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Original Article

Cause and Risk Factors of Delay Related to Neonatal Death in Afghan Immigrant Neonates Living in Tehran Province, Iran

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ABSTRACT

Background: Despite the global decline in neonatal mortality rates since 1990, reaching the Sustainable Development Goals (SDGs) targets by 2030 remains a considerable challenge. Three-quarters of infant deaths happen during the early infancy stage, influenced by fetal and maternal factors as well as health service readiness. Consequently, this period is crucial for mitigating the burden of infant mortality. Therefore, this critical period holds vital importance in alleviating the burden of infant mortality. Hence, the current study aimed to assess the factors contributing to early neonatal mortality, focusing on Afghan immigrant neonates and utilizing hospital information systems and medical records to identify potential determinants.

Methods: Throughout a 21-month study period from 2017 to 2018, data was collected from 576 neonates, comprising 441 neonatal near-miss (NNM) cases and 135 neonates who died and were admitted to the neonatal intensive care unit across six selected hospitals. Data collection methods included thorough reviews of hospital systems and medical records and conducting telephone or face-to-face interviews using checklists and questionnaires. Statistical analysis was performed using SPSS version 20 for Windows, with a significance level set at P<0.05 and confidence intervals at 95%. A logistic regression model was employed for analysis, enabling control for confounding variables. Results about risk factors were presented as both unadjusted (crude odds ratio) and adjusted odds ratios (ORs) alongside corresponding 95% confidence intervals (CIs). Statistical significance was established at a p-value of ≤ 0.05.

Results: Our data demonstrated that age of 20–35 (AOR = 1.394, 95% CI 1.209, 3.743; p = 0.005), mother's illiteracy [AOR 2.544, (95% CI, 1.316–6.498; p = 0.03)], newborn insurance [AOR 2.544, (95% CI, 2.387–10.656; p = 0.03)], risk factors of pregnancy [AOR 1.351, (95% CI, 1.833–5.978; p = 0.003)], number of pregnancies ≥ 5 [AOR 3.273, (95% CI, 2.083–10.84; p = 0.002)], 2-4 pregnancies [AOR 2.539, (95% CI,2.342–6.848; p = 0.007)], antenatal care [AOR 5.103, (95% CI,3.17- 056.901; p = 0.001)], gestational age [AOR 2.385, (95% CI, 2.322–9.652; p = 0.004)] and delay [AOR 3.178, (95% CI, 3.084–9.376; p = 0.001)] were linked to an increased risk of neonatal mortality. According to our findings, the first delay (delay in decision-making for care) was the most important delay factor involved in neonatal death, followed by the third delay (delay in receiving services) and the second delay (access to services).

Conclusion: The elevated neonatal mortality rate (NMR) observed among Afghan neonates in Iran underscores their heightened vulnerability when compared to their Iranian counterparts. Our study revealed significant associations between neonatal mortality risk and factors such as maternal age, maternal illiteracy, insurance coverage, pregnancy-related risk factors, high parity (≥ 5 pregnancies), moderate parity (2-4 pregnancies), antenatal care, gestational age, and delays in care-seeking behaviors. These findings emphasize the imperative of implementing targeted interventions to support Afghan mothers and their neonates by enhancing access to comprehensive antenatal care, promoting health literacy, addressing maternal health complexities, and raising awareness about neonatal morbidity risk factors.

Keywords: Fetal factor, Health service readiness, Delays in obstetric care, Maternal factor, Neonatal mortality, Risk factors

Introduction

The Neonatal Mortality Rate (NMR), defined as death within the first 28 days of life, is a crucial

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indicator for evaluating the healthcare system and socioeconomic development levels (1). The primary cause of infant mortality is concentrated in the neonatal period. In 2020, nearly half (47%) of all child deaths occurred in the newborn period within the first 28 days of life (2).

Globally, the NMR has witnessed a 52% decrease, dropping from 5 million in 1900 to 2.4 million in 2019. Nevertheless, its reduction trend is lower compared to post-neonatal period mortalities in under-five-year-olds (3,4). Various strategies are being implemented to reduce and prevent neonatal mortality, including initiatives like the Every Newborn Action Plan (ENAP), Promise Renewed, and Strategies towards Ending Preventable Maternal Mortality (EPMM) (4,5). The Promise Renewed and ENAP programs aim to decrease under-5 and neonatal mortalities by 2030 to fulfill the 2030 Sustainable Development Goals (SDGs) (5-7).

Despite significant progress in reducing neonatal mortality since 1990, there remains a substantial distance to traverse to achieve the SDG target by 2030 (8), particularly in South Asia (62%) and sub-Saharan Africa (36%), with the highest rates of under-five mortality (3). In Iran, 41% of neonatal deaths are linked to the care provided to pregnant women, while 18% are directly associated with childbirth and delivery.

Numerous factors are associated with determining the leading cause of neonatal deaths, yet the cause of most neonatal deaths often remains unknown in low- and middle-income countries (9-12). The main causes of death are classified based on factors related to the fetus (e.g., gestational age, gender, birth weight, birth order, monochorionic pregnancy, congenital malformations, birth injuries), maternal factors (e.g., maternal age, parity, health status, antenatal care, early initiation of breastfeeding, education level, residential and financial status), and healthcare service readiness (e.g., early diagnosis and proper monitoring of childbirth, appropriate referral systems, resource availability, and essential human resources) (12-20).

Studies indicate that perinatal mortality rates are higher among immigrants from industrialized countries compared to the native populations of those countries (9). Moreover, immigrants often face challenges like inadequate care due to language barriers, communication issues, and unequal access to obstetric services, more commonly than their European counterparts (21, 22).

Iran plays host to refugees from neighboring countries such as Afghanistan, with an estimated presence of one million registered migrants and over two million unregistered migrants from Afghanistan in the country (23). Despite fundamental interventions leading to 95% standard delivery care and a 75% reduction in maternal mortality in Iran between 1990 and 2015, inpatient care covered by health insurance was available to 90% of Iranians, with a lower coverage rate for immigrants (23-25). Afghan women are reported to encounter disparities in the quality of obstetric care, as indicated through evaluations of maternal near-miss (MNM) morbidity in Tehran (24, 26). A significant portion of infant deaths occur during early infancy, influenced by individual (neonatal and maternal) and facility-level factors, signifying a phase of decreasing burden on infant mortality (27).

Neonatal health conditions and maternal complications serve as determinants of neonatal mortality. Factors such as a lack of awareness regarding warning signs for neonatal illnesses, healthcare quality, socioeconomic and behavioral aspects, low maternal education levels, and limited autonomy can hinder mothers from seeking appropriate healthcare, thereby impacting children's health (27-29). Understanding the causes of neonatal mortality and its associated risk factors is crucial for reducing morbidity and mortality through necessary interventions. Therefore, the primary objective of the current study was to determine the rates of neonatal mortality, along with factors linked to neonatal mortality, by considering both individual (maternal and fetal) and facility-level factors among neonates born to Afghan immigrants.

Methods

The study design, and setting

This descriptive-analytical study aimed to identify the causes and risk factors associated with delays contributing to neonatal mortality. The study considered individual and facility-level factors among Afghan immigrants admitted to selected hospitals in Tehran province between March 21, 2017, and December 21, 2018.

Data source and study participant

The study selected general and academic maternity hospitals in Tehran through a complete population census. These hospitals are affiliated with three universities of Medical Sciences in Iran: Tehran and Shahid Beheshti. According to the Ministry of Health's annual report, six hospitals were chosen based on the highest number of

Afghan mothers giving birth.

In a study involving 10,011 deliveries, 576 neonates were analyzed, comprising 441 neonatal near-miss (NNM) cases and 135 neonatal deaths. Neonates and mothers with insufficient demographic and admission outcome information in the hospital system or medical records were excluded from the study if the mothers did not partake in telephone or face-to-face interviews. The data analyzed in our study focused on the 576 admitted newborns who met the inclusion criteria and were assessed for the four types of delay variables.

All Afghan neonates were incorporated into the study based on neonatal near-miss morbidity criteria from established studies. The eligibility criteria used to identify potential cases included all Afghan newborns admitted to the neonatal intensive care unit after birth or referred from home due to complications within the first 28 days of life, as well as all newborns who died within 28 days of birth.

Mothers were screened by hospital staff using data from the national Maternal and Neonatal Health Information Network (IMaN) and/or through phone calls or in-person interviews, ensuring written informed consent was obtained in cases where addresses were not accurately registered. Causes of death and the social determinants contributing to neonatal deaths were evaluated using verbal autopsy and social autopsy (VASA). Verbal autopsy involves conducting interviews with caregivers of deceased children to gather information about the signs and symptoms observed during the final illness. Social autopsy interviews focus on probing the family's and health system's reactions to the child's fatal illness.

Given the absence of a similar study and the lack of precise statistics on neonatal near-miss (NNM) cases and deaths among Afghan neonates in Iran, non-Iranian neonates in the hospital information system were initially extracted through a census. Subsequently, Afghan nationality was identified, and the number of Afghan neonates was determined. Medical records of Afghan neonates hospitalized in specialized and intensive care units, as well as records of deceased newborns in the hospital information system, were segregated from those of non-Iranian neonates.

Study setting

Tehran province, home to approximately 13.5 million residents, accommodates a significant Afghan immigrant population. The province boasts around 140 public and private hospitals offering medical services, with statistics indicating Tehran's prominence in the number of births. Official authorization from the Ministry of Health allowed the extraction of data on Afghan mothers and newborns registered in six hospitals across Tehran province from the IMaN network system.

Initially, access to the IMaN system information required approval from the Iran Ministry of Health and Medical Education and the Neonatal Health Department. However, the data within these systems proved incomplete, lacking comprehensive details on neonatal near-miss (NNM) cases and mortality among Afghan immigrant newborns in Tehran province. Consequently, a thorough review of individual medical records was imperative to gather the necessary information.

Upon endorsement of the proposed research plan and approval from the Ethics Committee of Iran University of Medical Sciences, a formal letter of recommendation was submitted to the relevant University of Medical Sciences. The researcher then sought a letter of recommendation for sampling in the designated hospitals of this university from the vice president of treatment in Tehran province. Clarifying the research objectives and its significance to the hospital's educational supervisor was a crucial step in the process.

Proceeding to each hospital's medical records, the researcher initially extracted the number of live births from Afghan mothers. Subsequently, NNM outcomes, neonatal deaths, and morbidity data pertaining to Afghan newborns were documented. Non-Iranian cases were isolated from the system, Afghan nationality was identified, and information was systematically recorded in the questionnaire after case extraction and review.

In instances of neonatal deaths, interviews with mothers were conducted either in person or via phone communication. All participating mothers completed written informed consent forms ahead of the interviews.

Data collection tool

The information for this study was gathered from various sources, including medical records of mothers and infants, the IMaN system, interviews with mothers conducted either in person or via telephone, reviews of the final reports from the university committee on maternal and infant mortality, and a delay checklist developed by the

researchers based on the World Health Organization model. The research team completed and finalized this checklist based on the data collected.

Maternal information encompassed details on reproductive health and demographics, such as age, education level, employment status, place of residence, residency status, family income, insurance coverage, birth dates of the newborns and dates of death, obstetric complications, number of antenatal care visits, type of delivery, history of abortion, history of stillbirth, maternal health conditions, pregnancy risk factors, childbirth complications, interventions during childbirth, parity, and gestational age.

Information about neonatal health included the newborns' gender, birth weight, 5-minute Apgar score, hospitalization history, neonatal morbidity leading to death, and reasons for admission of the baby before death.

The questionnaire comprised a checklist of delay factors affecting mortality, comprising 22 questions. Thirteen questions addressed the first delay, focusing on the delay in decision-making for care (e.g., location of delivery, maternal knowledge concerning neonatal near-miss morbidity, home remedies, time lost after diagnosis or onset of symptoms in the newborn, and choice of care facility). Two questions pertaining to the second delay are related to delays in reaching care (e.g., delays exceeding two hours due to distance or inadequate means of transportation). The remaining seven questions centered on the third delay, concerning delays in accessing appropriate health services (e.g., referral of the baby to another facility due to equipment shortages or logistical challenges and delays exceeding one hour in admitting the newborn to the health unit).

Statistical analysis

The data analysis included descriptive statistics (prevalence, mean, percentage) and inferential statistics (chi-square test). Logistic regression was employed to identify factors associated with neonatal mortality. The results of the risk factors were presented as unadjusted (crude odds ratio) and adjusted odds ratios (ORs), along with their 95% confidence intervals (CIs). Statistical analyses were conducted using SPSS version 20.0 for Windows (SPSS Inc., IBM Corp., Armonk, NY, USA), with a significance level set at a p-value of ≤ 0.05.

Ethical Approval

This study has been approved by the Iran University of Medical Science (IR.IUMS.REC. 1396.9411373006). All the experiments of this study were conducted in accordance to the relevant guidelines and regulations or in accordance to the Declaration of Helsinki.

Results

Socio-demographic characteristics of mothers

Socio-demographic characteristics of mothers of newborns are presented in Table 1. The mothers of 75.6% of the newborns that died were aged 20–35. Most, 422 (95.7%), of the mothers in NNM cases that survived were aged 20–35. Furthermore, 4 (3%) of mothers whose neonates died and 16 (3.6%) of mothers whose neonates survived (NNM cases) were university-educated. 33 (24.4%) mothers whose neonates died were rural residents, and 81 (18.44%) mothers whose newborns survived (NNM cases) were rural residents (Table 1). In addition, 108 (80%) mothers whose newborns died were low-income, compared with 362 (82.1%) mothers whose were low-income (Table 1). Additionally, 131 (97%) of mothers whose newborns died did not have insurance compared to 406 (92.2%) mothers whose neonates died.

Maternal characteristics

Forty-one (30.4%) of mothers whose newborns died received antenatal care, while 344 (78%) of mothers whose newborns survived (NNM cases) attended antenatal care. Furthermore, 40 (29.6%) mothers whose newborns died had a history of abortion, compared to 69 (15.6%) mothers whose newborns survived (Table 2).

One hundred and four (77 %) mothers whose newborns died had a gestational age of <37 weeks compared to 228 (51.7%) mothers whose newborns survived. Thirty-two (23.7%) of mothers whose neonates died had a history of corticosteroid administration compared to the mothers whose newborns survived, 47 (10.7%). In addition, out of the mothers whose neonates died, 7 (5.9%), 82 (60.7%), 25 (18.5), and 11 (8.1%) of mothers whose neonates died had a history of stillbirth and neonates death, pregnancy risk factors, childbirth risk factors, and disease history, respectively. In comparison, among the mothers of surviving neonates, 11 (2.5%), 231 (52.4%), 57 (12.9%), and 32 (7.3%) had similar respective experiences (Table 2).

Delivery associated characteristics

Delivery-related characteristics are detailed in

Table 1. Socio-demographic characteristics associated with neonatal mortality in the six selected Hospitals from 2017–2018

Demographic characteristics of the mother		The baby died		Babies close to death		Test result
		Number	Percent	Number	Percent	
Mother's age	20<	16	11.6	13	2.9	X2=53.539 P=0.0001 Df=2
	20-35	102	75.6	422	95.7	
	35>	17	12.6	6	1.4	
Education	illiterate	57	42.2	207	46.9	X2=33.97 P=0.001 DF=3
	elementary	49	36.3	121	27.4	
	Middle school -high school	25	18.5	97	22	
	University	4	3	16	3.6	
Certificate of residence	Application card	62	45.9	220	49.9	P=0.008 X2=9.743 Df=2
	Passport	40	29.6	162	36.7	
	Undocumented/ unregistrated	33	24.4	59	13.4	
Address	City	102	75.6	360	81.6	P=0.1 X2=2.405 DF=1
	Village	33	24.4	81	18.4	
Insurance	Yes	4	3	35	7.9	P=0.04 X2=4.050 DF=1
	No	131	97	406	92.2	
Family income	Low	108	80	362	82.1	P=0.7 X2=0.570 DF=2
	Middle	26	19.3	74	16.8	
	High	1	0.7	55	1.1	
Duration of migration	Born in Iran	16	11.9	90	20.4	P=0.01 X2=8.854 DF=2
	< 5 years	73	54.91	180	40.8	
	5> years	46	34.1	171	38.8	
Kinship relationship	has it	79	58.5	98	22.2	X2=1.950 P=0.1 DF=1
	does not have	56	41.5	343	77.8	

Table 2, where our analysis revealed that 76.6% of the neonates were classified as NNM cases, with 23.4% experiencing mortality. A higher percentage of male neonates was observed among both dead (73; 54.1%) and surviving neonates (247; 56%). Additionally, 65.9% of deceased neonates had a low birth weight (< 2499 grams) compared to 51% of surviving neonates. Most deceased neonates (94.1%) were born in a hospital, while the vast majority of survivors (99.1%) were also born in a hospital. Furthermore, 48.9% of dead neonates had a 5-minute Apgar score ≤ 7, in contrast to 15.6% of surviving neonates. Notably, half of the deceased neonates experienced birth delays, while none of the surviving neonates in the NNM cases encountered such delays.

Socio-demographic, maternal, and delivery characteristics associated with neonatal mortality

Socio-demographic factors associated with neonatal mortality are shown in Table 1. Delivery and pregnancy outcome associated with neonatal mortality is shown in Table 2. The non-parametric Chi-square test was used because the data did not have a normal distribution. The results revealed that neonates' death was significantly related to the variables of mother's age (P=0.001), mother's education (P=0.001), residency certificate (P=0.008), lack of insurance (P=0.04), duration of migration (P=0.01), antenatal care (P=0.0001), abortion history (P=0.0001), risk factors during pregnancy (P=0.001), number of pregnancies (P=0.0001), number of previous births (P=0.0001), delivery factor (P=0.0001), gestational age (P=0.0001), corticosteroid administration (P=0.001), neonate weight (P=0.002), 5-min Apgar score (P=0.0001) and delay (P=0.001).

Neonates' death was not found to be significantly related to the variables of residence (P=0.1), family income (P=0.7), marriage kinship (P=0.1), history of stillbirth and newborn death (P=0.05), risk factors during pregnancy (P=0.1), intervention during delivery (P=0.06), history of maternal illness (P=0.7), multiple births (P=0.1)), type of delivery (P=0.4), place of birth (P=0.08) and gender of the neonate (P=0.6).

Upon adjusting for socio-demographic characteristics, it was found that women aged 20–35 faced a 1.39 times higher risk of neonatal death compared to other age groups (AOR = 1.394, 95% CI 1.209, 3.743; p = 0.005). Furthermore, additional socio-demographic factors correlated

Table 2. Delivery and maternal outcome-related factors associated with neonatal death in the six selected Hospitals from 2017–2018

Obstetric characteristics of the mother		Death (baby)		Close to death (baby)		Test result
		Number	Percent	Number	Percent	
Care during pregnancy	Yes	41	30.4	344	78	X2=1.058 P=0.0001 DF=1
	no	94	69.6	97	22	
History of abortion	Yes	40	29.6	69	15.6	P=0.0001 X2=13.173 DF=1
	No	95	70.4	374	84.4	
History of stillbirth and infant death	Yes	7	5.9	11	2.5	P=0.05 X2=3.816 DF=1
	No	127	94.1	430	97.5	
Pregnancy risk factors	Yes	82	60.7	231	52.4	P=0.001 X2=27.763 DF=1
	No	53	39.3	210	47.6	
Birth risk factors	Yes	25	18.5	57	12.9	P=0.1 X2=2.648 DF=1
	No	110	81.5	384	87.1	
Intervention during childbirth	Yes	26	19.2	55	12.5	P=0.06 X2=3.527 DF=1
	No	109	80.8	386	78.5	
History of mother's illness	Yes	11	8.1	32	7.3	P=0.7 X2=0.119 DF=1
	No	124	91.9	409	92.7	
Gravida	1	37	27.4	173	39.2	P=0.0001 X2=35.284 DF=2
	2-4	61	45.2	232	52.6	
	≥5	37	27.4	36	8.2	
The number of previous births of the mother	First birth	29	21.5	160	36.3	P=0.0001 X2=33.145 DF=2
	2-1	51	37.7	185	41.9	
	≥3	55	40.8	96	21.8	
Care provider during birth	Expert	100	74.1	254	57.6	P=0.0001 X2=30.535 DF=3
	Midwife	27	20	183	41.5	
	The person has seen the course	1	0.7	1	0.2	
	The person has not seen the course	7	5.2	3	0.7	
Gestational age	≤37	104	77	228	51.7	P=0.0001 X2=29.75 DF=2
	≥37	31	23	213	48.3	
Multiple births	Yes	8	5.9	47	10.7	P=0.1 X2=2.679
	No	127	94.1	394	89.3	
Type of delivery	Normal	69	51.1	209	47.4	P=0.4 X2=0.572 DF=1
	Cesarean section	66	48.9	232	52.6	
Corticosteroid prescription in pregnancy	Yes	32	23.7	47	10.7	P=0.001 X2=14.870 DF=2
	No	100	74.1	382	86.6	
	Unknown	3	2.2	12	2.7	
Baby's profile		Death		Close to death		Test result
		Number	Percent	Number	Percent	
Place of birth	Hospital	127	94.1	437	99.1	P=0.08 X2=2.911 DF=1
	Non-hospital	8	5.9	4	0.9	
Baby's weight	≤2499 grams	89	65.9	225	51	P=0.002 X2=9.261 DF=1
	≥ 2500 grams	46	34.1	216	49	
Gender of the baby	Girl	62	45.9	194	44	P=0.6 X2=0.157 DF=1
	Boy	73	54.1	247	56	
5 min Apgar score	7≤	66	48.9	69	15.6	P=0.0001 X2=63.65 DF=1
	8-10	69	51.1	372	84.4	
Delay	Yes	50	37	0	0	P=0.0001 X2=1.73 DF=1

Table 3. Investigating the impact of demographic and obstetric factors of mothers on the mortality of Afghan immigrant infants in Tehran province through logistic regression analysis

Variable		Unadjusted				Adjusted			
		B	OR	95% confidence interval	P	B	OR	95% confidence interval	P
Mother's age	<20	0.834	2.302	0.705-2.522	0.1	0.241	1.273	0.245-1.616	0.7
	20-35	2.461	1.256	0.208 -2.715	0.0001	1.755	1.394	1.209 – 3.743	0.005
	>35	1		Reference		1		Reference	
Education	illiterate	1.241	3.968	1.454-8.793	0.04	1.631	2.643	1.316 -6.498	0.03
	Elementary and middle school	0.70	0.932	0.460-1.88	0.6	0.34	1.477	0.774 -2.594	0. 2
	High school	1.015	0.970	0.298-3.153	0/9	-0.259	0.77	0.222-1.699	0.6
	University	1		Reference		1		Reference	
Insurance	Yes	-1.038	0.354	0.124-1.015	0/05	-1.295	2.544	2.387-10.656	0.04
	No	1		Reference		1		Reference	
Proof of residence	Application card	0.685	1.845	1.003 – 3.197	0/009	-0.497	0.609	0.276-1.341	0. 2
	Passport	0.818	0.011	0.001 -0.221	0/004	-0.635	0.530	0.228-1.230	0. 1
	Undocumented	1		Reference		1		Reference	
Duration of migration	Born in Iran	0.825	2.351	1.693 -5.738	0.007	0.518	1.679	0.752-3.746	0. 1
	<5 years	0.411	1.508	0.698-2.304	0.05	0.379	1.460	0.793-2.689	0. 2
	> 5 years	1		Reference		1		Reference	
Gravida	1	1		Reference		1		Reference	
	4-2	1.363	3.555	2.825 -7.329	0.0001	1.066	2.539	2.342-6.848	0.007
	≥5	1.570	2.032	3.469 – 8.252	0.0001	1.458	3.273	2.083- 10.840	0.002
Number of previous births	First birth	0.83	2.30	728.322-0.7	0. 1	0.325	1.384	0.218 -8.970	0.7
	1-2	0.510	1.665	1.2-066.599	0.02	0.233	1.263	0.629 -2.537	0.5
	≥3	1		Reference		1		Reference	
History of abortion	Yes	-0.820	2.441	043.739-1.6	0.0001	-0.441	0/643	0.3-131.322	0.2
	No	1		Reference		1		Reference	
Pregnancy care	Yes	-2.096	3.123	080-3.19.248	0.0001	-2.268	5/103	3.17-056.901	0.0001
	No	1		Reference		1		Reference	
Pregnancy risk factors	Yes	0.341	1.407	1.15-2.083	0.08	0.923	1.351	1.5-833.978	0.003
	No	1		Reference		1		Reference	
Gestational age	< 37 weeks	1.973	1.264	1.156-0.567	0.02	1.869	2/385	2.322-9.652	0.04
	≥37 weeks	1		Reference		1		Reference	
Birth provider	Expert	0.716	2.489	1.5-262.583	0.02	1.311	2.126	0.5-807.604	0.1
	Midwife	0.212	1.339	1.2-083.380	0.01	0.785	1/228	0.665 -2.267	0.5
	The person has seen the course	0.352	0.228	0.198-0.281	0.05	0.532	0.849	0.458 -1.574	0.6
	The person has not seen the course	1		Reference				Reference	
Baby weight	≤2499	1.216	2.876	1.7-067.276	0.03	0.986	1.715	0.558 -5.271	0.1
	≥2500	1		Reference		1		Reference	
Corticosteroid administration	Yes	0.189	0.394	0.1-113.380	0.1	0.656	1.023	0.638-2.324	0.1
	No	1		Reference		1		Reference	
5 min Apgar score	≤7	1.564	1.779	1.220-4.968	0.02	1.246	1.690	1.123-2.803	0.05
	8-10	1		Reference	1	1		Reference	
Delay	Yes	5.556	3.109	3.8-055.215	0.0001	5.628	3.178	3.084-9.376	0.0001
	No	1		Reference		1		Reference	

Table 4. Frequency distribution of causes of neonatal deaths based on delay factors

Cause of death	Total	Delay in decision making for care		Delay in reaching care		Delay in receiving care	
		no	yes	no	yes	no	Yes
Premature delivery and respiratory complications	101 (100)	73 (72.3)	28 (22.7)	89 (88.1)	12 (11.9)	83 (82.2)	18 (17.8)
Congenital anomalies	46 (100)	33 (71.7)	13 (78.3)	39 (84.8)	7 (15.2)	38 (82.6)	8 (17.4)
Infections	35 (100)	16 (45/7)	19 (54.3)	27 (77.1)	8 (22.9)	20 (57.1)	15 (42.9)
Nervous	28 (100)	18 (64/3)	10 (35.7)	22 (78.6)	6 (21.4)	17 (60.7)	11(39.3)
Metabolic	8 (100)	6 (75)	2 (25)	6 (75)	2 (25)	3 (37.5)	5(62.5)
Kernicterus	3 (100)	1 (33/3)	2 (66.7)	2 (66.7)	1(33.3)	1(33.3)	2 (66.7)

with an elevated risk of neonatal death included maternal illiteracy [AOR 2.544, (95% CI, 1.316–6.498; p = 0.03)] and absence of newborn insurance [AOR 2.544, (95% CI, 2.387–10.656; p = 0.03)], (Table 3).

After adjusting for delivery and maternal outcome-related factors, number of pregnancies ≥ 5 [AOR 3.273, (95% CI, 2.083–10.84; p = 0.002)], 2-4 pregnancies (<1500g) [AOR 2.539, (95% CI,2.342–6.848; p = 0.007)], antenatal care [AOR 5.103, (95% CI,3.17- 056.901; p = 0.001)], risk factors of pregnancy [AOR 1.351, (95% CI, 1.833–5.978; p = 0.003)], gestational age [AOR 2.385, (95% CI, 2.322–9.652; p = 0.004)] and delay [AOR 3.178, (95% CI, 3.084–9.376; p = 0.001)] were found to be significantly associated with an increased risk of neonatal death (Table 3).

Factors contributing to the first delay included premature birth, respiratory problems, infections, and congenital abnormalities. The second delay encompassed premature birth, infections, and congenital anomalies. Lastly, the third delay involved premature birth, infections, and neurological conditions.

Discussion

In the present study, the mortality rate among Afghan immigrant neonates residing in Tehran province over one year stood at 13.4 per 1000 live births. Comparatively, the global NMR) was reported as 7.17 per 1000 live births in 2018 (30). Noteworthy progress has been made in Iran, with the NMR declining from 16 per 1000 live births in 2004 to 9.5 per 1000 live births in 2015 (31).

A significant number of neonatal deaths worldwide occur within the first week of birth, aligning with the outcomes of our investigation. Studies by Babaei et al. reported a similar pattern, with a majority of deaths among newborns taking place within the first week, often attributable to respiratory distress syndrome, particularly peaking after the third day (31,32).

In our current research, a higher percentage of male neonates was observed among both deceased (73; 54.1%) and surviving neonates (247; 56%). Consistent with a repeated cross-sectional study by Karlsson et al. (2019) (33), male neonates exhibited a higher mortality rate than female neonates, a trend that our study also reflected.

Furthermore, our study revealed that 89 (65.9%) of the dead neonates had a low birth weight (< 2499 grams), in contrast to the surviving neonates, where 225 (51%) fell into this category. Moreover, 34.1% of the deceased neonates weighed over 2500 grams, with the average weight amounting to 1900 grams, consistent with findings from various other studies (34,35). For neonates weighing over 2500 grams, mortality might be linked to congenital abnormalities, particularly cardiac issues, which also emerged as a significant cause of mortality.

Numerous studies conducted in Iran have highlighted various factors contributing to newborn mortality, such as birth asphyxia, low birth weight (below 2500 grams), premature birth, respiratory distress syndrome, sepsis, and congenital heart diseases (31,36,37). The NMR pattern appears to vary across different regions in Iran and even among different hospitals, influenced by socio-demographic, maternal, and delivery characteristics. Identifying the causes of death in Neonatal Intensive Care Units (NICUs) and addressing modifiable factors associated with

mortality holds promise for reducing neonatal deaths.

In our current study, premature birth, respiratory complications, congenital anomalies, and infections emerged as the three primary causes of death among Afghan immigrant neonates in Tehran province, Iran. Our findings align with a study by Rasmiya and colleagues in Iraq, where premature birth, congenital anomalies, and infections were also identified as the leading causes of neonatal mortality (38).

Premature birth was identified as the leading cause of neonatal death in our study, likely stemming from inadequate or insufficient antenatal care, low maternal literacy levels, and a lack of awareness among mothers regarding pregnancy risk symptoms. In Afghanistan, the main causes of infant mortality include premature birth, birth complications, asphyxia, and pneumonia. The incidence of premature and low birth weight babies among Afghan immigrant neonates was reported to be higher than that of Iranian and Pakistani neonates (39-41). Factors such as a lack of skilled healthcare providers, substandard quality of Maternal and Neonatal Health (MNH) services, poverty, and low maternal literacy contribute significantly to infant mortality in Afghanistan (39).

Furthermore, congenital anomalies ranked as the second leading cause of death among Afghan immigrant neonates in our study, aligning with findings from Demitto et al. (2017) (42). Failure to receive adequate prenatal care likely contributes to neonatal deaths associated with abnormalities (43).

Infection, notably neonatal sepsis, was reported as the third leading cause of neonatal mortality in our study, echoing findings from the research by Fottrell et al. (2015) (44). Sepsis is a predominant cause of death during the initial months of life, accounting for 30-50% of newborn deaths in developing nations. Prolonged hospitalization in neonatal units and exposure to invasive procedures increase the risk of infections among neonates (45).

In our study, following adjustments for delivery and maternal outcome-related factors, certain factors such as maternal age falling within the range of 20–35 years, maternal illiteracy, newborn insurance, pregnancy risk factors, having five or more pregnancies, 2-4 pregnancies, access to antenatal care, gestational age, and delays were found to be associated with an elevated risk of neonatal mortality.

Among the pregnancy risk factors highlighted, 21 mothers experienced high blood pressure during pregnancy, emerging as the most significant risk factor in this context. Studies have indicated that such pregnancy risk factors can lead to premature birth and complications affecting neonatal health. A higher level of maternal education has been linked to lower infant mortality rates, as observed in countries like Afghanistan and Iraq (46,47). Consistent with prior research findings (48-51), antenatal care was identified as a protective factor against neonatal mortality in our study, notwithstanding a relatively high percentage of Afghan immigrant women not receiving adequate antenatal care.

Consistent with our study results, an increase in the number of pregnancies has been associated with a heightened risk of neonatal mortality, potentially leading to premature birth and neonatal complications (42,52).

When comparing women aged 20–35 to other age groups, the risk of neonatal mortality was found to be 1.39 times higher in this particular age range ($p = 0.005$). This age group has been notably linked to neonatal mortality in Brazil (53). However, contrasting findings have indicated that women over 35 years old are more prone to pregnancy complications, including issues like high blood pressure, fetal growth restriction, premature birth, stillbirth, and neonatal mortality, as highlighted in a systematic review and meta-analysis (54). This discrepancy is likely attributable to the higher representation of mothers within the 20-35 age group in the current study.

Gestational age was significantly linked to an increased risk of neonatal mortality in our current study ($p = 0.004$), with infants born at 32-37 weeks facing a higher mortality rate. These findings are somewhat consistent with the research by Ndombo et al. (2017) (55). Maternal presence of pregnancy-related risk factors can contribute to premature birth, underscoring the need for vigilant monitoring to avert preterm deliveries (31). Among the mothers whose neonates died, 82 (60.7%) had pregnancy risk factors, childbirth complications, and medical histories, in contrast to 231 (52.4%) of the mothers whose newborns survived.

The absence of insurance coverage ($p = 0.03$) was identified as a factor associated with an elevated risk of neonatal death in our study, with 131 (97%) of mothers whose newborns died lacking insurance, compared to 406 (92.2%) of mothers whose neonates survived. Only 3% of mothers whose newborns and neonates died were

insured. Uninsured Afghan immigrant newborns displayed a statistically significant correlation with premature birth (40). Immigrant women receive less prenatal care compared to native women in developed nations due to lacking health insurance, resulting in adverse childbirth and neonatal outcomes (56). Besides health insurance coverage, sociocultural factors and language disparities can impede access to healthcare services.

Based on our findings, the primary delay (decision-making delay in seeking care) emerged as the most crucial factor contributing to neonatal mortality. In our study, the foremost predictive element in the primary delay was the mother's lack of awareness regarding her newborn's health condition. These results align with research by Salih et al. (2017) in Sudan (57), who investigated factors contributing to neonatal mortality through the three delays audit. Studies by Waiswa et al. (2010) in Uganda (58) and Bogale (2017) in Ethiopia (59) highlighted that the most critical factor predicting mortality was the delay in seeking care after the newborn's disease was diagnosed.

In certain studies conducted in Tanzania and India, the second delay (access to services) has been identified as the second most critical factor leading to neonatal mortality, whereas in the present study, access to services is ranked as the third most significant contributor to neonatal deaths (60). This distinction may stem from factors like more neonates facing challenges in reaching care facilities due to long distances, limited transportation options, or differences in how delays are categorized.

In our current study, the third delay (delay in receiving services) was recognized as the second factor linked to infant mortality. This finding aligns with the research by Waiswa et al. (2010) in Uganda (59). Contrarily, findings by Mbaruku (2009) in Tanzania (61) revealed a stark contrast to our study, as the third delay was highlighted as the primary factor associated with newborn deaths. This discrepancy could be attributed to the exclusion of hospital data for neonates aged over one week, alongside the inclusion of perinatal death data rather than focusing exclusively on infant mortality, which might have led to a potential overestimation of the impact of the third delay.

In an assessment of missed opportunities in neonatal deaths in Rwanda conducted by Wilmot et al. (2017), the third delay emerged as the foremost factor contributing to neonatal mortality (62). This variance could be tied to a notable percentage of infants being admitted to medical facilities before their demise and the omission of out-of-hospital deaths from consideration.

Conclusion

The elevated NMR observed among Afghan neonates in Iran underscores their heightened vulnerability in comparison to Iranian neonates.

Our findings revealed that factors such as maternal age, maternal illiteracy, availability of newborn insurance, pregnancy risk factors, higher number of pregnancies (≥ 5 or 2-4 pregnancies), antenatal care, gestational age, and delays were all associated with an escalated risk of neonatal mortality. Inadequate prenatal care or the absence thereof during pregnancy has tragically resulted in the loss of newborn lives. Therefore, comprehensive antenatal care must be universally accessible to all pregnant individuals, particularly those belonging to high-risk groups, transcending national, racial, and religious distinctions. Addressing antenatal care provision and enhancing awareness regarding health conditions, maternal complications, and warning signs of neonatal illnesses are paramount in preventing neonatal deaths.

Pregnancy-related risk factors significantly contribute to neonatal mortality, underscoring the importance of community education on promoting healthy pregnancies and recognizing potential complications. The lack of education and awareness among mothers regarding neonatal illnesses poses a significant barrier, constituting the primary delay factor in neonatal deaths. Premature delivery, respiratory issues, and subsequent complications stand out as major causes of mortality among Afghan neonates. Therefore, a concerted effort to reduce neonatal mortality hinges on strategies aimed at preventing preterm births, low birth weight, and infections, alongside implementing prenatal screenings, early intervention for congenital abnormalities, and expedited and effective management of pregnancy-related complications during labor and delivery.

Conversely, limited access to healthcare services, stemming from issues like lack of insurance coverage and cultural constraints, can lead to delays in treatment, amplifying the risk of neonatal mortality. Extending medical coverage to Afghan immigrants has the potential to alleviate the financial burden of treatment, thereby dismantling barriers to healthcare access. Low birth weight and appropriate drug therapy in

Afghan neonates emerge as pivotal factors in NNM, warranting focused attention on healthcare interventions aimed at enhancing neonatal outcomes.

Acknowledgments

None.

Conflicts of interest

The authors declare that they have no competing interests.

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