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Risk Factor Analysis of Peri-neonatal Mortality in Rural Guatemala[1]

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Peri-neonatal mortality is a serious health problem in Guatemala, especially in rural areas where most deliveries occur at home and are overseen by traditional birth attendants (TBAs) who function in the role of midwives. The three aims of the work reported here were to identify important predictors of peri-neonatal mortality within a rural area of Guatemala; to assess the effects of traditional and modern health care providers on such mortality; and to find ways of identifying high-risk women who might benefit from transfer to a hospital or clinic.

For these purposes a case-control study was conducted of 120 women in the rural department of Quetzaltenango who had lost their babies from the 20th week of pregnancy through the 28th day of life. These women and 120 controls were interviewed in their homes by trained physicians, using questionnaires in Spanish or the appropriate Indian dialect, and the results were analyzed through a series of statistical tests.

It was found that the complications of pregnancy and delivery with the greatest statistical significance were prematurity, malpresentation, and prolonged labor. Population-based attributable risks of these complications demonstrated that they accounted for significant proportions of the observed peri-neonatal mortality. While these conditions cannot be eliminated, within the rural Guatemalan context it appears that early referral of women with these complications to more specialized care settings could result in improved delivery outcomes.

Infant mortality is a serious health problem in Guatemala. The estimated rate of infant mortality is approximately 73 deaths per 1 000 live births, with higher rates occurring in the rural highlands (*1*, *2*). At least 31% of all infant deaths occur within the first 28 days of life, with actual percentages being as high as 50% if stillbirths are also included (*3*).

There is limited information about the causes of neonatal mortality within Guatemala. One study (*4*) identified intrapartum asphyxia, birth trauma, prematurity, and neonatal sepsis as principal causes of neonatal death. This same report determined that the following significant risk factors were associated with neonatal death: maternal illiteracy, nulliparity, short inter-birth intervals, and the use of traditional as opposed to modern medical care. It also suggested that the administration of oxytocin and multiple vaginal examinations during labor were associated with increased perinatal mortality.

Most births in Guatemala occur in the mother's home because of limited health

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resource availability. Only 20% of all births can be accommodated within hospitals, and this situation is not expected to change in the near future (*5*). Home births are generally managed by traditional birth attendants (TBAs), who attend approximately 70% of all deliveries and over 90% in certain areas of the rural highlands.

Traditional birth attendants are women, usually from the community, who function in the role of midwives. Their principal duty is to assist mothers during childbirth, but they may also provide some limited prenatal care. TBAs usually have little if any formal medical training and lack a defined position within the medical community (*6*).

In situations without obstetric complications, TBAs effectively perform home deliveries. However, when complications occur they may not have the necessary skills to manage the delivery. In the latter situation, the transfer of a woman in labor to a clinic or local hospital may be the safest alternative.

The purpose of the study reported here was threefold: (a) to identify important predictors of peri-neonatal mortality within a rural area of Guatemala; (b) to determine the effect of the health care provider (traditional versus modern) on peri-neonatal mortality; (c) to select predictors of peri-neonatal mortality in the traditional birthing setting that can be used as a basis for identifying women who may benefit from transfer to hospitals or clinics.

The use of risk assessment as a basis of obstetric program interventions has not always been effective within rural populations. While interventions based on identification of risk factors for the population as a whole (e.g., syphilis or tetanus) have met with some success (*7, 8*), the success of those based on identification of individuals with specific risk factors has been more problematic. The difficulties encountered have been attributed both to the unpredictable nature of obstetric emergencies and to the over-identification of many at-risk women (*9, 10*). These latter false positives can potentially overwhelm limited health care facilities with unnecessary referrals. Thus, it is necessary to focus on those risk factors that are strongly associated with poor peri-neonatal outcome and to use variables with a high population attributable risk percent to identify women for transfer to modern care (*11*).

METHODS

A case-control study was conducted in Quetzaltenango, a rural department in the Guatemalan Highlands. Cases were obtained through a random sample of all peri-neonatal deaths (defined as deaths from the 20th week of pregnancy through the 28th day after birth) recorded in the civil registry between August 1988 and July 1989. Controls were identified as the next registered birth after the study case in which the infant lived for at least 28 days. A total of 120 cases and 120 controls were selected. The response rate was greater than 99%.

Mothers were interviewed in their homes by trained physicians from February 1990 through June 1990 (1.5–2 years after the mother's baby was born). Interviews were conducted in either Spanish or the appropriate Indian dialect. Information was obtained on demographic factors, obstetric history, prenatal events, and management of pregnancy and delivery. Each questionnaire was reviewed by a physician, who assigned the probable cause of death to the case.

Univariate analysis of variables was initially performed in SAS (*12*). Chi-square tests were used for dichotomous variables, except where Fisher's exact test was indicated for small cell frequencies (*13*). T-tests were used for continuous variables. Categorization of continuous variables was based on existing literature or logical break-points in the data. Logistic regression was performed on variables statistically associated with peri-neonatal mortality using the LOGIT module in SYSTAT for model construction and goodness of fit testing (*14*).

Two analyses were performed, the first identifying predictors of peri-neonatal mortality and the second comparing baseline characteristics between women who elected traditional versus modern care. In addition, population-based attributable risk percentages were estimated for predictors of mortality to identify which risk factors accounted for a significant proportion of the peri-neonatal mortality in the community.

RESULTS

The distribution of the 120 cases was analyzed according to the time of death. In 14% of the cases the subject was stillborn and died prior to the onset of labor. Approximately 42% of the subjects died at delivery or in the first 24 hours after birth. Death through the first week of life accounted for an additional 29% of the total. Approximately 15% of the deaths occurred from day 8 through day 28.

The 120 cases were also categorized according to the following general causes of death: asphyxia, sepsis, prematurity, and other. The most common cause was sepsis (34%), followed by asphyxia (25%), prematurity (20%), and other (4%). No cause of death could be assigned in 17% of the cases, predominantly those stillbirths occurring prior to the onset of labor.

Sociodemographic variables, obstetric history, prenatal and delivery events, and patient management factors were examined in univariate analyses to determine significant predictors of mortality. Table 1 presents the results of univariate analysis of the sociodemographic variables, mother's obstetric history, and prenatal and delivery factors. Where there are missing data, the number of respondents is indicated.

Previous studies have identified increased risk for both younger and older mothers (*15, 16*). Consequently, three maternal age categories were considered (<18 yrs, 18–34 yrs, and >34 yrs); however, no statistically significant differences were identified in this study. The marital status variable compared women married or living with a partner to those who were single, separated, or divorced. A statistically significant association was found, with control mothers being more likely to be married than case mothers; but the number of unmarried women was extremely small. Both literacy and socioeconomic status were significantly lower in case mothers than in control mothers. Because no information was available on the income of study population members, socioeconomic status was defined in terms of dwelling quality (see the first footnote in Table 1).

Previous studies have identified higher risks for primigravidas and women with many prior pregnancies (*15*). As a result, the study mothers were classified into three groups (no previous pregnancies, 1–5 previous pregnancies, and >5 previous pregnancies); however, the univariate analysis did not show parity to be a significant predictor of peri-neonatal mortality. Of the obstetric history events, only one variable was found to be statistically significant, this being the death of a prior child. In contrast, a number of pregnancy and delivery factors were found to be strongly significant predictors—with a second pregnancy in 12 months, premature delivery, prolonged labor, and malpresentation all being associated with increased mortality.

Complications of labor and delivery—such as a prolapsed body part, a prolapsed cord, the presence of meconium, and hemorrhage—were associated with

Table 1. Univariate analysis of sociodemographic and obstetric characteristics of cases and controls.

Variable	Cases	Controls	p-value	Odds ratio (95% CI)
Maternal age (n = 235):			0.402	
<18 years	7 (6%)	3 (3%)		2.59 (0.6, 10.4)
18–34 years	84 (71%)	88 (76%)		1.00
>34 years	28 (24%)	25 (22%)		1.35 (0.7, 2.5)
Marital status (n = 239):			0.025	
Married	107 (89%)	115 (97%)		1.00
Single	13 (11%)	4 (3%)		0.28 (0.1, 0.9)
Literacy (n = 240):			0.005	
Reads	25 (21%)	45 (38%)		1.00
Reads a little	16 (13%)	20 (17%)		1.38 (0.6, 3.1)
Unable to read	79 (66%)	55 (46%)		2.6 (1.4, 4.8)
*Low SES (n = 238)**	77 (65%)	58 (48%)	0.008	2.00 (1.2, 3.4)
Parity (n = 240):			0.234	
0 (primipara)	22 (18%)	21 (18%)		1.15 (0.6, 2.3)
1–5	58 (48%)	70 (58%)		1.00
>5	40 (33%)	29 (24%)		1.55 (0.8, 2.9)
Obstetric history (n = 197):†				
Prior miscarriage	21 (21%)	17 (17%)	0.449	1.40 (0.7, 2.8)
Prior stillborn	15 (15%)	11 (11%)	0.384	1.45 (0.6, 3.6)
Prior child death	53 (54%)	35 (35%)	0.008	2.01 (1.1, 3.6)
Prior preterm	10 (10%)	7 (7%)	0.434	1.49 (0.5, 4.6)
Pregnancy and delivery factors:				
2nd pregnancy in <12 months (n = 184)	37 (32%)	23 (20%)	0.028	2.01 (1.1, 3.6)
Premature delivery (n = 240) (<9 months)	32 (27%)	5 (4%)	0.000	7.47 (2.8, 20.2)
Prolonged labor (n = 239) (>12 hrs)	33 (28%)	11 (9%)	0.000	3.55 (1.6, 7.7)
Malpresentation (n = 239)‡	28 (24%)	4 (3%)	0.000	7.74 (2.6, 23.1)

*SES is based upon type of floor, number of rooms in the house, and presence of electricity. It is dichotomized into two levels, low and medium.
†Analysis limited to women with a prior pregnancy.
‡Includes both breech and transverse presentations.

increased risk of mortality but were not statistically significant due to the small numbers of such events observed. No women indicated that their membranes ruptured more than 24 hours before delivery. Of those women whose membranes ruptured before labor (n = 31), a t-test on the number of hours that the membranes were ruptured indicated that the effect was not statistically significant (p = 0.75).

Regarding illnesses, the numbers of women identified with a history of tuberculosis, diabetes, hypertension, or epilepsy were extremely small, and no estimations of risk could be made. Also, no complications of pregnancy such as infectious diseases, anemia, edema, and bleeding were identified as significant predictors due to their rare occurrence.

Patient management factors were also examined to see if any specific practices

Table 2. Univariate analysis of patient management factors of cases and controls.

Variable	Cases	Controls	p-value	Odds ratio (95% CI)
Prenatal care (n = 239)	*107 (89%)*	*114 (96%)*	*0.052*	*0.36 (0.1, 1.1)*
MD visit during pregnancy (n = 223)	*31 (29%)*	*53 (46%)*	*0.010*	*0.44 (0.3, 0.8)*
Tetanus vaccination (n = 240)	*48 (40%)*	*57 (48%)*	*0.242*	*0.74 (0.4, 1.2)*
Delivery attendant (n = 240):			*0.014*	
Physician	12 (10%)	27 (23%)		1.00
TBA	100 (83%)	90 (75%)		3.44 (1.5, 7.8)
Other	8 (7%)	3 (3%)		5.78 (1.2, 28.0)
Place of delivery (n = 240):			*0.004*	
Hospital	7 (6%)	21 (18%)		1.00
Home	111 (93%)	95 (79%)		3.25 (1.4, 7.9)
Other	2 (2%)	4 (3%)		
>2 vaginal exams (n = 238)	*18 (15%)*	*19 (16%)*	*0.836*	*0.93 (0.4, 2.0)*
Injections (n = 215)	*19 (16%)*	*19 (20%)*	*0.505*	*0.76 (0.4, 1.6)*

could be associated with peri-neonatal mortality (Table 2). Prenatal care, defined as having at least one prenatal visit, was protective and was found to be of borderline statistical significance. The occurrence of at least one visit with a physician during the pregnancy was also protective. While the place of delivery and type of birth attendant were highly significant variables, they were also strongly correlated. Categories of birth attendants considered were physicians, TBAs, and others (family members or friends). Tetanus vaccinations, multiple vaginal examinations, and injections during labor (primarily for oxytocin administration) were not associated with increased mortality.

A multivariate model was constructed that included all the variables with a p-value of 0.25 or less. These were marital status, literacy, socioeconomic status, parity, death of a prior child, prior hospital delivery, second pregnancy in 12 months, premature delivery, prolonged labor, malpresentation, prenatal care, physician visit during the pregnancy, tetanus vaccination, number of vaginal examinations, and delivery attendant. In addition, age was included because of its potential as a significant confounder. Although place of delivery was statistically significant, this variable was omitted because of its strong correlation with delivery attendant. A total of 23 cases were omitted because of missing data. The data missing in these cases related mainly to the time elapsed between the previous pregnancy and the subject pregnancy, as many women were uncertain regarding the date of their last child's birth.

All variables with a p-value <0.15 were kept in a second multivariate analysis (Table 3). Of these, only age and SES were not significant at the 0.05 level. However, both age and SES were kept in the model as they were considered potentially significant confounders. Six variables were identified as significant predictors of peri-neonatal mortality in the multivariate analysis. These included malpresentation, prolonged labor, preterm labor, second pregnancy in 12 months, number of pregnancies, and delivery attendant.

The model was then assessed for possible interactions between delivery management by a physician versus a traditional birth attendant for the three major risk factors: preterm delivery, malpresentation, and prolonged labor. Although a

Table 3. Multivariate analysis of predictors of peri-neonatal mortality controlling for age and SES (n = 217).

Variable	Coefficient	Standard error	Odds ratio	95% CI
*Preterm delivery**	*2.838*	*0.631*	*17.1*	*(5.0, 59.3)*
*Malpresentation**	*2.601*	*0.703*	*13.5*	*(3.4, 53.9)*
*Prolonged labor**	*1.806*	*0.532*	*6.09*	*(2.1, 17.3)*
2nd pregnancy in <12 months	*0.911*	*0.401*	*2.49*	*(1.1, 5.5)*
Delivery attendant:[†]				
TBA	2.285	0.611	9.83	(3.0, 32.5)
Other	2.920	0.988	18.5	(2.7, 128.6)
Maternal age:[‡]				
<18 years	−0.197	0.934	0.82	(0.1, 5.1)
>34 years	0.119	0.502	1.13	(0.4, 3.0)
No. *of previous pregnancies:*[§]				
0	0.470	0.562	1.60	(0.5, 4.9)
>5	1.054	0.474	2.87	(1.1, 7.3)
Low SES	*0.520*	*0.359*	*1.68*	*(0.8, 3.4)*

*As defined in Table 1.
[†]Delivery by physician is the referent group.
[‡]18–34 years is the referent group.
[§]1–5 is the referent group.

stratified analysis had identified increased risk of mortality when the delivery was managed by a traditional birth attendant, none of the interaction terms were statistically significant, and they were not included in the model.

Overall model fit was assessed with the Hosmer-Lemeshow Goodness of Fit Test (*17*). The Hosmer-Lemeshow statistic was 4.89 with 8 degrees of freedom and had a p-value of 0.769, indicating good fit of the model. Diagnostics were then used to assess if any individual observations had extreme influence on the model. Measures of leverage, change in deviance Chi-square, and influence (standardized change in Beta as proposed by Pregibon) were performed (*17*). Only one observation appeared to have undue influence on the model. This observation involved an individual with many risk factors who, in fact, had a live birth. The data for this subject was judged to be biologically correct; thus, it was not deleted from the model.

When the analysis was repeated excluding all stillbirths (n = 172), similar results were obtained. With the exception of the variable "number of previous pregnancies," all variables that were statistically significant in the first analysis were also significant in the subset analysis, where stillbirths were excluded.

Preterm delivery is defined as a live birth at <9 months. Determination of prematurity as a risk factor should be based upon neonatal mortality of liveborn infants, and so the odds ratio for preterm delivery is more appropriately identified when stillbirths are excluded. The odds ratio for preterm delivery in the subset analysis was 15.3 (95% CI: 4.1, 56.9).

The population-based attributable risk percentage (*11*) was calculated for each of the three most significant risk factors.

This statistic, which is calculated using the prevalence and relative risk of a given condition, provides an estimate of the proportion of peri-neonatal mortality in the community that is due to a specific risk factor. Since peri-neonatal mortality is a relatively rare condition, odds ratios were used as an estimate of relative risk. Estimates of prevalence, which were obtained from a community-based surveillance system in Quetzaltenango, were as follows: 3.39% for malpresentation, 1.79% for prematurity, and 2.70% for prolonged labor.

As stated above, identification of prematurity as a risk factor for mortality should only include live births. Thus, the population-attributable risk for prematurity was based on the odds ratio obtained from the subset analysis. Estimates for malpresentation and prolonged labor were based on the odds ratio when stillbirths were included. The population-based attributable risk percentage for preterm delivery was 20%, for malpresentation was 30%, and for prolonged labor was 12%. While these risk factors were not mutually exclusive, it is clear that any one of them had a significant impact on peri-neonatal mortality.

Delivery by TBAs was associated with increased mortality. However, this increase may have stemmed from preexisting demographic and obstetric differences between women having their delivery managed by traditional versus more technical care providers. Table 4 presents a comparison of baseline factors for women attended by either a physician or a TBA. Since only 11 women were attended by someone other than a physician or TBA, these individuals were eliminated from this analysis.

Age was not found to be a statistically

Table 4. Comparison of baseline characteristics of women by delivery attendant (n = 229).

Variable	TBA delivery (n = 190)	Physician delivery (n = 39)	p-value
Age (n = 224):			*0.072*
<18 years	9 (5%)	1 (3%)	
18–34 years	140 (75%)	23 (61%)	
>34 years	37 (20%)	14 (37%)	
Literacy	*45 (24%)*	*23 (59%)*	*<0.001*
Low SES (n = 228)*	*113 (60%)*	*15 (38%)*	*0.015*
Prenatal care (n = 228)	*177 (94%)*	*37 (95%)*	*0.772*
2nd pregnancy in <12 months (n = 217)	*52 (29%)*	*7 (19%)*	*0.253*
Number of prior pregnancies			*0.002*
None	29 (15%)	13 (33%)	
1–5	109 (57%)	11 (28%)	
>5	52 (27%)	15 (38%)	
Malpresentation (n = 228)*	*21 (11%)*	*7 (18%)*	*0.236*
*Premature delivery**	*30 (16%)*	*6 (15%)*	*0.950*
Prolonged labor (n = 228)*	*33 (17%)*	*10 (26%)*	*0.234*

*As defined in Table 1.

significant difference between the two groups, but as the table indicates a greater percentage of women who were attended by physicians were in the older (>34 years) age category. Women attended by physicians were statistically more likely to be literate and had a higher socioeconomic status. There were no significant differences between the groups with respect to four important complications: inter-pregnancy interval <12 months, malpresentation, premature delivery, and prolonged labor. Women attended by a physician were more likely than those attended by TBAs to have had either no previous pregnancies or more than 5 previous pregnancies (72% vs. 43%).

DISCUSSION AND CONCLUSIONS

The foregoing results show significant indicators of peri-neonatal mortality in a rural Guatemalan community where approximately 90% of the deliveries are managed by traditional birth attendants. The study was conducted before initiation of a TBA training project in order to obtain baseline information about variables that should be included in the project. Complications of pregnancy and delivery with the greatest statistical significance were found to be prematurity, malpresentation, and prolonged labor. Population-based attributable risks of these complications demonstrated that they accounted for significant proportions of the observed peri-neonatal mortality. While these conditions cannot be eliminated, it was anticipated that early referral of women to more specialized care settings could result in improved outcomes, an expectation in need of further evaluation.

In this study, delivery by physicians included both planned modern care and referral in case of emergency. Thus, comparisons between TBAs and physicians are difficult to assess. However, since physician deliveries also included high-risk referrals from TBAs, it seems reasonable to assume that poor outcomes reflected this case mix and that the odds ratio associated with TBA delivery alone would likely be even higher. Similarly, the ability to determine whether there are differing outcomes when women with complications are attended by a TBA versus a physician is limited. Again, these differences are likely to be greater than those indicated by this study.

Baseline comparisons showed few differences between the women who were attended by a TBA versus a physician, with the exception of their literacy and SES. However, these variables are important, reflecting not only increased resources but also an increased ability to solve problems. Studies have shown that women with higher SES are less likely to experience perinatal mortality when complications occur (*18*).

A short inter-birth interval (<12 months) was also a statistically significant predictor of mortality. In addition, women with over 5 pregnancies were more likely to have a poor outcome when stillbirths were included in the analysis. A separate analysis of number of pregnancies and child spacing showed that short inter-birth intervals entailed greater risk as the number of pregnancies increased, but this difference was not statistically significant (data not shown). Although prenatal care was a significant variable in the univariate analysis, it was not found to be significant in the multivariate analysis. The fact that the quality and timing of prenatal care varies could explain the lack of effect.

Regarding inclusion of stillbirths, because this study was formulated to provide a basis for program implementation, a broad outcome variable was identified. There could of course be significant differences between factors resulting in a stillbirth prior to labor as compared with factors affecting a neonatal death. In contrast, the causes of a stillbirth during labor and early neonatal death are often quite similar. In addition, the 15% of deaths from day 8 through day 28 could reflect the effects of both perinatal and other factors, such as infection at delivery (*19*).

In a retrospective community-based study there is likely to be some misclassification of time of death. However, this misclassification would more likely result in a bias toward the null because individuals were included who may not have been affected by study variables. For example, stillbirths prior to labor would not be affected by prolonged labor. Because of the potential misclassification, particularly of the time of death for a stillborn, it was decided to keep these stillbirths prior to labor in the study. When the analysis was repeated with all stillbirths excluded, the results remained consistent.

Recall bias was a potential confounder in this study, as mothers with a poor outcome could be more likely to recall problems during labor and delivery. This bias may have been somewhat mediated by the cultural values of the women involved, who often ascribe complications or peri-neonatal mortality to such things as the "evil eye," the will of God, or having a fright during pregnancy rather than lack of prenatal care or medical conditions (*20*). Thus, recall bias may be lessened in this population where the "felt" risk factors are quite different from those being studied.

Since there are limited hospital beds available in Guatemala, it is important that TBAs be supported in managing the care and delivery of most birthing women. However, the high population-attributable risks for peri-neonatal mortality among women with preterm delivery, malpresentation, and prolonged labor provide easily identifiable situations in which TBAs can be trained to transfer either pregnant or laboring women to a hospital for a safer delivery. These transfers can be accomplished without overwhelming the medical system with many "false-positive" referrals of women who could likely give birth safely in the community.

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