Predictors of fetal demise after trauma in pregnant Saudi Arabian women

A.S. Al Mulhim,[1] M.H. Balaha[2] and F. Tudiver[3]

منبئات عن موت الأجنة بعد تعرُّض النساء الحوامل في المملكة العربية السعودية للرضوح

عبد الرحمن صالح الملحم، مجدي حسن بلحة، فرد توديفر

الخلاصة: في المملكة السعودية العربية، أصبحت الحوادث المرورية مشكلة صحية عمومية خطيرة، ولا توجد تقارير منشورة حديثة واسعة النطاق تناقش إصابات الأمهات والأجنة. وقد أجريَت دراسة استعادية للحالات والشواهد للكشف عن حالات الرضوح بين الأمهات. واشتملت مجموعة الدراسة على 118 امرأة فقدت محصول حملها، و308 امرأة لم تفقد محصول حملها شكَّلن مجموعة الشواهد. وقارن الباحثون بين جميع المعطيات باستخدام تحليل وحيد المتغير تلاه تحليل تحوف متعدد المتغيرات. وارتبطت ثلاثة منبئات فقط ارتباطاً يُعْتَدُّ به بالتأثير على فقدان الحمل بعد الرضوح (P <0.05) وهي: الثلث الثاني من الحمل (نسبة الأرجحية 2.77، فاصلة الثقة 95٪: 1.66-4.63)، وانفصال المشيمة (نسبة الأرجحية 3.69، فاصلة الثقة 95٪: 2.01-6.79)، وتصنيف الرضوح على أنها من درجة وخيمة (نسبة الأرجحية 6.78، فاصلة الثقة 95٪: 4.04-11.37).

ABSTRACT In Saudi Arabia, road traffic crashes are becoming a serious public health problem and there are no recent, large-scale, published reports discussing maternal and fetal injuries. We aimed to explore the predictors of fetal death/abortion after maternal trauma. A retrospective case–control study was performed exploring cases of maternal trauma. The study group included 118 women with pregnancy loss while 308 women without loss represented the control group. All data were compared using univariate analysis followed by multivariate regression analysis. Only 3 predictors were associated with significant effect on pregnancy loss after trauma (P < 0.05): second trimester of pregnancy (OR 2.77, 95% CI: 1.66–4.63, placental abruption (OR 3.69, 95% CI: 2.01–6.79) and severe injury score (OR 6.78, 95% CI: 4.04–11.37).

Facteurs prédictifs des décès fœtaux après un traumatisme chez des femmes saoudiennes enceintes

RÉSUMÉ En Arabie saoudite, les accidents de la circulation deviennent un problème de santé publique majeur. Toutefois, aucun rapport de grande envergure n'a été récemment publié sur les traumatismes maternels et fœtaux. Nous avions pour objectif de rechercher les facteurs prédictifs des décès fœtaux ou des avortements après un traumatisme maternel. Une étude cas-témoin rétrospective a été menée pour rechercher des cas de traumatismes maternels. Le groupe de l'étude comprenait 118 femmes ayant eu une fausse couche alors que le groupe témoin était composé de 308 femmes dont le fœtus avait survécu. Toutes les données ont été comparées à l'aide d'une analyse univariée suivie d'une analyse de régression multivariée. Seuls trois facteurs prédictifs ont été associés à un effet important pour la fausse couche suite à un traumatisme (P < 0,05) : le deuxième trimestre de grossesse (O.R. 2,77 ; IC à 95 % : 1,66–4,63) ; un hématome rétroplacentaire (O.R. 3,69 ; IC à 95 % : 2,01–6,79) et le score de gravité du traumatisme (O.R. 6,78 ; IC à 95 % : 4,04–11,37).

[1]Department of Surgery; [2]Department of Obstetrics and Gynaecology, King Faisal University, Al Ahsa, Saudi Arabia.
[3]Department of Family Medicine, James H Quillen College of Medicine, East Tennessee State University, Johnson City, Tennessee, United States of America (Correspondence to F. Tudiver: tudiverf@etsu.edu).

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Introduction

In the past, most causes of maternal mortality and morbidity during pregnancy were obstetric resulting from a lack of prenatal care and/or inadequate assistance during delivery. Nowadays the rate of maternal mortality is much lower; fetal demise has not, however, been significantly reduced because of a rise in non-obstetric causes, especially trauma [1].

Between 6% and 7% of pregnant women have some type of physical trauma [2]. Many studies have reported that the most common etiologies of trauma injuries in pregnancy include transportation crashes, falls, domestic abuse and assaults, puncture wounds and burn injuries [3,4]. Trauma in pregnancy is currently a leading cause of non-pregnancy-related maternal death, and maternal death remains the most common cause of fetal demise [5]. The effect of trauma on pregnancy depends on gestational age, intensity of maternal–fetal aggression (severity of both maternal and fetal injury) and type and severity of the injury [6].

In Saudi Arabia there is rapid modernization, expansion and economic growth with massive new road construction and increased numbers of high powered luxury vehicles. Road traffic crashes are becoming a serious public health problem [7]. In 2006, the Saudi Arabian Ministry of Health reported that accidents were the third most common cause of death among all groups (18.3% of all deaths) [8]. According to the 2009 WHO health statistics report, the maternal mortality ratio in Saudi Arabia was 18 per 100 000, comparable to that of developed countries [9]. Moreover, the mortality rate due to injuries was reported as 76 per 100 000.

In the eastern province of Saudi Arabia, Al Ahsa, it was reported that the average daily number of accidents was 14–18. The accident–injury rate and accident–death rate per 100 accidents was 26.2 and 2.6 respectively [10]. With such accident rates, the ability to predict adverse outcomes for both the mother and fetus is an important goal in pregnancies where there is trauma, particularly since the frequency and onset of adverse outcomes are uncertain. We hypothesized that by identifying a group of injured pregnant women who were "at risk" for termination of their pregnancy, we could define a subpopulation of women who should be targeted in future prevention efforts. To our knowledge, there has been no local or regional study published addressing this subject.

The aims of this research were to identify the characteristics of pregnant women in Eastern Saudi Arabia who had been injured and who had pregnancy loss in the form of abortion or fetal demise and to determine the risk factors for pregnancy loss and compare these findings to those of injured pregnant women who did not have pregnancy loss.

Methods

This study was conducted in Al-Ahsa, Saudi Arabia. Al-Ahsa is the largest province in the Eastern Region, covering an area of 2500 km^2. It has a population of more than 900 000 people, who mainly inhabit Al-Ahsa's 4 major cities: Al-Hofuf, Al-Mobarraz, Al-Oyoun, and Al-Omran, plus 50 scattered villages. Small desert collections of people, called hegars, are also present. Al Hofuf King Fahd Hospital is the central pooling hospital in Al Ahsa Province. This hospital is a referral centre providing secondary level of care to approximately 1.5 million people in Al Ahsa and the nearby regions.

The data used in the current study were derived from Al Hofuf King Fahd Hospital database with the permission of the hospital authorities and maintaining file and patient confidentiality. The study protocol and the data collection forms were approved by the ethics committees of King Faisal University, Al Ahsa, and Al Hofuf King Fahd Hospital.

The design of this research was a retrospective, case–control study. The researchers searched through all the files in the period July 2006–August 2009, searching for cases on patients who had survived after being admitted with trauma during pregnancy. The fetal stage was defined as the period from the beginning of the ninth week after fertilization through to birth [11]. Trauma survivors were defined as all traumatized pregnant women admitted during the study period who had had fetal loss. Fetal loss was defined as either abortion (< 24 gestational weeks), fetal death at any gestational duration, or preterm delivery of a non-viable fetus (< 28 gestational weeks) [12]. Controls were traumatized pregnant women admitted in the same time period, at the same stage of gestation (9–40 weeks) but who had not had pregnancy loss.

Our sample included 459 survivors: these included 118 women who had pregnancy loss (cases) and 341 who did not have pregnancy loss (controls). All the files were cross-checked, either through the same file in Al Hofuf King Fahd Hospital or through files in the Maternity Department where data were missing or needed to be checked. All the files were also checked for all investigations available and all recorded findings. During the search and data collection, 33 of the control group were excluded as their files contained conflicting or incomplete data. The final number of cases that were included in the control group was 308.

Each file was reviewed regarding the admission data, history, examination and investigations. The sociodemographic characteristics included maternal age, residence (urban, rural, hegar or desert scattered) education, nationality and family income (< 3000, 3000–< 6000, ≥ 6000 Saudi riyals). Obstetric history data included gravidity, gestational age, diseases associated with

pregnancy (diabetes mellitus, sickle-cell disease, hypertension), and presenting with leucorrhoea, vaginal bleeding or abdominal pain. Each file was reviewed regarding the mode of injury, site of injury, cause of trauma (motor vehicle crash, physical domestic violence, or fall), and distance (km) from the site where the trauma occurred to hospital.

The data retrieved included the injury severity score [13], vital signs, the presence of shock on admission (systolic blood pressure < 90 mmHg), length of stay in hospital, the number of days spent in the intensive care unit, whether or not a blood transfusion was given, details of the injury and surgical interventions. The injury severity score was used because it is an anatomic scoring system used for trauma patients and it works by assigning 6 body regions with scores, the highest 3 scores are then squared and summed to produce the injury severity score. Scores less than 9 are categorized as non-severe and scores 9 or greater as severe injuries [13]. One study found that an injury severity score ≥ 9 had 85.7% sensitivity and 70.9% specificity in predicting a nonviable pregnancy, which was the highest compared to other cut-off values [5].

The findings of the obstetric examinations, including fetal heart, uterine monitoring with cardiotocography, and ultrasonography, were assessed regarding the presence or absence of a retro-placental haematoma (placental abruption), fetal position, biophysical profile, and fetal weight. Mode of delivery was also recorded. Neonatal data, including birth weight and respiratory problems, were also collected. Fetal/neonatal/infant outcomes included: premature delivery (before 37 weeks), low birth weight (under 2500 g), respiratory distress syndrome, and neonatal and infant death [11,12].

Data analysis

Data were analysed using *Epi-Info*, version 3.5.1, and *SPSS*, version 16. Descriptive statistics were used to present the findings in both the case and control groups. To determine which variables served as predictors of pregnancy loss, univariate analysis was employed with reporting of crude odds ratios and 95% confidence intervals. For continuous data, mean and standard deviation were used for expression; *t*-test was also employed for comparison when appropriate. *P*-value < 0.05 was considered statistically significant. Multivariate logistic regression models were then constructed to adjust for and to control for the influence of all predictors on pregnancy loss. All the significant predictors in the univariate analysis were included in 2 multivariate logistic regression models: model I for the sociodemographic factors and model II for the obstetric and surgical factors.

Results

The final sample size in this study was 426 (92.8%) and these were evaluated according to their allocation in either the study (n = 118) or control (n = 308) groups. Car crashes represented 90% and 68% of trauma respectively in the study and control group with significant differences [odds ratio = 1.2 (1.05–1.37)]. In the study group (cases), abortion, intrauterine fetal death and non-viable birth occurred in 59 (50.0%), 34 (28.8%) and 25 (21.2%) cases, respectively. The clinical and ultrasonographic findings showed that placental abruption occurred in 58 cases (49.2%).

While normal, continuing pregnancy was reported in 59.7% of cases in the control group, continued pregnancy with some antenatal obstetric problems was reported as preterm labour (14.6%), placental abruption (17.5%) and premature rupture of membranes (11.4%) (Table 1). Comorbidity was nearly the same in both groups: 20.4% in the study group and 19.2% in the control group. Combined diabetes and sickle-cell disease were found in 16.7% and 13.6% respectively, and combined hypertension, diabetes and sickle-cell disease were present in 2.8% and 3.6% respectively. Reassuring cardiotocography, normal vaginal delivery and normal neonatal outcomes were reported in 52.6%, 57.1% and 58.1% respectively (Table 1).

Table 2 shows the results of univariate analysis of the sociodemographic, obstetric, and surgical risk factors for pregnancy loss. The following showed significantly higher odds of pregnancy loss (P < 0.05): older age (> 40 years), non-urban residence, employment outside the home, family income > 6000 riyals, second trimester of pregnancy, vaginal bleeding at admission, placental abruption, car crash, abdomino-pelvic trauma, injury score ≥ 9, stay in hospital > 21 days and having an antenatal medical disease. Women with secondary or post-secondary education, women in the first trimester of pregnancy, and women undergoing laparotomy were less likely to suffer from a pregnancy loss.

Table 3 displays the results of the multivariate logistic regression models for pregnancy loss after inclusion of all the significant variables in the univariate analysis. In model I, none of the sociodemographic predictors were significant, so none of those risk factors were independent predictors of loss of pregnancy.

In Model II only 3 variables were significant predictors for pregnancy loss (P < 0.05): second trimester of pregnancy, placental abruption and injury score ≥ 9. This confirmed that these putative risk factors were predictors of pregnancy loss. Although vaginal bleeding and abdomino-pelvic trauma increased the risk for pregnancy loss, the associations were not statistically significant as predictors in the regression model. The correlation between the different factors in the model showed that each of these 3 risk factors was significantly correlated to the others, and all were significantly

Table 1 Obstetric outcomes in pregnant Saudi Arabian women after admission to hospital due to trauma

Outcome	No.	%
Women who had pregnancy loss (*n* = 118)		
Outcome		
Abortion	59	50.0
Intrauterine fetal death	34	28.8
Non-viable birth (< 28 weeks)	25	21.2
Course of condition[a]		
Abruptio placentae	58	49.2
Preterm rupture of membranes	14	11.9
Co-morbidity	7	5.9
No data found	46	38.9
Women who did not have pregnancy loss (*n* = 308)		
Course of pregnancy[a]		
Uncomplicated pregnancy	184	59.7
Abruptio placentae	54	17.5
Preterm labour	45	14.6
PROM	35	11.4
Co-morbidity	16	5.2
Delivery		
After trauma period[b]	292	63.6
During the trauma period[b]	16	3.5
Delivery mode		
Normal vaginal	176	57.1
Assisted	81	26.3
Caesarean	51	16.6
At birth cardiotocography		
Reassuring	162	52.6
Non reassuring	79	25.8
Ominous	67	21.8
Neonatal outcome		
Normal	179	58.1
Respiratory problems	85	27.6
Low birth weight	44	14.3

[a] *The sum of the percentage exceeds the total item percentage due to the co-morbid findings.*
[b] *Trauma period is 1 month after the trauma.*
PROM = premature rupture of membranes.

correlated with the abdomino-pelvic cause of trauma.

Discussion

To our knowledge, this is the largest reported study which used statistical regression analysis to document the prediction of pregnancy loss secondary to trauma in the Eastern region of Saudi Arabia. We found that there were 3 important predictors of pregnancy loss after trauma: second trimester of pregnancy, placental abruption, and severe injury score.

Trauma, whether major or minor, has been associated with an increased risk of spontaneous abortion; premature labour; preterm, premature rupture of the membranes; uterine rupture; placental abruption; fetal distress; maternal death; and stillbirth [5,14].

It has been reported that motor vehicle crashes account for 66% of all traumas, and falls and assaults account for the remaining 33% [15]. In this study, car crashes were responsible for 76.3% and 67.8% of trauma respectively in the study and control groups. Despite this, in the multivariate analysis it was not a significant predictor for pregnancy loss after trauma. This may be because the increased number of car crashes did not necessarily result in greater severity of injuries.

A number of studies have reported a variable incidence of physical violence during pregnancy; ranging from 8% to 20% [16,17]. In this study, it represented nearly 15% in both the case and control groups. In contradiction to our findings, a study in Saudi Arabia reported physical violence in 21% of pregnancies. These cases were associated with increased preterm labour, placental abruption, caesarean section and fetal distress [18].

In the univariate analysis, we found that pregnancy loss was significantly greater in older, non-urban, employed women and in women with family income > 6000 riyals. This appears to be a new finding as there are no published reports of this in the literature. We considered higher family income could be a proxy for the presence of high powered, luxury cars, which may encourage fast driving [7].

Although we found that pregnancy loss was associated with increased severity of the trauma score, it was not associated with the presence of maternal shock at admission (see Table 2). This may be explained by the presence of other factors such as direct uterine trauma in cases of severe trauma. Severe fetal suffering may occur in the absence of clinical signs of shock because the physiological changes during pregnancy may mask the diagnosis. Moreover, a reduction of up to 20% in uterine blood

Table 2 Univariate analysis of the risk factors in the study group (having pregnancy loss) and control group (no pregnancy loss)

Variable	Control group (*n* = 308)		Study group (*n* = 118)		OR (95% CI)
	No.	%	No.	%	
Maternal age groups (vs < 20)					
20–40	234	76.0	32	27.1	0.86 (0.73–1.02)
> 40	39	12.7	75	63.6	2.22 (1.64–3.01)*
Residence (vs urban)					
Rural/hegar	220	71.4	99	83.9	1.19 (1.06–1.34)*
Level of education					
Illiterate	54	17.5	15	12.7	Reference
< Secondary	69	22.4	20	16.9	1.04 (0.46–2.38)
Secondary or higher	185	60.1	83	70.3	1.62 (0.83–3.18)
Occupation (vs housewife)					
Student	35	11.4	14	11.8	1.18(0.96–1.44)
Employment outside the home	210	68.2	92	78.0	1.21(1.07–1.37)*
Family income (Saudi riyals)					
< 3000	75	24.4	20	16.9	Reference
3000– < 6000	185	60.1	70	59.3	1.09 (0.96–1.24)
≥ 6000	48	15.6	28	23.7	1.25 (1.02–1.53)*
Mean (SD) gravidity[a]		4.3 (1.9)		4.08 (1.8)	*t* = –0.86 (–0.22–0.57)
Vaginal bleeding	64	20.8	42	35.6	1.26 (1.07–1.49)*
Antenatal medical disease (≥ 1)	147	47.7	65	55.1	1.09 (0.96–1.22)
Gestational age groups (weeks)					
≤ 13 (first semester)	71	23.1	20	16.9	Reference
14–26 (second semester)	100	32.5	73	61.9	1.35 (1.14–1.6)*
> 26 (third semester)	137	44.5	25	21.2	0.92 (0.81–1.05)
Placental abruption	54	17.5	58	49.2	1.68 (1.37–2.05)*
Premature rupture of membranes	35	11.4	14	11.8	1.01 (0.84–1.22)
Mean (SD) distance[b,c] (km)		23.7 (3.6)		22.9 (3.3)	2.28 (0.11–1.55)*
Cause of trauma					
Falling	51	16.6	10	8.5	Reference
Home violence	48	15.6	18	15.3	1.15 (0.96–1.38)
Car crash	209	67.8	90	76.3	1.20 (1.05–1.37)*
Site of trauma					
Head, spine, limbs	110	35.7	21	17.8	Reference
Abdomen	104	33.8	58	49.2	2.92 (1.60–5.36)*
Pelvis	94	30.5	39	33.1	2.17 (1.15–4.13)*
Injury severity score ≥ 9 (vs < 9)	64	20.8	76	64.4	1.87 (1.55–2.25)*
Shock at admission	42	13.6	11	9.3	0.90 (0.77–1.05)
Surgical treatment					
Non-laparotomy	144	53.5	47	44.3	Reference
Laparotomy	125	46.5	59	55.7	1.45 (0.90–2.23)
Stay in hospital (days)					
< 7	54	17.5	12	10.2	Reference
7–21	215	69.8	84	71.2	1.76 (0.86–3.66)
> 21	39	12.7	22	18.6	2.54 (1.05–6.23)*

**Significant at P < 0.05.*
[a]Range: 1–8; [b]from trauma site to hospital; [c]range: 15–33 km.
OR = odds ratio; CI = confidence interval; SD = standard deviation.

Table 3 Multivariate logistic regression analysis for sociodemographic, obstetric and surgical predictors of pregnancy loss in 118 Saudi Arabian women who had pregnancy loss after trauma

Model and variables	β	SE	*P*-value	OR (95% CI)
Model I: sociodemographic predictors				
Age group: ≥ 40 years	–0.106	0.377	0.780	0.90 (0.43–1.88)
Residence: rural/hegar	–0.398	0.242	0.099	0.67 (0.42–1.07)
Occupation: employed	–0.055	0.339	0.872	0.95 (0.49–1.80)
Family income (Saudi riyals): ≥ 6000	0.091	0.225	0.687	0.89 (0.70–1.70)
Constant	–0.805	0.334	0.016	0.45
Predicted (%)	72.3			
χ^2	3.23			
Model II: clinicosurgical predictors				
Gestational age: second trimester	1.018	0.262	< 0.001	2.77 (1.66–4.63)
Vaginal bleeding: present	0.183	0.328	0.577	1.20 (0.63–2.28)
Placental abruption: present	1.308	0.311	< 0.001	3.69 (2.01–6.79)
Cause of trauma: car crash	–0.125	0.356	0.726	0.88 (0.44–1.77)
Site of trauma: abdomen/pelvis	0.109	0.276	0.693	1.12 (0.65–1.92)
Injury severity: severe (score ≥ 9)	1.914	0.264	< 0.001	6.78 (4.04–11.34)
Length of hospital stay: >21 days	–0.582	0.355	0.101	0.56 (0.28–1.12)
Constant	–2.173	0.543	< 0.001	0.114
Predicted (%)	79.8			
χ^2	123.94			

SE = standard error; OR = odds ratio; CI confidence interval.

flow can occur without changes in maternal blood pressure. Maternal blood pressure and pulse rate in predicting fetal loss has been shown to be unreliable [19].

Our findings indicated that placental abruption was significantly more common in the study group than in the control group. Schiff and Holt reported that placental abruption complicates 1%–5% of minor and 20%–50% of major injuries, and causes most of the associated fetal death [20]. A small Saudi Arabian study on motor vehicle crashes showed that they caused fetal loss of 13% with placental abruption present in 17% of all cases [21]. These results support our finding of the association between trauma-associated placental abruption and fetal loss, but reported frequencies were lower in that study. This difference may be due to different inclusion criteria and number of included cases.

In our study, pregnancy loss was significantly greater in women in the second trimester of pregnancy compared to the first trimester. Some studies have reported that the second trimester represented the most vulnerable period for fetal trauma because the gravid uterus ascends out of the bony pelvis in the cephalad direction to reach the level of the umbilicus by 24 weeks; here the gravid uterus may sustain direct traumatic injury. In the third trimester, the fetus is well protected by the amniotic fluid [22,23].

A study in Saudi Arabia on motor vehicle crashes and pregnancy outcomes concluded that a high injury severity score was associated with a 17-fold increase in the rate of fetal loss. This conclusion was based on a small number of cases (45); it did not exclude the effect of maternal death and did not use suitable statistical analyses to delineate the association [21].

Other studies have covered a number of independent risk factors: collectively, the significant predictors in these studies were: increased injury severity score, increased face and abdominal injury severity, increased fluid requirements, maternal acidosis, maternal hypoxia, maternal shock, placental abruption, and gestational age < 32 weeks [24,25]. These findings support our results.

Study limitations

This study had several limitations. First, the retrospective design did not allow the investigators to study patients in a prospective, uniform, standardized manner for each group of risk factors. Second, the study included only hospitalized patients and cannot be generalized to minor traumas not requiring hospitalization. Third, the files did not contain complete obstetric data for some cases, making it difficult to fully comment on the neonatal outcome and the related risk factors. The typical management options and investigations for obstetric cases were not documented owing to either under-use or under-reporting, as management was done case by case based mainly on personal preference and not on a specific protocol.

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