Hospital-based case–control study of risk factors for early neonatal mortality in the Gaza Strip

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Abstract

Background: Early neonatal death is an essential epidemiological indicator of maternal and child health.

Aims: To identify risk factors for early neonatal deaths in the Gaza Strip.

Methods: This hospital-based case–control study included 132 women who experienced neonatal deaths from January to September 2018. The control group comprised 264 women who were selected using systematic random sampling and gave birth to live newborns at the time of data collection.

Results: The controls who had no history of neonatal death or stillbirth were less likely to have an early neonatal death than women who had such history. The controls who did not have meconium aspiration syndrome or amniotic fluid complications were less likely to have an early neonatal death than women who experienced these complications during delivery. The controls who had a singleton birth outcome were less likely to have an early neonatal death than women who had multiple births.

Conclusion: Interventions are needed to provide preconception care, improve the quality of intrapartum and postnatal care, provide high-quality health education, and improve the quality of care provided by neonatal intensive care units in the Gaza Strip.

Keywords: neonatal mortality, risk factor, intervention, case control, Gaza Strip

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Introduction

Globally, there are ~7000 neonatal deaths every day, amounting to 46% of all under-5 mortality (*1*). Seventy-five percent of neonatal deaths occur during the first week of life, and ~1 million newborns die within the first 24 hours after delivery (*2*). The Sustainable Development Goals that were adopted in 2015 by the United Nations included under Goal 3 the reduction of neonatal mortality (*3*).

In the Gaza Strip and West Bank, the neonatal mortality rate declined from 22 deaths per 1000 live births in 1990 to 11 deaths per 1000 live births in 2016 (*4*). The annual report of the Palestinian Ministry of Health estimates that the neonatal mortality rate (0–28 days) reached 6.2 deaths per 1000 live births in 2018 compared with 4.8 deaths per 1000 live births in 2017, which accounted for 59.6% of infant mortality (*5*). In Palestine, particularly in the Gaza Strip, despite the progress in reducing maternal mortality (*5*), there are limited data about early neonatal deaths. In the Gaza Strip, a neonatal network was established in 2013, with the aim of ensuring that infants and their families receive appropriate care in healthcare settings and at home. The network estimates that there were 6769 admissions per annum to neonatal units in 2013 (*6*).

Methods

Study design

This was a hospital-based case–control study. We enrolled 132 women who had early neonatal deaths between January and August 2018. The control group was selected by systematic random sampling and comprised 264 women who gave birth to live infants in the same week at the same hospital. The study was conducted at 4 public hospitals in the Gaza Strip: Al-Shifa Hospital, Nasser Complex Hospital, Al Aqsa Hospital, and Al Imarati Hospital. The estimated sample size was 110 cases and 220 controls.

Data collection

The study was conducted using a self-developed questionnaire that collected data on all possible risk factors related to early neonatal mortality. The questionnaire was modified by an expert review panel and tested through a pilot study, and a final version was formulated. It covered the most relevant independent variables: (1) participants' socioeconomic factors such as age, education, economic status, and income; (2) history of preterm birth, neonatal mortality, ruptured membranes, and pregnancy outcome; and (3) fetal factors such as gestational age, sex, weight, and congenital abnormalities. All these factors are known to contribute

to perinatal mortality. We also used the General Health Questionnaire 12, which is a reliable and valid instrument that can be used for measuring psychological well-being of women during pregnancy. A score of 6 was taken as the cutoff point to indicate well-being, while a score ≥ 6 suggested evidence of distress. The General Health Questionnaire 12 was administered through face-to-face interviews in March 2019. The response rate among controls was 100%, but there were 2 cases who had an early neonatal death and refused to respond, so the response rate among cases was 99.2%.

Statistical analysis

The data were analysed using SPSS version 23. In addition to the descriptive statistics, the χ^2 test and *t* test were used to compare between cases and controls. Multivariate logistic regression was used to identify the main predictors of early neonatal mortality. $P \leq 0.05$ was considered significant.

Ethical considerations

Data collection and analysis were confidential and only the researchers had access to the data. All ethical and administrative approvals were obtained from the Institutional Review Board of Al-Quds University. Informed consent was obtained from all participants (cases and controls) after giving them sufficient information about the study and guaranteeing complete confidentiality and privacy.

Limitations of the study

First, we were unable to calculate prevalence because it was a case–control study. Second, the study was conducted only at public hospitals and did not include other providers or home deaths.

Results

Socioeconomic characteristics of the study participants

The overall mean age of the study participants was 26.8 (standard deviation 5.6) years. There was no significant difference between the mean age of the cases [27.13 (5.9) years] and the controls [26.64 (5.5) years] (*t* test 0.805, $P = 0.421$). The overall mean duration of schooling was 13.1 (2.59) years, with no significant difference between cases and controls (*t* test 0.752, $P = 0.453$) (Table 1). The mean age of mothers at first marriage was 20.17 (standard deviation 3.47) years, with no significant difference between the cases and controls (*t* test 1.698, $P = 0.091$). Higher maternal education level has been shown to enhance the ability of mothers to acquire knowledge about health issues and make optimal use of health services (7). In 2018, the illiteracy rate among Palestinians aged ≥ 15 years was 2.8%, which is considered to be one of the lowest in the world (8).

Obstetric information

Last pregnancy characteristics

Twenty-three (5.8%) of the study participants used assisted reproductive technology in their last pregnancy, including 15 (11.4%) of the cases and 8 (3.0%) of the controls, which was a significant difference (χ^2 11.17, $P = 0.001$) (Table 2). Among the women who used assisted reproductive technology, 12 (80.0%) cases used *in vitro* fertilization and 3 (20.0%) used pregnancy-inducing medication, compared with 2 (25.0%) and 6 (75.0%), respectively, among the controls.

We found that 167 (42.2%) participants used a contraceptive method prior to their last pregnancy, including 37 (28.0%) cases and 130 (49.2%) controls, which was a significant difference ($\chi^2 = 16.23$, $P < 0.001$) (Table 2). The most common contraceptive method used among all participants was the natural method (38.3%), followed by intrauterine device (24.6%). The Palestinian Ministry of Health estimates that intrauterine device was the most frequent contraceptive method used in the Gaza Strip (39.7%) (5).

In 109 (27.5%) participants, their last pregnancy was classified as high-risk, including 47 (35.6%) cases and 62 (23.5%) controls, which showed a significant difference ($\chi^2 = 6.48$, $P = 0.011$) (Table 2). High-risk pregnancies were classified according to the national antenatal care protocols.

Complications during the last pregnancy were reported by 162 (40.9%) participants, including 69 (52.3%) cases and 93 (35.2%) controls, which showed a highly significant difference ($\chi^2 = 10.57$, *P* value =0.001) (Table 2). One hundred and sixty-seven (42.2%) participants experienced infection during their last pregnancy, including 44 (33.3%) cases and 123 (46.4%) controls, which showed a significant difference ($\chi^2 = 6.34$, $P = 0.012$).

Characteristics of last delivery

The overall mean gestational age at last delivery was 37.35 (4.06) weeks. The mean gestational age in the cases was

Table 1 Socioeconomic characteristics of study participants

Variables	Cases		Controls		*t* test	*P* value
	No.	Mean (SD)	No	Mean (SD)		
Mother's age at delivery	132	27.13 (5.95)	264	26.64 (5.50)	0.805	0.421
Mother's years of schooling	132	13.24 (2.69)	264	13.03 (2.54)	0.752	0.453
Mother's age at first marriage	132	20.65 (4.37)	264	19.94 (2.89)	1.698	0.091

SD = standard deviation.

33.80 (5.02) weeks and 39.12 (1.68) weeks in the controls, which showed a significant difference (*t* test 11.83, $P < 0.001$).

One hundred (25.3%) participants had caesarean section (Table 3), which was consistent with the 23.2% in public hospitals, reported by the Palestinian Ministry of Health (5). Sixty (45.5%) cases had a caesarean section for their last delivery, which was significantly higher than for the controls ($n = 40$, 15.2%) ($\chi^2 = 44.76$, $P < 0.001$).

Intrapartum complications developed in 148 (37.7%) participants, including 78 (60.5%) cases and 70 (26.5%) controls, which showed a significant difference ($\chi^2 = 42.5$, $P < 0.001$) (Table 3). The most common intrapartum complications were fetal distress (33.5%) and premature rupture of membranes (32.4%). Placental complications developed in 30 (7.6%) participants, including 22 (16.7%) cases and 8 (3.0%) controls, which showed a significant difference ($\chi^2 = 23.3$, $P < 0.001$). The most common placental complication was placenta previa (40.0%). Placental abruption and abnormalities were other common problems reported. Umbilical cord complications developed in 16 (4.0%) participants, including 11 (8.3%) cases and 5 (1.9%) controls, which was a significant difference ($\chi^2 = 9.4$, $P = 0.002$). Fifty-nine (14.9%) participants had an amniotic fluid complication, including 49 (37.1%) cases and 10 (3.8%) controls, which showed a significant difference ($\chi^2 = 77.1$, $P < 0.001$). Sixty-two (15.7%) participants had a uterine complication, including 43 (32.6%) cases and 19 controls (7.2%), which showed a significant difference ($\chi^2 = 42.9$, $P < 0.001$).

Postpartum complications developed in 65 (16.4%) participants, including 29 (22.0%) cases and 36 (13.6%) controls, which showed a significant difference ($\chi^2 = 4.45$, $P = 0.035$). The most common postpartum complications were haemorrhage (49.2%) and fever for > 3 days (29.2%). Other complications were sepsis, metabolic acidosis, and deep vein thrombosis.

Haemoglobin concentration at the time of delivery did not differ significantly between the cases and controls. This was not surprising as anaemia is one of the most important health issues in the Gaza Strip. In 2018, 39.7% of pregnant women with anaemia attended government health clinics (9). We found that 177 (44.7%) participants had anaemia at the time of delivery, including 62 (47.0%) cases and 115 (43.6%) controls. The lack of association between perinatal mortality and haemoglobin level in our study reflected that anaemia is a common problem among women in the Gaza Strip.

Infant-related characteristics of last pregnancy

We found that 97.8% of early neonatal deaths occurred in the hospital. The most common causes of early neonatal deaths were prematurity (40.7%), congenital malformation (38.5%), septicaemia (25.2%), and intrapartum complications (11.1%). These results agree with previous studies that reported an association between prematurity and early neonatal deaths (*11–14*).

Most participants ($n = 265$, 92.2%) had a singleton birth at their last pregnancy, including 104 (78.8%) cases and 261 (98.9%) controls, which showed a significant difference (Table 4). In contrast, significantly more cases ($n = 28$, 21.2%) than controls ($n = 3$, 1.1%) had twins or more. Triplets and quadruplets were reported only among cases, at 0.8% and 0.1%, respectively.

One hundred and six (26.8%) participants gave birth to a fetus weighing < 2500 g at their last pregnancy, including 91 (68.9%) cases and 15 (5.7%) controls, which showed a significant difference ($\chi^2 = 179.9$, $P < 0.001$) (Table 4). The cases had lower gestational age than the controls at the time of birth; therefore, they did not complete their full-term pregnancies and their neonates had low birth weight. These results agree with previous studies that reported an association between neonatal mortality and low birth weight (*11,12,15,16*). There were 353 (91.0%)

Table 2 Characteristics of last pregnancy

Variable	Category	Cases		Controls		χ^2 test	*P*
		No.	%	No.	%		
Type of pregnancy: assisted/normal	Normal	117	88.6	256	97	11.17	0.001
	Assisted	15	11.4	8	3.0		
Using contraceptive prior current pregnancy	No	95	72.0	134	50.8	16.23	0.000
	Yes	37	28.0	130	49.2		
Risky of pregnancy	Low risk	85	64.4	202	76.5	6.48	0.011
	High risk	47	35.6	62	23.5		
Complications developed during pregnancy	No	63	47.7	171	64.8	10.57	0.001
	Yes	69	52.3	93	35.2		
Infection during pregnancy	No	88	66.7	141	53.4	6.34	0.012
	Yes	44	33.3	123	46.4		
Exposure to X-ray or other imaging	No	130	98.5	255	96.6	1.16	0.280
	Yes	2	1.5	9	3.4		
Previous diseases	No	116	87.9	232	87.9	0.00	1.000
	Yes	16	12.1	32	12.1		

participants who had normal fetal growth. Twenty-nine (23.4%) cases had a fetus with growth restriction, compared with only 6 (2.3%) controls, and the difference was highly significant ($\chi^2 = 45.8$, $P < 0.001$).

Sixty-seven (16.9%) participants had a newborn with fetal abnormalities at their last pregnancy, including 67 (50.8%) cases but no controls ($P < 0.001$). The most common fetal abnormalities were cardiac deformities (21.9%) and body dysmorphia (17.1%). Our results are consistent with those of Zaqout et al., who showed that congenital heart diseases were common in the Gaza Strip, with a higher incidence than in neighbouring countries (17). According to Zaqout et al., the most frequent abnormalities were ventricular septal defect (28%), ostium secundum atrial septal defect (17%), patent ductus arteriosus (8.5%), and pulmonary valve abnormality (8%).

Multivariate regression analysis

Our logistic regression analysis showed a negative association between early neonatal deaths and absence of history of early neonatal deaths (Table 5). Controls without a history of early neonatal death were less likely to experience it in a subsequent pregnancy, in contrast to cases who did have a history of early neonatal death. The odds of early neonatal death among the controls who did not have a history of early neonatal death decreased by 86.1% (OR 0.139; 95% CI: 0.020–0976), after controlling for all other variables. Our results are consistent with previous studies that reported an association between

Table 3 Characteristics of last delivery

Variable	Category	Cases		Controls		χ^2 test	P
		No.	%	No.	%		
Gestational age	< 37 weeks	82	62.1	15	5.7	151.6	0.000
	≥ 37 weeks	50	37.9	249	94.3		
Mode of delivery	Spontaneous	71	53.8	211	79.9	44.76	0.000
	Assisted	1	0.8	13	4.9		
	CS	60	45.5	40	15.2		
Intrapartum complication	No	51	39.5	194	73.5	42.5	0.000
	Yes	78	60.5	70	26.5		
Placental complication	No	110	83.3	256	97.0	23.3	0.000
	Yes	22	16.7	8	3.0		
Umbilical complication	No	121	91.7	259	98.1	9.4	0.002
	Yes	11	8.3	5	1.9		
Amniotic complication	No	83	62.9	254	96.2	77.1	0.000
	Yes	49	37.1	10	3.8		
Uterine complication	No	89	67.4	245	92.8	42.9	0.000
	Yes	43	32.6	19	7.2		
Post-partum complication	No	103	78.0	228	86.4	4.45	0.035
	Yes	29	22.0	36	13.6		
Haemoglobin concentration-at the time of delivery	< 11 g/dl	62	47.0	115	43.6	0.414	0.520

Table 4 Infant characteristics of last pregnancy

Variable	Category	Cases		Controls		χ^2 test	P
		No	%	No	%		
Current pregnancy outcome	Singleton	104	78.8	261	98.9	49.1	0.000
	Twins or more	28	21.2	3	1.1		
Gender	Male	75	56.8	147	55.7	2.09	0.35
	Female	56	42.2	117	44.3		
Fetus weight	< 2500 g	91	68.9	15	5.7	179.9	0.000
	≥ 2500 g	41	31.1	249	94.3		
Fetal growth restriction	Yes	29	23.4	6	2.3	45.8	0.000
	No	95	76.6	258	97.7		
Fetal abnormalities	Yes	67	50.8	0	0.0	161.2	0.000
	No	65	49.2	264	100.0		

Table 5 Predictors of early neonatal deaths using binary logistic regression

Variable	B	SE	Wald	*P*	OR	95% CI
Previous history of early neonatal deaths	−1.973	0.994	3.937	0.047	0.139	(0.020–0.976)
History of previous stillbirth	2.448	1.175	4.340	0.037	0.086	(0.009–0.865)
Meconium aspiration syndrome	1.375	0.699	3.871	0.049	0.253	(0.064–0.995)
Amniotic fluid complication	−2.050	0.570	12.948	0.000	0.129	(0.042–0.393)
current pregnancy outcome	−3.145	1.094	8.265	0.004	0.043	(0.005–0.368)
Number of previous pregnancies	0.264	0.135	3.818	0.051	0.768	(0.590–1.001)
previous history of abortion	0.484	0.622	0.605	0.437	0.616	(0.182–2.086)
Mother age	−1.429	0.887	2.594	0.107	0.239	(0.042–1.363)
Premature rupture of membrane complication during delivery	−0.112	0.493	0.052	0.820	0.894	(0.340–2.349)
Umbilical cord complication	−0.867	0.920	0.888	0.346	0.420	(0.069–2.551)
Associated disease with current pregnancy	−0.144	0.430	0.112	0.738	0.866	(0.373–2.012)
Stress score	−0.149	0.746	0.040	0.842	0.862	(0.200–3.718)
Constant	13.662	3.163	18.657	0.000	857 671.869	

CI = confidence interval; OR = odds ratio.

early neonatal death and history of early neonatal death (*18*, *19*).

There was an association between history of stillbirth and early neonatal death (Table 5). The odds of early neonatal death among the controls who did not have a history of stillbirth decreased by 91.4%, compared with cases who did have a history of stillbirth (OR 0.086; 95% CI 0.009–0.865), after controlling for all other variables.

There was a negative association between early neonatal death and meconium aspiration syndrome (Table 5). The odds of early neonatal death among the controls who did not have meconium aspiration decreased by 74.7% compared with the cases who did have meconium aspiration (OR 0.253; 95% CI 0.064–0.995), after controlling for all other variables. Our results are consistent with previous studies that reported that meconium aspiration syndrome was an important cause of neonatal mortality and morbidity (*20*, *21*).

There was a negative association between early neonatal death and amniotic fluid complications such as oligohydramnios and polyhydramnios (Table 5). The odds of early neonatal death among the controls who did not have amniotic fluid complications during the last delivery decreased by 87.1% compared with the cases who did have amniotic fluid complications (OR 0.129; 95% CI 0.042–0.393), after controlling for all other variables. Our results are consistent with previous studies that reported an association between early neonatal death and amniotic fluid complications (*13*, *22*, *23*).

There was a negative association between early neonatal death and singleton pregnancy outcome (Table 5). The odds of early neonatal deaths among controls who had a singleton birth decreased by 95.7% compared with cases who did not have a singleton birth (OR 0.043; 95% CI: 0.005–0.0368). Our results are consistent with previous studies that showed an association between perinatal mortality and multiple births (*24–26*).

Conclusion

The main risk factors for early neonatal death were history of stillbirth, neonatal death, amniotic fluid complications, meconium aspiration, and outcome of last pregnancy. To reduce the prevalence of early neonatal mortality in the Gaza Strip, we recommend that healthcare providers introduce preconception care to their package of services, along with health education campaigns to raise women's awareness of pregnancy and obstetric complications and their impact on fetal and maternal mortality and morbidity. Postnatal care needs to be provided in a systematic way covering all new deliveries and not just high-risk pregnancies as in governmental primary health care, and the quality of care provided in neonatal intensive care units needs to be enhanced.

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Competing interests: None declared.

Étude cas-témoins en milieu hospitalier des facteurs de risque de mortalité néonatale précoce dans la bande de Gaza

Résumé

Contexte : La mortalité néonatale précoce est un indicateur épidémiologique essentiel de la santé maternelle et infantile.

Objectifs : Identifier les facteurs de risque des décès néonatals précoces dans la bande de Gaza.

Méthodes : La présente étude cas-témoins en milieu hospitalier a été menée auprès de 132 femmes ayant perdu un/des nouveau-né(s) entre janvier et septembre 2018. Le groupe témoin comprenait 264 femmes qui ont été sélectionnées par échantillonnage aléatoire systématique et qui ont donné naissance à des nouveau-nés vivants au moment de la collecte des données.

Résultats : Les témoins qui n'avaient pas d'antécédents de décès néonatal ou de mortinatalité étaient moins susceptibles d'avoir un décès néonatal précoce que les femmes qui avaient de tels antécédents. Les témoins qui n'avaient pas de syndrome d'aspiration méconiale ou de complications au niveau du liquide amniotique étaient moins susceptibles d'avoir un décès néonatal précoce que les femmes ayant connu ces complications pendant l'accouchement. Les témoins qui ont eu une grossesse unique avaient une moins grande probabilité d'avoir un décès néonatal précoce que les femmes ayant eu des naissances multiples.

Conclusion : Il est nécessaire de mettre en place des interventions pour fournir des soins préconceptionnels, améliorer la qualité des soins intrapartum et postnatals, assurer une éducation sanitaire de haute qualité et renforcer la qualité des soins dispensés par les unités de soins intensifs néonatals dans la bande de Gaza.

دراسة حالات وشواهد مستنِدة إلى المستشفيات لعوامل الخطر المتعلقة بوفيات المواليد المبكرة في قطاع غزة

أسماء النجار، ختام أبو حمد

الخلاصة

الخلفية: تُعدُّ وفيات المواليد المبكرة مؤشرًا وبائيًا أساسيًا لصحة الأمهات والأطفال.

الأهداف: هدفت هذه الدراسة إلى تحديد عوامل الخطر المتعلقة بوفيات المواليد المبكرة في قطاع غزة.

طرق البحث: شملت دراسة الحالات والشواهد المستندة إلى المستشفيات 132 امرأة تُوفي مولودها في المدة من يناير/ كانون الثاني إلى سبتمبر/ أيلول 2018. وتألفت المجموعة الشاهدة من 264 امرأة مُختارة باستخدام عينة عشوائية منتظمة، وولدت طفلًا حيًّا في وقت جمع البيانات.

النتائج: كانت النساء ضمن المجموعة الشاهدة اللاتي لم يسبق أن يملصن أو يُتوفى مواليدهن أقل عرضة لوفاة مواليدهن مبكرًا من النساء اللاتي لهن سوابق في ذلك. وكانت النساء ضمن المجموعة الشاهدة اللاتي لم يعانين من متلازمة اسْتِنشَاق العِقْي أو مضاعفات السائل السَّلَوي أقل عرضة لوفاة مواليدهن مبكرًا من النساء اللاتي عانين من هذه المضاعفات أثناء الولادة. وكانت النساء ضمن المجموعة الشاهدة اللاتي وضعن مواليد فرادى (حمل فردي) أقل عرضة لوفاة مواليدهن مبكرًا من النساء اللاتي ولدن ولادات متعددة (توائم).

الاستنتاج: يلزم إعداد تدخلات لتوفير الرعاية السابقة للحمل، وتحسين جودة الرعاية أثناء الولادة وبعدها، وتوفير تثقيف صحي عالي الجودة، وتحسين جودة الرعاية التي تقدمها وحدات الرعاية المركزة للحديثي الولادة في قطاع غزة.

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