



Does the presence of conflict affect maternal and neonatal mortality during Caesarean sections?

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Introduction: Conflicts frequently occur in countries with high maternal and neonatal mortality and can aggravate difficulties accessing emergency care. No literature is available on whether the presence of conflict influences the outcomes of mothers and neonates during Caesarean sections (C-sections) in high-mortality settings.

Objective: To determine whether the presence of conflict was associated with changes in maternal and neonatal mortality during C-sections.

Methods: We analysed routinely collected data on C-sections from 17 Médecins Sans Frontières (MSF) health facilities in 12 countries. Exposure variables included presence and intensity of conflict, type of health facility and other types of access to emergency care.

Results: During 2008–2015, 30,921 C-sections were performed in MSF facilities; of which 55.4% were in areas of conflict. No differences were observed in maternal mortality in conflict settings (0.1%) vs. non-conflict settings (0.1%) ($P = 0.08$), nor in neonatal mortality between conflict (12.2%) and non-conflict settings (11.5%) ($P = 0.1$). Among the C-sections carried out in conflict settings, neonatal mortality was slightly higher in war zones compared to areas of minor conflict ($P = 0.02$); there was no difference in maternal mortality ($P = 0.38$).

Conclusions: Maternal and neonatal mortality did not appear to be affected by the presence of conflict in a large number of MSF facilities. This finding should encourage humanitarian organisations to support C-sections in conflict settings to ensure access to quality maternity care.

Médecins Sans Frontières (MSF) is a humanitarian medical organisation that supports C-sections in emergency settings, including areas of conflicts, performing over 1.3 million deliveries worldwide from 2008 to 2015.^{10–14} The MSF facilities therefore present a unique opportunity to examine whether the presence of conflict affects maternal and neonatal outcomes following C-sections.

METHODS

Aim

We sought to assess whether the presence of conflict is associated with a difference in the rate of maternal and neonatal mortality during C-section interventions in 17 MSF-supported health facilities in 12 countries during 2008–2015.

Design

This was an analysis of routinely collected maternal programme data.

Setting

We included 12 countries, whose maternal and neonatal mortality rates are shown in Table 1.

Each of the facilities was operational for different time periods between 2008 and 2015. Facilities were classified into general hospitals or maternities, defined as comprehensive emergency obstetric and newborn care centres (CEmONC), and according to whether they were the only CEmONC in the city, or whether there were other facilities also performing C-sections free of charge.

Emergency C-sections were carried out according to the MSF protocol,¹⁵ in which the following absolute indications are defined as life-threatening to the mother: 1) severe, uncontrolled ante-partum bleeding; 2) malpresentation that cannot be turned; 3) absolute fetopelvic disproportion and no possibility of instrumental extraction; 4) uterine rupture; and 5) a history of ≥ 3 C-sections.

The relative indications to perform a C-section is based on a consideration of the short and medium or long-term risk/benefit for the mother on a case-by-case basis. MSF C-sections were performed by local or international surgeons, by obstetricians or by general doctors with surgical skills.

The standard prerequisites for performing C-sections are the availability of skilled human resources for assessing whether a C-section is indicated; administering anaesthesia and performing surgery; and appropriate facilities, equipment, intrapartum/postpartum care

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War-affected populations can suffer from an increase in mortality rates.^{1,2} During active stages of conflict the outcomes are poorer and there are significant challenges to provide health care.^{3,4} Conflict frequently affects countries that already account for the world's greatest burden of maternal and neonatal mortality.⁵

Caesarean section (C-section) rates are below the recommended level in some countries with high neonatal mortality; C-section rates of up to 10% are associated with decreases in maternal and neonatal mortality rate at population level.⁶ This suggests that some women who need emergency C-sections do not receive them.^{7,8}

While conflict has been shown to increase neonatal and maternal mortality rates overall,^{1,9} there have been no studies of whether it impacts the rate of neonatal and maternal mortalities following C-sections.

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TABLE 1 Neonatal and maternal mortality rates reported by country

Country	Neonatal mortality rate*	Maternal mortality rate†	Caesarean section rate‡ % (year)
Afghanistan§	35.5	396	3.7 (2010)
Burundi	28.6	712	4.3 (2010)
Central African Republic§	42.6	882	4.5 (2010)
Democratic Republic of Congo§	30.1	693	5.5 (2010)
Haiti	24.9	359	5.8 (2010)
Ivory Coast	37.9	645	3.1 (2010)
Mauritania	35.7	602	9.6 (2010)
Niger	26.8	553	1.6 (2010)
Pakistan§	45.5	178	15.9 (2010)
Sierra Leone	34.5	1360	3.6 (2010)
Syria	7.0	68	15.0 (2002)
Somalia	39.7	732	35 (refugees in Lebanon, 2012) NA

*Defined as number of deaths per 1 000 live births. (Source: United Nations Interagency Group for Child Mortality Estimation, 2014).

†Defined as number of maternal deaths per 100 000 live births. (Source: World Health Organization, United Nations Children's Fund, United Nations Population Fund, World Bank Group and United Nations Development Programme (UN Maternal Mortality Estimation Inter-agency Group, 2015).

‡Defined as the percentage of births achieved by caesarean among all live births in the period before the survey (referring to births in the 3 years before Demographic and Health Surveys and 2 years before Multiple Indicator Cluster Surveys).

§Countries with ≥ 2 facilities.

NA = not available.

and monitoring. For neonates, standard routine care was offered in the first hours of life, including resuscitation (if needed), clearing the airway, cord clamping and cord care, assessing Apgar score, clinical examination, thermoregulation, feeding, preventive treatments, vaccinations and daily monitoring.¹⁵

Study population and sampling strategy

The study population was defined as the women who underwent an emergency C-section conducted by MSF Operational Center Brussels and the neonates of these women, from January 2008 to December 2015, in selected facilities under the Emergency Obstetric Care programme. We excluded hospitals that performed <10 C-sections in a given month. There were 198 cases identified with intrauterine foetal deaths during the C-sections, which were not included in the analysis. We also excluded C-sections for which outcomes were not recorded.

Study variables and definitions

Conflicts were classified according to the Uppsala Conflict Data/Peace Research Institute Oslo (UCDP/PRI) Armed Conflict Database classification as follows:^{16,17} 1) the presence or absence of conflict by country and time period (semester);¹⁷ 2) conflict intensity: 'minor' if between 25 and 999 battle-related deaths were reported and 'war-intensity' if there were ≥ 1000 battle-related deaths by country in a given year.¹⁷

Maternal mortality was defined as the total number of maternal deaths that occurred during the time in the theatre or in the recovery room, divided by the total number of C-sections conducted. Neonatal mortality was defined as the number of neonatal deaths occurring during the C-section or the resuscitation period, divided by the total number of C-sections conducted.

The average C-section rate was the percentage of C-sections performed of the total deliveries for each

year in which the facility was active from 2011 onward.

Data collection and quality assurance

MSF local staff routinely collected and entered the data into an Excel dataset (Microsoft Corp, Redmond, WA USA) in each facility for programme monitoring and evaluation. The data were reviewed at facility level and reported to the MSF Brussels headquarters, where they were revised, cleaned and validated.

Data analysis

We used a univariate analysis to describe the number of C-sections, the year, the type of facility and the presence and intensity of conflict.

We used a bivariate analysis to describe the association between the maternal and neonatal mortality outcome variables and the exposure variables described above, with significance determined as $P < 0.05$. The data were analysed using Stata v14 (StataCorp LLC, College Station, TX, USA).

Ethics approval

Confidentiality of information was ensured during all processing of data entry and analysis. The data were de-identified, therefore individual consent was not required. This research fulfilled the exemption criteria set by the MSF Ethics Review Board (ERB) for a posteriori analyses of routinely collected clinical data and thus did not require MSF ERB review. The study was conducted with permission from the Medical Director of MSF (Brussels, Belgium).

RESULTS

Health facility characteristics

The study included 30,921 C-sections from 2008 to 2015. There were 17 health facilities in 12 countries (three in Afghanistan, two each in Central African Re-

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Availability of data and materials

The data that support the findings of this study are available from MSF.

Restrictions apply to the availability of these data, which were utilised under license for the current study and are not publicly available. These data are, however, available from the authors upon reasonable request and with permission of MSF.

Conflicts of interest: none declared.

TABLE 2 Neonatal and maternal mortality rates by country and type of facility in C-sections, 2008–2015

Facility by country	Neonatal mortality <i>n</i> (%)	Maternal mortality <i>n</i> (%)	Type of facility	Access Other CEmONC facility*	Mean deliveries per year <i>n</i>	Mean C-sections per year <i>n</i>	Average C-section rate† %
Afghanistan I	74 (4.5)	1 (0.1)	General	Yes	11 564	1 622	2.8
Afghanistan II	214 (15.2)	0	Maternity	Yes	14 939	1 400	2.3
Afghanistan III	234 (31.1)	6 (0.8)	General	No	2 172	1 062	48.9
Burundi	277 (6.2)	3 (0.1)	Maternity	No	1 912	1 581	41.4
Central African Republic I	34 (13.3)	0	General	No	1 658	253	7.6
Central African Republic II	97 (9.34)	2 (0.2)	Maternity	No	7 424	813	11.0
Ivory Coast	56 (13.1)	5 (1.2)	General	Yes			
Democratic Republic of Congo I	100 (10.4)	1 (0.1)	General	No	4 101	1 241	30.3
Democratic Republic of Congo II	490 (6.7)	11 (0.2)	General	No	4 125	4 650	28.2
Haiti	98 (8.2)	0	General	Yes	1 645		
Mauritania	19 (6.7)	0	General	No	1 843	1 306	23.6
Niger	289 (21.4)	2 (0.2)	General	No	2 774	535	9.6
Pakistan I	45 (7.4)	0	General	No			
Pakistan II	773 (17.6)	7 (0.2)	General	No	6 159	3 426	13.9
Sierra Leone	753 (18.8)	5 (0.1)	Maternity	No	1 670		
Syria	6 (4.0)	0	General	No	0		
Somalia	70 (11.1)	3 (0.5)	General	No	2 213	484	10.9

*Facilities were classified as 'Yes' if there were other facilities in the town providing free of charge CEmONC and 'No' if MSF was the only facility to provide this service.

†Percentage of C-sections performed out of the total deliveries for the years in which the facility was active; data were available between 2011 and 2015.

C-section = Caesarean section; CEmONC = comprehensive emergency obstetric and newborn care centres.

public, Democratic Republic of Congo and Pakistan and one each in Burundi, Haiti, Ivory Coast, Mauritania, Niger, Sierra Leone, Syria and Somalia).

Of the 17 health facilities, 13 were general hospitals and four were CEmONC, accounting for respectively 64.6% and 35.4% of the C-sections (Table 2).

All the facilities provided free care, with 14 of 17 offering the only CEmONC care available in their respective towns and accounting for the majority of the C-sections (84.9%, $n = 26,267$).

Conflict characteristics

We categorised each of the C-sections according to whether they occurred within a country and during a period of conflict. Forty-four per cent of the C-sections took place in settings that were not in a defined conflict; the remaining 56% were in conflict settings.

Of the C-sections performed in conflict settings, the majority (12,240, 71.6%) were in minor-intensity country conflicts, with 4858 (28.4%) in war-intensity zones. Most minor-intensity country conflicts were internal conflicts, whereas the war-intensity conflicts tended to be across borders.

Maternal mortality

The overall maternal mortality (MM) was 0.15% (46 maternal deaths) related to C-sections. It ranged from 0% in Syria, Haiti and one of the Pakistani facilities to 0.80% (six maternal deaths) in one of the Afghan facilities ($P < 0.001$).

The MM decreased from 0.25% (four maternal deaths) in 2008 to 0.07% (three maternal deaths) in 2015 ($P < 0.02$).

C-sections performed in non-conflict countries showed a MM of 0.11%, which was not statistically different from that in conflict settings (0.18%). In conflict settings, the MM was not statistically different (0.1% vs. 0.2%) between minor and war-intensity conflicts.

C-sections in general hospitals reported a higher MM (0.18%) compared to maternities (0.09%), with a borderline statistically

significant difference ($P = 0.05$). MM was not different in towns where no other facilities were offering free-of-charge C-sections compared to those where care was available at other facilities.

Neonatal mortality

The overall neonatal mortality (NM) was 11.7% ($n = 3629$) of neonates born through C-section. It ranged from 3.9% in the Syrian facility to 31.1% in one of the Afghan facilities ($P < 0.001$) (Table 2). The NM decreased from 15.9% ($n = 252$) in 2008 to 10.0% ($n = 429$) in 2015 ($P < 0.001$).

The NM in non-conflict settings was 11.8%, which was not statistically different from that of neonates born in conflict settings (11.7%) (Table 3). Table 3 shows the NM for each facility during periods of conflict compared to non-conflict. In conflict zones, the NM was 11.2% in areas of minor conflicts compared to 13.0% in war settings, showing a small difference.

General hospitals showed no statistically significant difference in NM compared with maternity facilities.

Neonates born in towns where no other facilities were offering free-of-charge C-sections showed a significantly higher NM (12.1%) than those where care was available at other facilities (9.5%).

DISCUSSION

Our study assessed whether conflict settings were associated with differences in maternal and neonatal mortality during MSF-supported emergency C-sections in a number of high mortality countries. To our knowledge, this is the largest published study of this question. Surprisingly, there were no increases in maternal or neonatal mortality in conflict settings. We present the implications and potential reasons for these findings.

From 2008 to 2015, 17 MSF-supported facilities performed the majority of C-sections in conflict settings and in towns where the facility was the only one to offer free emergency care. This demonstrates the feasibility of providing quality emergency C-sections in

TABLE 3 Neonatal and maternal mortality distribution by conflict setting and access to C-sections, 2008–2015

	Neonate deaths			Maternal deaths		
	<i>n</i>	%	<i>P</i> value	<i>n</i>	%	<i>P</i> value
Presence of conflict						
Absence of conflict	1632	11.8	0.7	15	0.1	0.09
Conflict (internal and international)	1997	11.7		33	0.2	
Intensity of the conflict						
Minor	631	11.2	0.001	20	0.2	0.38
War	658	13.0		11	0.2	
Type of facility						
General hospital	2288	11.4	0.03	36	0.2	0.05
Maternity	1341	12.3		10	0.1	
Access to other CEmONC						
No (MSF only free care)	3187	12.1	0.001	40	0.2	0.7
Yes	442	9.5		6	0.1	

C-section = Caesarean section; CEmONC = comprehensive emergency obstetric and newborn care centres; MSF = Médecins Sans Frontières.

conflict settings, despite the perceived threats. The literature on the provision of C-sections during conflicts varies according to the conflict. During the Balkans War, C-section rates decreased, while the rate remained high in northern Sri Lanka and among Syrian women living in Lebanon during those conflicts.¹⁸

Our study found no differences in maternal or neonatal mortality in emergency C-sections between conflict and non-conflict periods. This is in contrast to a previous MSF study by Chu et al. of 19,643 surgical procedures (including obstetrics, trauma, abdominal conditions, infections, neoplasms, accidental and violent injury) from 2001 to 2008, which showed a rate of operative general mortality 4.6 times higher in conflict settings than in non-conflict settings.¹⁹

There were two main differences between the studies, which may explain this discrepancy. First, we only included C-sections in our study, whereas Chu et al. incorporated all surgical procedures and reported differences in mortality according to whether the procedures were abdominal, gynaecological or under emergency circumstances, and according to the American Society of Anesthesiologists (ASA) physical status. Second, we used a more specific definition of conflict for each facility by time period.

Since we found no differences in mortality according to conflict, type of conflict or type of facility, we suggest that other factors could influence mortality. These could be related to the accessibility of healthcare, clinical presentation or type of procedure. Our study included only those women who had reached health facilities and had one specific operation. Further studies that includes other forms of delivery, number of stillborn, more complex pathology or patients with delayed access to care during conflict would be required to assess other reasons.

Access to health care during conflict is a key dimension and further evidence is needed to understand how access influences patient outcomes.²⁰ Higher maternal mortality, for example, has been reported in countries with recent conflicts compared to countries without conflict (respectively 1000 per 100,000 births vs. 690 per 100,000 births), but confounders were missing and the possible reasons not clarified.²¹

There is also a complex relationship between exposure to conflict and the utilisation of maternal health services.²² Previous studies have shown that conflict is associated with worse indicators of maternal health service utilisation such as contraceptive use and institutional deliveries, whereas, ironically, skilled birth assistance was better in conflict areas.²² Conversely, other sources

have shown limited associations between conflict and maternal health indicators, such as antenatal care and institutional deliveries.^{23,24} Further research is needed to document the mechanisms through which conflict influences mortality in C-sections.²⁵

A previous study reported that the barriers to accessing health care in Afghanistan were associated with a higher number of maternal deaths compared with women who died from non-maternal causes.²⁶ In one maternity clinic in a small provincial town in Afghanistan in our study, maternal mortality was >30% when more complicated C-sections were attended compared to <5% in a Kabul facility where women usually presented with fewer obstetrical complications. In Afghanistan, accessibility to C-sections is a problem, and timely referral has been identified as a priority to decrease the proportion of emergency C-sections.²⁷ This hypothesis is supported by our findings of a higher mortality in settings located in towns with less access to CEmONC.

Ideally, studies that explore the relation between conflict and health care should include information about women who do not reach the health facilities, through aspects such as availability of services, geographical accessibility, acceptability and contact with the service.²⁸ In our study, this would have allowed a better understanding of the relations between conflict, accessibility and mortality outcome. Unfortunately, in practice, this information is rarely available in conflict settings, due to limited feasibility of conducting household and community surveys during war.

Regarding the clinical presentation of the patients, a study conducted in three MSF facilities in Burundi, the Democratic Republic of the Congo and Sierra Leone showed that type of facility was not a factor associated with maternal or neonatal mortality.²⁹ However, in the same analysis, parity, certain C-section indications and age (for neonatal mortality) were associated with increased mortality. This suggests that the outcomes of C-sections may be influenced more by individual factors than by facility- or setting-related factors.

We also suggest that the lack of a difference in mortality rates with or without conflict could be related to the MSF's use of standardised procedures, adequate equipment and proper staff in all their supported surgical facilities. Donabedian's framework defines quality of care as: structure (i.e., equipment, human resources); process (i.e., implementation of standardised protocols, diagnostic resources); and outcome, where each component is influenced by the previous one, making the components interdependent.^{30,31} For the MSF C-sections, standards for provision of

surgical care were maintained for these three domains in both conflict and non-conflict settings, leading to similar outcomes.³² To continue health-care provision during conflict and non-conflict, homogenous minimal quality standards should therefore continue to be implemented and monitored.

There were a number of strengths to this study. The large number of C-sections over a sustained period of time in different settings permitted the observation of meaningful maternal mortality, with a unique comparability between MSF-supported facilities due to similar standardised clinical protocols, team structures, medical devices, drugs, patient files, data collection and supplies in all countries and facilities.

A major limitation of our study was the use of conflict definitions per UCDP/PRIO, which reflects active conflict only at country level. This categorisation may not correspond to the local situation at facility level. To minimise this, we validated the conflict category with the staff at each of the facilities. Another limitation was that data on neonatal mortality were only collected intraoperatively and the outcomes at the time of discharge were not assessed. This may have led to an underestimation of the number of neonatal deaths, although this may not have had a different impact between the conflict and non-conflict settings.

CONCLUSION

Despite the presence of conflict, a large number of C-sections were performed in MSF-supported facilities over the 8 years of the study period across multiple settings, with no differences in neonatal or maternal mortality compared with non-conflict settings. This is encouraging evidence, supporting the continuation of emergency C-section provision as part of maternity care in conflict settings.

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Cadre : Des conflits surviennent souvent dans les pays où sévissent une mortalité maternelle et néonatale élevées et peuvent aggraver les difficultés d'accès aux soins d'urgence. Aucune littérature n'est disponible sur l'impact de la présence d'un conflit sur les résultats des césariennes pour les mères et les nouveaux-nés dans des contextes de mortalité élevée.

Objectif : Evaluer si la présence d'un conflit est associée à des modifications de la mortalité maternelle et néonatale pendant les césariennes.

Méthode : Nous avons utilisé des données recueillies en routine sur les césariennes effectuées dans 17 centres de santé de Médecins Sans Frontières (MSF) dans 12 pays. Les variables d'exposition ont inclus la présence et l'intensité du conflit, le type de structure de santé et les autres accès aux soins d'urgence.

Résultats : Entre 2008 et 2015, 30921 césariennes ont été réalisées

dans les structures de MSF ; 55,4% l'ont été dans un contexte de conflit. Aucune différence n'a été observée en termes de mortalité maternelle en situation de conflit (0,1%) ou sans conflit (0,1%) ($P = 0,08$) ni en termes de mortalité néonatale en période de conflit (12,2%) et hors conflit (11,5%) ($P = 0,1$). Parmi les césariennes réalisées dans un contexte de conflit, la mortalité néonatale a été légèrement plus élevée dans les zones de guerre comparées aux zones de conflits mineurs ($P = 0,02$) ; il n'y a pas eu de différence en termes de mortalité maternelle ($P = 0,38$).

Conclusion : La mortalité maternelle et néonatale n'a pas semblé affectée par la présence de conflits dans un grand nombre de structures de MSF. Ces résultats devraient encourager les organisations humanitaires à soutenir les césariennes dans les contextes de conflit afin d'assurer l'accès à des soins de santé de qualité en maternité.

Marco de Referencia: Los conflictos armados son frecuentes en países con elevada mortalidad materna y neonatal los cuales pueden agravar la dificultad de acceso a la salud maternal de urgencia. No existe evidencia científica que analice en conflictos, la asociación de los conflictos con el desenlace clínico de las madres y los recién nacidos tras cesáreas.

Objetivo: Evaluar si la presencia de conflicto se asocia con modificaciones de la mortalidad materna o neonatal tras partos por cesárea.

Métodos: Se utilizaron los datos recogidos durante las cesáreas en 17 establecimientos dirigidos por Médicos Sin Fronteras (MSF) en 12 países. Las variables de exposición incluyeron la presencia y la intensidad del conflicto, el tipo de establecimiento de salud y el acceso a otros tipos de atención de urgencia.

Resultados: En el período 2008–2015 se practicaron 30921 cesáreas en los establecimientos de MSF; 55,4% tuvieron lugar en situaciones de conflicto. No se observaron diferencias en la mortalidad materna durante los períodos con o sin conflicto (0,1% en ambos casos; $P = 0,08$) ni en la mortalidad neonatal (12,2% en períodos de conflicto y 11,5% sin conflicto; $P = 0,1$). En las cesáreas realizadas en entornos en conflicto, la mortalidad neonatal fue levemente superior en las zonas de guerra, en comparación con las zonas de conflicto menor ($P = 0,02$); no se observó diferencia en la mortalidad materna ($P = 0,38$).

Conclusión: La presencia de conflicto no afecta la mortalidad materna ni neonatal en establecimientos de MSF. Nuestros resultados deberían estimular a las organizaciones humanitarias a fomentar la práctica de cesáreas en las zonas de conflicto, con el fin de garantizar el acceso a una atención de calidad.