women who reported having an induced abortion in last 5 years		Adjusted women with induced abortion in last 5 years[b]	
	Sample	%	Sample	%	Sample	%	Sample	%	Sample	%
Economic status										
Non-poor	6741	46.0	537	53.8	522	54.0	50	68.5	229	53.9
Poor	7919	54.0	462	46.3	444	46.0	23	31.5	196	46.1
Education										
≤5 years	2688	18.3	145	14.5	135	14.0	10	13.7	80	18.8
6–9 years	7792	53.2	518	51.9	494	51.1	39	53.4	230	54.1
10–12 years	2843	19.4	227	22.7	221	22.9	12	16.4	74	17.4
≥13 years	1337	9.1	109	10.9	116	12.0	12	16.4	41	9.7
Age group (at time of abortion)										
15–19 years	898	6.1	160	15.9	144	14.7	13	17.8	55	12.9
20–24 years	3476	23.5	211	21.0	205	21.0	13	17.8	67	15.8
25–34 years	7513	50.8	447	44.5	448	45.8	39	52.1	193	45.4
35–55 years	2888	19.5	187	18.6	181	18.5	9	12.3	110	25.9
Marital status										
Married	12 730	86.8	886	88.7	862	89.2	64	87.7	368	86.6
Single, divorced, widowed	1930	13.2	113	11.3	104	10.8	9	12.3	57	13.4
No. of children (at time of abortion)										
0	132	0.9	299	29.9	280	29.0	17	23.3	62	14.6
1	3424	23.4	278	27.8	264	27.3	21	28.8	82	19.3
2	4740	32.3	234	23.4	232	24.0	19	26.0	91	21.4
≥3	6364	43.4	188	18.8	190	19.7	16	21.9	190	44.7
Planned pregnancy										
Wanted	–	–	–	–	679	70.3	39	53.4	–	–
Mistimed	–	–	–	–	88	9.1	10	13.7	–	–
Unwanted	–	–	–	–	199	20.6	24	32.9	–	–
Months of pregnancy										
1	–	–	161	16.1	152	15.7	11	15.1	69	16.2
2	–	–	325	32.5	318	32.9	33	45.2	136	32.0
3	–	–	348	34.8	333	34.5	19	26.0	135	31.8
≥4	–	–	165	16.5	163	16.9	10	13.7	85	20.0
No. of abortions										
>1	–	–	308	30.8	215	22.3	21	28.8	96	22.6
1	–	–	691	69.2	751	77.7	52	71.2	329	77.4
Indigenous population										
Not indigenous	13 491	92.0	942	94.3	913	94.5	70	95.9	397	93.4
Indigenous	1169	8.0	57	5.7	53	5.5	3	4.1	28	6.6
Area of residence										
Rural area	4597	31.4	283	28.3	265	27.4	12	16.4	109	25.7
Urban area	10 063	68.6	716	71.7	701	72.6	61	83.6	316	74.4
Total sample	14 859		999		966		73		425	

[a]The variables of age group and number of children are information reported at the time of the survey.

[b]Adjusted number includes reported induced abortions and predicted induced abortions based on the logistic regression model shown in Table 3.

In our sample 6.5% of women aged between 15 and 55 years who had been pregnant reported having an abortion in the last 5 years.

Out of 966 women who reported having had an abortion in the past 5 years, 7.6% (73 cases) reported that their most recent abortion was induced. Table 3 shows the first logistic regression model to estimate the probability of having an induced abortion among all abortions. After controlling for other socio-economic characteristics, the probability of having an induced abortion is significantly related to whether the woman reported that the pregnancy was mistimed or unwanted, and if the woman had three or more children at the time of the abortion. Abortions in pregnancies that were mistimed are 4.5 times more likely to be induced compared with abortions in wanted pregnancies (OR = 4.5, 95% CI = 1.95–10.95); pregnancies that were unwanted are almost 3 times more likely to be induced compared with abortions in wanted pregnancies (OR = 2.86, 95% CI = −1.40–5.88); and abortions in women with three or more children are almost 4 times more likely to be induced compared with women with no children at the time of the abortion (OR = 3.73, 95% CI = 1.20–11.65).

Table 3 also shows that socio-economic status and years of education were negatively and significantly associated with the probability of reporting an abortion as induced. Poorer women are 58% less likely to have an induced abortion than richer women (OR = 0.42, 95% CI = 0.19–0.92). Similarly, women with 10–12 years of education are 72% less likely to have an induced abortion than women with no years of education (OR = 0.28, 95% CI = 0.09–0.88).

Based on the results of this regression model, we reclassified abortions as 'probably induced' if they were reported to be spontaneous and the pregnancy was reported as mistimed or unwanted or if the women had more than three children at the time of the abortion. From the 893 cases reported as spontaneous abortions, 39% (352 cases) were reclassified as probably induced. We created a measurem of adjusted numbers of induced abortions as the sum of the reported cases of induced abortions (73 cases) and probably induced abortions (352 cases). Then the adjusted number of induced abortions is estimated to be 425, which represents 44% of all abortions. Consistent with our findings, a recent study in Peru, where abortion is also illegal, found that 53% of all abortions were induced (Bernabe-Ortiz *et al*. 2009). Subsequent analyses referring to induced abortions use the adjusted estimate.

In our sample, 16.5% (70 cases) of induced abortions (425 cases) were identified as unsafe. Among unsafe abortions, 23% (16) employed hazardous techniques and 77% (54) took place in facilities considered as unsafe and/or were performed by unskilled providers.

Figure 2 shows the proportion of induced abortions (425 cases) performed by unskilled providers by gestation age at termination of pregnancy. About half of the abortions performed by unskilled personnel during the first 4 months of pregnancy are reported to have been done by the respondent herself. Abortions performed by unskilled personnel are most prevalent in the first 4 months of pregnancy. The fewer induced abortions during the fifth month of pregnancy (4.5%) were all performed by a traditional birth attendant.

Table 3 Logistic regression results on the probability of reporting an abortion as induced, among women who report having had an abortion (966 women)

Variable name	Odds ratio	95% CI
Economic status		
Non-poor (ref)	1.000	
Poor	0.416*	0.19–0.92
Education		
<5 years (ref)	1.000	
6–9 years	0.422	0.15–1.23
10–12 years	0.278*	0.09–0.88
≥13 years	0.744	0.24–2.35
Age group (at time of abortion)		
15–19 years	1.734	0.56–5.37
20–24 years (ref)	1.000	
25–34 years	1.095	0.43–2.77
35–55 years	0.385	0.10–1.45
Marital status		
Married (ref)	1.000	
Single, divorced, widow	0.770	0.34–1.74
No. of children (at time of abortion)		
0 (ref)	1.000	
1	1.839	0.71–4.78
2	2.054	0.73–5.76
≥3	3.738*	1.20–11.65
No. of abortions		
>1 (ref)	1.000	
1	0.650	0.32–1.32
Planned pregnancy		
Wanted (ref)	1.000	
Mistimed	4.520***	1.95–10.45
Unwanted	2.867**	1.40–5.88
Months of pregnancy		
1 (ref)	1.000	
2	1.472	0.60–3.62
3	0.877	0.33–2.29
≥4	0.961	0.34–2.73
Indigenous population		
Not indigenous (ref)	1.000	
Indigenous	0.265	0.05–1.30
Area of residence		
Rural area (ref)	1.000	
Urban area	1.904	0.78–4.67
Sample	966	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
(ref) = reference group.

Table 4 shows the logistic regression results for the probability of having an unsafe abortion among induced abortions (425 cases). Three factors appeared to be significantly related to the probability of having an unsafe abortion: whether the household was poor, the woman's years of education and

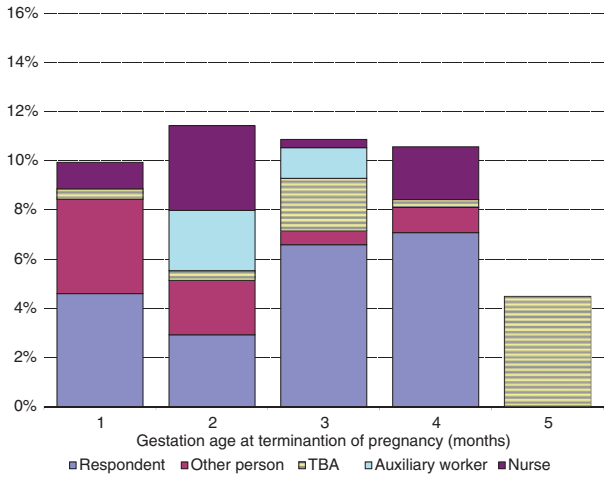

Figure 2 Proportions of abortions performed by unskilled providers by month of pregnancy (sample 425 induced abortions). The height of the bar corresponds to the total proportion of abortions performed by unskilled providers. The different colours show the proportion performed by the respondent herself, a traditional birth attendant, an auxiliary worker, nurse or another person.

the woman's indigenous origin. Poorer women are 2.5 times more likely to have an unsafe abortion than richer women (OR = 2.48, 95% CI = 1.09–5.63). In general, there is a negative gradient in the likelihood of having an unsafe abortion across categories of educational attainment. Women with 6–9 years of education are 70% less likely to have an unsafe abortion than women with no years of education (OR = 0.30, 95% CI = 0.11–0.81). Women with more than 13 years of education are 93.5% less likely to have an unsafe abortion than women with no years of education (OR = 0.065, 95% CI = 0.01–0.43). However, there was no significant association for the group of women with 10–12 years of education. Women of indigenous origin are 5 times more likely to have an unsafe abortion than non-indigenous women (OR = 5.44, 95% CI = 1.91–15.51). It is interesting to note that the age at the time of abortion, marital status, number of children at the time of the abortion, number of abortions, gestational age and urban/rural residence were not significantly associated with an increased probability of having an unsafe abortion.

We predicted the probability of having an unsafe abortion by the level of deprivation for each state (see the Appendix for a description on the level of deprivation of Mexican states). We found that states with a high deprivation index (poorest states) have a higher probability of having unsafe abortions (around 22%) compared with states with a low deprivation index (richer states, with a probability of around 15%); these differences are statistically significant. At the same time, we found that highly deprived states have the highest proportion of women who have had sex and have never used modern contraceptive methods (27%) or heard about them (9%).

The coefficients of the logistic regression model shown in Table 4 were used to estimate probabilities of having an unsafe abortion for subgroups of women in the population. Table 5 shows that, all else being equal, the probability of having an unsafe abortion for poor women with indigenous origin who have less than 5 years of education is 9 times higher compared with non-poor, not indigenous, educated women. The results in Table 5 also imply that among poor indigenous women, those with more than 5 years of education have a lower probability of having an unsafe abortion than those who have less than 5 years of education.

Table 4 Logistic regression results on the probability of having an unsafe abortion among women with an induced abortion (425 women)

Variable name	Odds ratio	95% CI
Economic status		
Non-poor (ref)	1.000	
Poor	2.479*	1.09–5.63
Education		
<5 years (ref)	1.000	
6–9 years	0.303*	0.11–0.81
10–12 years	0.854	0.24–3.08
≥13 years	0.065**	0.01–0.43
Age group (at time of abortion)		
15–19 years	2.191	0.73–6.55
20–24 years (ref)	1.000	
25–34 years	1.483	0.54–4.11
35–55 years	1.243	0.36–4.29
Marital status		
Married (ref)	1.000	
Single, divorced, widow	0.580	0.21–1.62
No. of children (at time of abortion)		
0 (ref)	1.000	
1	1.582	0.53–4.71
2	2.198	0.61–7.89
≥3	1.054	0.26–4.33
No. of abortions		
>1 (ref)	1.000	
1	1.695	0.71–4.03
Months of pregnancy		
1 (ref)	1.000	
2	1.277	0.48–3.37
3	0.807	0.30–2.19
≥4	1.095	0.38–3.12
Indigenous population		
Not indigenous (ref)	1.000	
Indigenous	5.444**	1.91–15.51
Area of residence		
Rural area (ref)	1.000	
Urban area	0.790	0.33–1.88
Sample	425	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
(ref) = reference group.

Discussion

This analysis demonstrates that the most significant determinant of having an induced abortion is whether the pregnancy

Table 5 Probability (and 95% uncertainty intervals) of having an unsafe abortion by indigenous origin, poverty and years of education (probabilities are predicted based on the results of the logistic regression presented in Table 4)

	Indigenous		**Not indigenous**	
	Poor	Non-poor	Poor	Non-poor
Less than 5 years of education	0.72 (0.49–0.89)	0.57 (0.28–0.83)	0.35 (0.18–0.55)	0.21 (0.09–0.36)
More than 5 years of education	0.47 (0.24–0.72)	0.32 (0.12–0.57)	0.15 (0.08–0.23)	0.08 (0.05–0.12)

was wanted/mistimed or not and whether the women had three or more children at the time of the abortion. Consistent with our findings Lara *et al*. found that, in Mexico, women who had unwanted pregnancies are more likely to have induced abortions (Lara *et al*. 2006a). They also found that growing up in a city and having not yet given birth are significantly and positively associated with the probability of having an induced abortion. However, we found that, as in the USA, women who have more children are more likely to have an induced abortion (Boonstra *et al*. 2006).

We found that unsafe abortions are significantly associated with lower economic status, a woman's indigenous origin and years of education. This is also consistent with other studies of countries where abortion is illegal. For example, in the USA, when abortion was illegal, poor and minority women were exposed to unsafe procedures while women with financial resources were able to afford safe procedures (Boonstra *et al*. 2006).

Our results imply that there is poor access to effective family planning methods in Mexico. This might be due to lack of knowledge, misuse or failure of the contraceptive methods, or because of economic and other barriers that impede women from preventing unwanted pregnancies. As a result, and in combination with the fact that abortion is illegal in Mexico, women demand clandestine services. This illegal market of services contributes to socio-economic inequalities, as well-off women have the ability to seek and pay for safe abortions while disadvantaged women are exposed to unsafe procedures and the long-term consequences related to them (Sousa 2001).

The Mexican government has invested in several efforts to improve maternal services in the past 10 years, including the *Program for the Extension of Coverage* (PAC), *Oportunidades* and *Fair Start in Life* (*Arranque parejo en la vida*) (Secretaria de Salud 2002a). However, further efforts are required to ensure that all women of reproductive age know of and have access to modern contraceptive methods. This analysis shows that women living in the poorest states have a much higher risk of having an unsafe abortion and at the same time have less knowledge and use of modern contraceptive methods.

In parallel, efforts are required to provide access to safe abortion services to reduce the burden resulting from unsafe procedures. There is an urgent need to eliminate the institutional and legal barriers to provide safe abortion services for all women, and especially for victims of rape (Human Rights Watch 2006). Efforts are required to educate the population on the availability of abortion services as 54% of all Mexicans are unaware that abortion is legal in some circumstances, including rape (Becker *et al*. 2002). In addition, mid-level health professionals should be trained to provide abortion and post-abortion services (World Health Organization 2003; Chong and Mattar 2006; Warriner *et al*. 2006). By increasing the number of skilled providers, the barrier imposed by doctors who refuse to provide abortion services would be reduced (Human Rights Watch 2006). In Mexico, among health providers who report that they believe that public health systems should offer abortion services for legal indications, few of them would agree to personally provide the service (Gonzales de Leon and Billings 2001).

In April 2007, induced abortions in Mexico City were legalized within the first 12 weeks of pregnancy (Organo del Gobierno del Distrito Federal 2007). It is therefore likely that the rate of induced abortions will increase in Mexico City, as women will now report abortions that before were hidden because of their illegality. The probability of having an unsafe abortion is likely to decrease as it has been found that in countries where abortion is legal, procedures are more likely to be safe, whereas in countries where it is illegal, procedures are more likely to be performed in unsafe conditions (Jewkes *et al*. 2005). However, unless women have information on the possibility of having a safe abortion, it is unlikely that poor, uneducated women will immediately profit from the accessibility of safe abortion services. This argument is supported by our findings, which show that a large proportion of women still have never heard about contraception methods. We also found that indigenous women, who are concentrated in rural areas, are more likely to have unsafe abortions. The gains in the safety of the procedures attained in Mexico City will be undermined by unsafe procedures that will still occur in the rest of the country where abortion is still illegal.

As in the USA where liberalization of abortion laws occurred in some states (Boonstra *et al*. 2006), women seeking an abortion will travel to Mexico City to get a safer procedure. Several consequences will emerge from this: (1) only women with enough financial resources will be able to travel to obtain a safe abortion; (2) the travel from faraway states will delay obtaining the abortion which will therefore increase the risk of complications due to higher gestational weeks; (3) for some women the timing will be determinant as they may pass over the gestational week limit for having a legal abortion; and (4) women who will travel are at higher risk of not receiving proper follow-up and care if a complication arises while returning to their state of residence.

Legalizing abortion is an important step towards reducing the burden of unsafe abortion, but on its own it is not sufficient. As has been shown in India, where abortion is legal, the burden due to unsafe abortion is not reduced unless the provision of services is scaled up to guarantee access to safe abortion for all women (Grimes *et al*. 2006). Worldwide 48% of all induced abortions are unsafe, in developed regions 92% of abortions are safe, while in developing countries 55% are unsafe (Sedgh *et al*. 2007).

In this study, we used the WHO classification of unsafe abortion. The limitation of using this classification is that all abortions performed by unskilled providers are defined as unsafe regardless of the procedure. There is increasing evidence that the use of drugs such as misoprostol to perform an abortion is very common in most Latin American countries where abortion is illegal (Misago *et al*. 1998; IPAS 2005; Miller *et al*. 2005; Sherris *et al*. 2005; Lara *et al*. 2006b). For example, in Brazil, misoprostol was used in 66% of induced abortions (Misago *et al*. 1998). Several reasons have contributed to increase the use of misoprostol to perform medical abortions: (1) it is known to be an effective self-induced abortifacient and it has been associated with a high reduction in abortion-related mortality (Miller *et al*. 2005; Harper *et al*. 2007; Moreno-Ruiz *et al*. 2007); (2) it is an inexpensive drug; (3) it generally does not require prescription; and (4) it is normally available at the pharmacy (Misago *et al*. 1998; Miller *et al*. 2005; Sherris *et al*. 2005; Lara *et al*. 2006b). It is therefore likely that many of the self-induced abortions and the abortions performed by a nurse or another person reported in ENADID were induced with misoprostol and misclassified as unsafe according to the WHO classification. Nevertheless, we would like to point out that although the WHO classification is likely to misclassify self-induced abortions as unsafe, further research should be conducted to obtain more detailed information on the use of misoprostol. It has been found that, in Latin America, a large proportion of women, pharmacy staff and providers know neither the recommended dosing regimen of misoprostol to make it an effective abortifacient nor the complications or side effects that could arise from using it (Misago *et al*. 1998; Miller *et al*. 2005; Sherris *et al*. 2005; Lara *et al*. 2006b).

The limitations of this study should be taken into account when interpreting the findings. ENADID is a survey that was not specifically designed to collect data on abortion, so only limited information is available. It would be beneficial to also have information on the reasons why an abortion was sought, whether any complications arose from it, and other important factors. Only women who reported ever being pregnant were asked questions on abortions. Women might be reluctant to report having had an abortion in a face-to-face interview because of the illegality of abortion in Mexico. Further, ENADID is a cross-sectional survey that relies on retrospective data, so it is susceptible to recall bias as past abortions may tend to be reported less frequently than recent ones. We tried to mitigate this problem by using the last 5 years of the survey.

In a face-to-face interview, under-reporting of abortions (either induced or spontaneous) is common among women of certain socio-economic characteristics regardless of the legal status of abortion. In the USA, for example, poor, Hispanic and black women are less likely to report an abortion (Jones and Kost 2007). In our study, we analysed data from a face-to-face survey collecting information on pregnancy histories. It is therefore likely that our study suffers from problems of under-reporting. This is likely to affect the magnitude of unsafe abortions among certain groups of the population, such as single women or women in rural areas, categories for which we did not find a significant association with the probability of having an unsafe abortion. Nevertheless, we did find significant and positive associations with the probability of having an unsafe abortion among women who are expected to report fewer abortions, such as poor, indigenous and uneducated women.

Although our results do not show that teenage women (in our sample 15–19 years old) are at highest risk for unsafe abortions, we found that 42.5% of women in this age group who have had sex have never used modern contraceptive methods and 8% have never heard of them. Therefore further research should be undertaken focusing on women between 15 and 19 years old regarding their exposure to unwanted pregnancies, practice and use of contraceptive methods, and exposure to unsafe abortion as we believe they are at high risk for unsafe abortions.

Despite the limitations associated with survey data, this analysis has highlighted some critical issues for maternal health and the links with other central factors in development, such as poverty, women's empowerment and education. In countries like Mexico, where abortion is illegal, the practice of abortion is still ongoing, with the consequences of unsafe abortion being disproportionately born by poor, indigenous and less educated women. Continuing efforts to monitor maternal health, and especially abortion and contraceptive use, will be critical in the coming years.

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References

Becker D, Garcia S, Larsen U. 2002. Knowledge and opinion about abortion law among Mexican youth. *International Family Planning Perspectives* **28**: 205–13.

Berer M. 2004. National laws and unsafe abortion: the parameters of change. *Reproductive Health Matters* **12**(Suppl.):1–8.

Bernabe-Ortiz A, White PJ, Carcamo CP *et al.* 2009. Clandestine induced abortion: prevalence, incidence and risk factors among women in a Latin American country. *Canadian Medical Association Journal* **180**: 298–304.

Boonstra HD, Benson GR, Richards LC, Finer BL. 2006. *Abortion in Women's Lives*. New York: Guttmacher Institute.

Canto de Cetina TE, Colven CE, Hernandez Cano JM, Vera GL. 1985. [Incomplete abortion: characteristics of the patients treated in the O'Horan Hospital of Merida, Yucatan]. *Salúd Pública de México* **27**: 507–13.

Chong YS, Mattar CN. 2006. Mid-level providers: a safe solution for unsafe abortion. *The Lancet* **368**: 1939–40.

CONAPO. 1996. *Indicadores Basicos de Salud Reproductiva y Planificacion Familiar*. Mexico City: Consejo Nacional de Poblacion.

CONAPO. 2006. *Indice de Marginacion 2005*. Mexico City: Consejo Nacional de Poblacion.

Fathalla MF, Sinding SW, Rosenfield A, Fathalla MM. 2006. Sexual and reproductive health for all: a call for action. *The Lancet* **368**: 2095–100.

Ferguson B, Tandon A, Gakidou E, Murray CJL. 2003. Estimating permanent income using indicator variables. In: Murray CJL,

Evans DB (eds). *Health System Performance Assessment: Debates, Methods, and Empiricism*. Geneva: World Health Organization.

Gakidou E, Lozano R, Gonzalez-Pier E *et al.* 2006. Assessing the effect of the 2001-06 Mexican health reform: an interim report card. *The Lancet* **368**: 1920–935.

GIRE. 2005. Leyes del aborto en Mexico. Mexico City: Grupo de Informacion en Reproduccion Elegida. Online at: http://www.gire.org.mx/.

Glasier A, Gulmezoglu AM, Schmid GP, Moreno CG, Van Look PF. 2006. Sexual and reproductive health: a matter of life and death. *The Lancet* **368**: 1595–607.

Gonzales de Leon DA, Billings DL. 2001. Attitudes towards abortion among medical trainees in Mexico City public hospitals. *Gender and Development* **9**: 87.

Grimes DA, Benson J, Singh S *et al.* 2006. Unsafe abortion: the preventable pandemic. *The Lancet* **368**: 1908–19.

Guttmacher Institute. 1999. *Sharing Responsibility: Women, Society and Abortion Worldwide*. New York: The Alan Guttmacher Institute.

Harper CC, Blanchard K, Grossman D, Henderson JT, Darney PD. 2007. Reducing maternal mortality due to elective abortion: potential impact of misoprostol in low-resource settings. *International Journal of Gynecology & Obstetrics* **98**: 66–9.

Henshaw SK, Singh S, Haas T. 1999. The incidence of abortion worldwide. *International Family Planning Perspectives* **25**(Suppl.):S30–8.

Human Rights Watch. 2006. *The Second Assault: Obstructing Access to Legal Abortion After Rape in Mexico*. New York: Human Rights Watch. Online at: http://www.hrw.org/en/reports/2006/03/06/mexico-second-assault.

INEGI. 2006. Encuesta Nacional de Dinamica Demografica. Instituto Nacional de Estadistica. Mexico: Geografia e Informatica.

IPAS. 2005. *El Aborto Con Medicamentos en America Latina. Las Experiencias de Las Mujeres en Mexico, Colombia, Ecuador y Peru*. Chapel Hill: IPAS.

Jewkes R, Rees H, Dickson K *et al*. (2005). The impact of age on the epidemiology of incomplete abortion in South Africa after legislative change. *BJOG* **112**: 355–9. Cited in Guttmacher Institute. 2009. *Facts on Induced Abortion Worldwide: Worldwide Incidence and Trends*. Online at: http://www.guttmacher.org/pubs/fb_IAW.html.

Jones RK, Kost K. 2007. Underreporting of induced and spontaneous abortion in the United States: an analysis of the 2002 national survey of family growth. *Studies in Family Planning* **38**: 187–97.

Khan S. 2005. Abortion: a major contributor to maternal ill health. *Journal of the Pakistan Medical Association* **55**: 269.

King G, Tomz M, Wittenberg J. 2000. Making the most of statistical analyses: improving interpretation and presentation. *American Journal of Political Science* **44**: 347–61.

Lara D, Garcia S, Ellerston C, Camlin C, Suarez J. 2006a. The measure of induced abortion levels in Mexico using random response technique. *Sociological Methods Research* **35**: 279–301.

Lara D, Strickler J, Olavarrieta C, Ellerston C. 2004. Measuring induced abortion in Mexico: a comparison of four methodologies. *Sociological Methods Research* **32**: 529.

Lara D, Abuabara K, Grossman D, Diaz-Olavarrieta C. 2006b. Pharmacy provision of medical abortifacients in a Latin American city. *Contraception* **74**: 394–9.

Leridon H. 1977. *Human Fertility: The Basic Component*. Chicago: University of Chicago Press.

Magnani RJ, Rutenberg N, McCann HG. 1996. Detecting induced abortions from reports of pregnancy terminations in DHS calendar data. *Studies in Family Planning* **27**: 36–43.

Miller S, Lehman T, Campbell M *et al.* 2005. Misoprostol and declining abortion-related morbidity in Santo Domingo, Dominican Republic: a temporal association. *BJOG* **112**: 1291–6.

Misago C, Fonseca W, Correia L, Fernandes LM, Campbell O. 1998. Determinants of abortion among women admitted to hospitals in Fortaleza, North Eastern Brazil. *International Journal of Epidemiology* **27**: 833–9.

Moreno-Ruiz NL, Borgatta L, Yanow S *et al.* 2007. Alternatives to mifepristone for early medical abortion. *International Journal of Gynecology & Obstetrics* **96**: 212–8.

Nunez L, Palma Y. 1994. El aborto en cifras. In: Ortiz A (ed.). *Razones y Psaiones en Torno al Aborto*. Mexico City: EDAMEX, pp. 154–8.

Organo del Gobierno del Distrito Federal. 2007. *Gaceta Oficial del Distrito Federal*. Mexico.

Pongou R, Salomon JA, Ezzati M. 2006. Health impacts of macroeconomic crises and policies: determinants of variation in childhood malnutrition trends in Cameroon. *International Journal of Epidemiology* **35**: 648–56.

Rasch V, Muhammad H, Urassa E, Bergstrom S. 2000. Self-reports of induced abortion: an empathetic setting can improve the quality of data. *American Journal of Public Health* **90**: 1141–4.

Reinis K. 1992. The impact of the proximate determinants of fertility: evaluating Bongaart's and Hobcraft and Little's methods of estimation. *Population Studies* **46**: 309–26.

Ronsmans C, Graham WJ. 2006. Maternal mortality: who, when, where, and why. *The Lancet* **368**: 1189–200.

Secretaria de Salud. 2002a. Panorama epidemiologico de la mortalidad materna en Mexico. *Epidemiologia* **19**: 13.

Secretaria de Salud. 2002b. *Panorma General Secretaria de Salud*. Mexico City: Secretaria de Salud.

Secretaria de Salud. 2004. *Sistema de Egresos Hospitalarios*. Mexico City: Secretaria de Salud.

Sedgh G, Henshaw SK, Singh S, Bankole A, Drescher J. 2007. Legal abortion worldwide: Incidence and recent trends. *International Family Planning Perspectives* **33**: 106–16.

Shapiro S, Jones WE, Densen MP. 1962. A life table of pregnancy terminations and correlates of fetal loss. *Milbank Memorial Fund Quarterly* **40**: 7–45.

Sherris J, Bingham A, Burns MA *et al.* 2005. Misoprostol use in developing countries: results from a multicountry study. *International Journal of Gynecology & Obstetrics* **88**: 76–81.

Sousa A. 2001. Los costos sociales del aborto clandestino. In: Espionza A (ed.). *Calidoscopio del Aborto*. Mexico City: DEMAC.

StataCorp. 2005. Stata Statistical Software [Release 9]. College Station, TX: StataCorp LP.

Talamanca FI, Repetto F. 1988. Correcting spontaneous abortion rates for the presence of induced abortion. *American Journal of Public Health* **78**: 40.

Tomz M, Wittenberg J, King G. 2003. CLARIFY: Software for interpreting and presenting statistical results [Version 2.1]. USA: Stanford University, University of Wisconsin, and Harvard University.

Vapattanawong P, Hogan MC, Hanvoravongchai P *et al.* 2007. Reductions in child mortality levels and inequalities in Thailand: analysis of two censuses. *The Lancet* **369**: 850–5.

Warriner IK, Meirik O, Hoffman M *et al.* 2006. Rates of complication in first-trimester manual vacuum aspiration abortion done by doctors and mid-level providers in South Africa and Vietnam: a randomized controlled equivalence trial. *The Lancet* **368**: 1965–72.

Wilcox AJ, Treloar AE, Sandler DP. 1981. Spontaneous abortion over time: comparing occurrence in two cohorts of women a generation apart. *American Journal of Epidemiology* **114**: 548–53.

World Health Organization. 1992. *The Prevention and Management of Unsafe Abortion. Report of a Technical Working Group*. Geneva: World Health Organization.

World Health Organization. 1994. *Abortion: A Tabulation of Available Data on the Frequency and Mortality of Unsafe Abortion*. Geneva: World Health Organization.

World Health Organization. 1996. *Studying Unsafe Abortion: A Practical Guide for Programme Managers*. Geneva: World Health Organization.

World Health Organization. 2003. *Safe Abortion: Technical and Policy Guidance for Health Systems*. Geneva: World Health Organization.

World Health Organization. 2004. *Unsafe Abortion: Global and Regional Estimates of Incidence of Unsafe Abortion and Associated Mortality in 2000*. 4th edition. Geneva: World Health Organization.

Appendix

Definition of household wealth index

The measure of household wealth was calculated using a hierarchical probit model with a Bayesian adjustment, developed by Ferguson and colleagues and applied previously in other studies (Ferguson *et al*. 2003; Gakidou *et al*. 2006; Pongou *et al*. 2006; Vapattanawong *et al*. 2007). In this model, wealth is estimated using information on predictors of economic status (such as age and education of the household head, urban/rural residence), and indicators of economic status, primarily consumer goods (such as ownership of televisions, cars, radios) as well as household services (such as source of drinking water or type of toilet). The following 19 indicators of wealth are available in ENADID: type of housing material (roof and wall), type of sanitary facilities, type of water, type of drainage, type of fuel used for cooking, whether the kitchen is a separate room in the house, room density, electricity, television, VCR, mixer, refrigerator, washing machine, stove, heater, car, fixed-line telephone, mobile telephone, and computer. These indicators were used to estimate an index of household wealth and households were subsequently assigned to a wealth quintile. Poor households were defined as belonging to the bottom two quintiles.

Definition of deprivation index

Data on the level of deprivation of Mexican states come from the National Population Council (CONAPO 2006). The level of deprivation is an index estimated for communities and is based on various indicators of economic development including: the proportion of the population living in households without electricity, piped water inside the residence, and sewerage; the proportion living in households with earth floors; the proportion of the adult population who earn less than twice the minimum wage, and the proportion who have not completed primary school; the proportion of the population who live in communities with less than 5000 inhabitants; and, housing density (number of rooms per people). States are classified into five categories ranging from high to low levels of deprivation.