Article

Not peer-reviewed version

Determinants of Neonatal Mortality at the David Bernardino Paediatric Hospital in Angola: A Case-Control Study Using Theoretical Frameworks

Israel C. Avelino *, Joaquim Van-Dúnem , Luís Varandas *

Posted Date: 7 October 2024

doi: 10.20944/preprints202410.0434.v1

Keywords: Angola; neonatal mortality; neonatal care; case-control study

Article

Determinants of Neonatal Mortality at the David Bernardino Paediatric Hospital in Angola: A Case-Control Study Using Theoretical Frameworks

Israel C. Avelino [1,2,*], Joaquim Van-Dúnem [3] and Luís Varandas [1,4,5,*]

[1] Global Health and Tropical Medicine, GHTM, LA-REAL, Instituto de Higiene e Medicina Tropical, IHMT, Universidade NOVA de Lisboa, Lisboa, Portugal
[2] Clínica Multiperfil, Luanda, Angola
[3] Faculty of Medicine, Agostinho Neto University, Luanda, Angola; joaquim.vandunen@uan.ao
[4] Nova Medical School, Faculdade de Ciências Médicas, Universidade Nova de Lisboa, Lisboa, Portugal
[5] Departamento de Pediatria, Hospital Dona Estefânia, Lisboa, Portugal
* Correspondence: a21001355@ihmt.unl.pt (I.C.A.); varandas@ihmt.unl.pt (L.V.)

Abstract: Neonatal mortality rates in developing countries are influenced by a complex array of factors. Despite advancements in healthcare, Angola has one of the highest neonatal mortality rates in sub-Saharan Africa, with significant contributors including premature birth, intrapartum events, tetanus, and sepsis. This study aimed to identify the primary causes and contributing factors of neonatal mortality among infants admitted to the Neonatology Service at DBPH in Luanda from May 2022 to June 2023. A retrospective matched case-control design was employed, pairing each neonatal death with two surviving neonates based on age and sex. The analysis included 318 newborns, of whom 106 experienced hospital deaths. A stepwise binary logistic regression model was used to examine associations between variables and neonatal mortality. Variables with $p < 0.25$ in bivariate analysis were included in the multivariate model. Significant factors associated with neonatal mortality included: a low Apgar score at 1 minute (< 7) (OR 2.172; 95% CI: 1.436–4.731); maternal age under 20 years (OR 3.746; 95% CI: 2.172–6.459); home delivery (OR 1.769; 95% CI: 1.034–3.027); and a short hospital stay of ≤ 48 hours (OR 2.791; 95% CI: 1.183–6.587). Addressing these issues requires urgent interventions, including improving Apgar score management through enhanced training for healthcare professionals, supporting young mothers with intensified maternal education, ensuring deliveries occur in appropriate healthcare settings, and improving universal health coverage and referral systems. These measures could be crucial for enhancing neonatal care and reducing mortality.

Keywords: Angola; neonatal mortality; neonatal care; case-control study

1. Introduction

Neonatal mortality, defined as death occurring within the first 28 days of life [1], poses a significant challenge to global public health, particularly in developing nations [2,3] with limited resources [4,7]. Statistics from the World Health Organization (WHO, 2020) indicate that approximately 2.4 million neonatal deaths occur annually, accounting for nearly half of all deaths in children under five years old [4].

Sub-Saharan Africa has recorded the highest neonatal mortality rate, with 27 deaths per 1000 live births in 2019, followed by Central and South Asia with 24 deaths per 1000 live births [8,9] . The likelihood of death within the first month of life is approximately ten times higher in these regions compared to high-income countries [8,10].

Sustainable Development Goal (SDG) 3 has set ambitious targets for 2030, including reducing neonatal mortality to 12 or fewer deaths per 1000 live births [11]. Despite significant reductions in

 doi:10.20944/preprints202410.0434.v1

neonatal mortality since 1990, continuous efforts are required to accelerate progress and achieve SDG 3 targets by 2030 [12].

Neonatal mortality rates in developing countries are influenced by a complex interplay of factors. These include access to prenatal care, pregnancy complications, place of delivery, birth weight, neonatal healthcare and overall maternal health indicators. These factors exhibit significant regional and national variability, underscoring disparities in healthcare access and quality. Understanding these dynamics is crucial for developing effective and affordable interventions aimed at reducing neonatal mortality.

Angola faces significant challenges in meeting the Sustainable Development Goals (SDGs), including inadequate healthcare infrastructure, a shortage of qualified health professionals [2,13,14], limited access to prenatal and postnatal care [14], a low percentage of institutional deliveries attended by qualified personnel [2,15], as well as issues related to extremes of maternal age, poverty, and low levels of caregiver education [15]. Despite 5these obstacles, the country has made notable progress, reducing its under-five mortality rate from 105 to 71.5 per 1,000 live births between 2012 and 2020 [1,2,8]. Nevertheless, one in every 42 live-born infants dies within the first month of life [2]. Approximately 60% of child deaths occur within the first year, with over half (54.5%) specifically during the neonatal period [2].

Leading causes of neonatal death in Angola include complications from premature birth, intrapartum events, and neonatal sepsis [2,15], underscoring the critical need for quality maternal and neonatal care services to prevent these deaths.

Most studies on neonatal mortality in Angola to date have relied on data from population surveys and general hospital records with a cross-sectional approach [2,6,16,17]. The rationale for this hospital-based case-control study lies in the urgent need to comprehensively understand the determinants of neonatal mortality in Angola. By examining clinical conditions, socioeconomic factors, and access to healthcare, this study aims to address critical gaps in the existing literature on neonatal mortality. Such a comprehensive analysis is crucial for informing the development of targeted maternal and child health policies and interventions tailored to local contexts.

Moreover, this study aligns explicitly with SDGs. Here, we analyze determinants of hospital neonatal mortality at David Bernardino Pediatric Hospital (DBPH) in Luanda. Insights gained could be critical for guiding national and international strategies aimed at enhancing child health in Angola, thereby contributing significantly to achieving global targets.

This study utilizes key theoretical frameworks to analyze factors associated with hospital neonatal mortality, with the goal of identifying significant patterns and implications for public health. We apply **Intersectionality Theory** to understand how social factors—such as gender, race, and socioeconomic status—interact to influence neonatal outcomes [18]. This theory helps elucidate how variables like newborn sex, maternal age, and residential location impact mortality rates.

In addition, we use the **Social Determinants of Health (SDOH)** Framework to explore how factors such as maternal education, access to prenatal care, delivery type, and living conditions affect neonatal mortality. This framework emphasizes disparities and structural issues in healthcare access [19,20].

Furthermore, **Ecosocial Theory** is employed to integrate social, environmental, and biological factors affecting health outcomes. This broader context includes variables such as gestational age, birth weight, and maternal health [21].

By addressing gaps in the understanding of neonatal mortality determinants in hospital settings, this study examines the interplay of clinical and sociodemographic factors. Our findings aim to inform public health policies and enhance maternal and child care, particularly in Angola.

2. Materials and Methods

Study Design, Type, and Location

A matched case-control study was conducted at the David Bernardino Pediatric Hospital (DBPH) in Luanda, a tertiary-level teaching and research centre, and the primary referral facility for paediatric care within Angola's National Health Service. Operating with 554 inpatient beds across 12

 doi:10.20944/preprints202410.0434.v1

services and maintaining a 97% occupancy rate, DBPH admits neonates primarily from other healthcare facilities due to its lack of a maternity unit. This study investigates neonatal mortality within this specific context, where the clinical profiles of admitted neonates are influenced by prior care at public or private institutions. Data were retrospectively retrieved from the neonatology service records at DBPH's Statistics Department for the period from May 2022 to June 2023. Factors associated with neonatal deaths were identified based on relevant literature [14,15,22–24], using routinely collected data from the neonates' medical records.

The Neonatology Service comprises a main ward with 21 beds, a specialised room for the care of premature infants, a dedicated unit for infants with tetanus, and a post-operative care area staffed by a nurse. Each area is equipped to deliver comprehensive care tailored to the specific needs of neonatal patients, providing a secure and supportive environment for their recovery and development. This structured setup is designed to optimise care for neonates with diverse clinical needs and enhance overall patient outcomes.

Population and Sample

The study defined cases as neonates admitted to the neonatology service between May 2022 and June 2023 who died within the first 28 days of life. Controls were neonates admitted to the same service in the same month as the corresponding case's death and who survived beyond the first 28 days of life. Controls were matched to each case by age (±2 days) and sex (1 case: 2 controls).

Inclusion and Exclusion Criteria

All neonatal cases recorded in the service's registry book, matched by age and sex with two control neonates each, were included and analysed. Neonates with incomplete records or insufficient information for the study's objectives were excluded, as were those with unknown discharge outcomes or unknown dates of birth.

Sample Size Estimation

Sample size was determined using G*Power software (Version 3.1.9.7, Heinrich-Heine-Universität Düsseldorf, Germany) [25]. Based on hospital statistics from the previous year, the following parameters were used: a 95% confidence interval, 90% power, a proportion of non-institutional births among cases (P1) of 63.4%, and among controls (P0) of 44.1%. The minimum detectable odds ratio was set at 2.2 with a case-to-control ratio of 1:2, and a phi coefficient of 0.2 was assumed for the correlation coefficient (r) between cases and controls [26]. The estimated minimum sample size was initially 276 (92 cases and 184 controls), which was increased by 15% to account for contingencies, resulting in a final sample of 318 participants (106 cases and 212 controls).

Sample Selection

A simple random sampling approach was employed to ensure the representativeness of the case and control groups and to enable valid comparative analyses. The medical records department provided files of cases and controls based on the hospital admission list during the study period, which comprised 3,653 admissions, including 527 deaths. Each neonatal death case was assigned a unique number, and cases were selected using an electronic random number generator until the desired sample size was achieved, ensuring that each newborn had an equal chance of being included in the case group. Similarly, two controls were randomly selected for each case from patients discharged home, matched by age (±2 days of the corresponding case) and sex. If a generated control did not meet the matching criteria, another number was generated until a suitable match was found. During this process, 16 records (5 cases and 11 controls) were excluded.

Data Collection and Questionnaires

 doi:10.20944/preprints202410.0434.v1

A structured data collection instrument was used to assess factors associated with neonatal death by reviewing medical records. The instrument included only variables routinely collected during newborn admissions. The following components were considered:

- Dependent variable: Neonatal mortality.
- Independent variables: Demographic and biological data, including gestational age, newborn sex, birth weight, Apgar score at one minute, Apgar score at five minutes, and neonate's age.
- Socioeconomic factors: Maternal age, maternal parity, place of residence,
- Prenatal care and delivery: Type of delivery, place of delivery, number of prenatal visits, length of hospital stay.
- Exposures and health conditions: Maternal HIV status, breastfeeding, vaccinations, umbilical cord treatment.

Data Quality Assurance Techniques, Data Processing, and Analysis

Two data collectors participated in the process. They underwent a two-day training session conducted by the principal investigator on the checklist and data extraction procedures. Prior to actual data collection, a pilot testing phase was conducted on 5% of the checklists to ensure adequacy. Following data collection, a rigorous validation process was implemented where 10% of the data entries were cross-checked against medical records to ensure data consistency. Subsequently, the coded data underwent thorough cleaning to address missing values and variables. Data analysis was performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA®) under the supervision of the principal investigator.

Statistical Analysis

Statistical analysis was conducted in two stages. The initial descriptive analysis summarized quantitative variables using the median and interquartile range (IQR), given their non-normal distribution (p=0.001). Categorical variables were described using absolute and relative frequencies, with cutoff points derived from the literature. The proportionate mortality rate (PMR) was calculated by dividing the number of cause-specific deaths by the total number of deaths and then multiplying by 100. The effect size of explanatory variables was estimated using the crude Odds Ratio (OR) with 95% Confidence Intervals (CI). In the second stage, a stepwise binary logistic regression model was used to examine the association between each independent variable and the dependent variable (neonatal mortality). Variables with a significance level of $p < 0.25$ in bivariate analysis were considered for inclusion in the multivariate model. Model adequacy was assessed using the Hosmer-Lemeshow goodness-of-fit test, and collinearity among independent variables was evaluated with variance inflation factors (VIF), revealing no significant multicollinearity. Adjusted Odds Ratios (AOR) with 95% CI were computed to quantify the strength of associations, with statistical significance set at $p < 0.05$ for neonatal mortality.Finally, the results were meticulously presented using tables and narrative text.

All maternal and neonatal factors were extracted from the Neonatal Intensive Care Unit (NICU) registry and hospital statistics department records. The International Classification of Diseases (ICD-10) was utilized to classify the underlying causes of neonatal deaths.

Table 1. Operational definitions of variables.

Variable	Definition	Categorization
Gestational Age	The duration of pregnancy, expressed in completed weeks, calculated from the first day of the mother's last menstrual period or confirmed by ultrasound.	According to WHO recommendations [27]: Preterm: Less than 37 weeks gestation. Term: Between 37 and 42 weeks gestation. Post-term: More than 42 weeks gestation.
Birth Weight	The weight of the newborn measured shortly after birth	Low Birth Weight: Less than 2500 grams; Appropriate Birth Weight: Between 2500 and

 doi:10.20944/preprints202410.0434.v1

	using a calibrated scale, recorded in grams.	4000 grams; High Birth Weight: Above 4000 grams
Apgar Scores	Assessment of the newborn's vital signs by a healthcare professional at the first and fifth minutes after birth.	Apgar ≥7: Adequate adaptation; Apgar <7: Requires additional attention
Neonate Age	The age of the newborn calculated in complete days from the exact date and time of birth.	≤ 7 days (Early neonatal); 8 – 28 days (Late neonatal).
Maternal Age	The age of the mother at the time of delivery.	<20 years; 20–35 years; ≥ 35 years
Maternal Parity	Number of previous pregnancies lasting more than 20 weeks, including the current delivery [28].	Less than 3 previous pregnancies; Three or more previous pregnancies
Place of Residence	The geographical location where the mother resides, as defined by official administrative boundaries.	Rural or Urban
Type of Delivery	Method used for the baby's delivery.	Normal (Vaginal) or Cesarean
Place of Delivery	Setting where the baby's birth occurs.	Hospital or Home
Number of Antenatal Visits	The total number of prenatal care visits attended by the mother during pregnancy, with the WHO recommending a minimum of four visits for adequate care.	< 4 visits (inadequate); ≥ 4 visits (adequate)
Maternal HIV Status	Presence or absence of HIV infection in the mother during pregnancy. Determined by specific laboratory tests during pregnancy or before delivery.	HIV positive: Presence of HIV infection in the mother during pregnancy; HIV negative: Absence of HIV infection in the mother during pregnancy
Breastfeeding	Practice of exclusively feeding the newborn with breast milk in the first months of life.	(Yes/No)
Vaccinations	The record of administration of vaccines recommended by national and international health guidelines during pregnancy and for the newborn.	Received: Record of administration of recommended vaccines for the newborn; Not received: Absence of record of administration of recommended vaccines
Umbilical Cord Care	The practice and technique used for the care of the umbilical cord stump after birth, including cleaning and monitoring to prevent infection.	Appropriate (The use of antiseptics, such as 70% ethyl alcohol) or Inappropriate (The application of substances like salt, palm oil, clay, leaves, and other non medical materials).

 doi:10.20944/preprints202410.0434.v1

3. Results

Sample Characterization

A total of 318 medical records (106 cases and 212 controls) were retrospectively reviewed from May 2022 to June 2023, with a slight predominance of females (57.9%). Maternal age had a median (IQR) of 22 (10) years, while the newborns included in the study had a median (IQR) age of 9 (9) days, ranging from 1 to 28 days. The median (IQR) length of hospital stay was 4 (4) days, with durations ranging from 1 to 24 days. The median (IQR) birth weight of the neonates was 2880 (955) grams, with weights ranging from 800g to 5000g. Among the cases, 56 (52.8%) were born in a hospital setting, while 50 (47.2%) were born at home or in an ambulance. In contrast, among the controls, 137 (64.6%) were born in a hospital.

Table 2. Frequency distribution of diagnoses for cases (cause of death) and controls (hospital discharge). David Bernardino Pediatric Hospital (Angola): May 1, 2022 - June 30, 2023.

ICD-10 Diagnosis	Diagnosis	Case n (%)	Control n (%)	Total n (%)	PMR
A33	Neonatal tetanus	35 (33.0)	18 (8.5)	53 (16.7)	33.0
P07	Prematurity	19 (17.9)	22 (10.4)	41 (12.9)	17.9
P21-P24	Birth complications (perinatal asphyxia, trauma, meconium aspiration)	7 (6.6)	8 (3.8%)	15 (4.7)	6.6
Q00-Q99	Congenital malformations (cardiac, chromosomal, Central Nervous System)	18 (17.0)	70 (33.0)	88 (27.7)	17.0
P36	Neonatal sepsis	12 (11.3)	33 (15.6)	45 (14.1)	11.3
P59	Neonatal jaundice	4 (3.8)	30 (14.2)	34 (10.7)	3.8
P61	Anaemia	4 (3.8)	7 (3.3)	11 (3.5)	3.8
Others	(encephalopathy, surgical abdomen, arthritis, cellulitis, haemorrhages, meningitis, pneumonia)	7 (6.6)	24 (11.3)	31 (9.7)	6.6
Total		**106 (100)**	**212 (100)**	**318 (100)**	**100**

PMR-Proportionate Mortality Rate.

Table 3. Association between Demographic and Biological Factors and Neonatal Mortality at David Bernardino Pediatric Hospital (Angola): May 1, 2022 – June 30, 2023.

Variable	Cases (number/%)	Controls (number/%)	OR (95% CI)
Gender			
Male	45(42.5)	90(42.5)	1,0(0.6-1.6)
Female	61(57.5)	122(57.5)	1
Neonate's age			
≤ 7 days	49(46.2)	79(37.3)	1.5(0.9-2.3)
8 -28 days	57(53.8)	133(62.7)	1
Gestational age			
Preterm	28(26.4)	37(17.5)	1.7(1.0-30)
Term	76(71.7)	170(80.2)	1

 doi:10.20944/preprints202410.0434.v1

Post-Term	2(1.9)	5(2.3)	0.9(0.2-4.7)
Birth weight			
Low Birth Weight	42(39.6)	59(27.8)	1.6(1.0-2.7)
Normal Birth Weight	61(57.6)	140(66.1)	1
Macrosomia	3(2.8)	13(6.1)	0.5(0.1-1.9)
1st minute Apgar			
< 7	35(33.0)	42(19,8)	2(1.2-3.4)
≥ 7	71(67.0)	170(80.2)	1
5th minute Apgar			
< 7	11(10.4)	15(7,7)	1.5(0.6-3.4)
≥ 7	95(89.6)	197(92,3)	1

Table 4. Association between Socioeconomic Factors and Neonatal Mortality at David Bernardino Pediatric Hospital (Angola): May 1, 2022 – June 30, 2023.

Variable	Cases (number/%)	Controls (number/%)	OR (95% CI)
Maternal age			
<20 years	60(56.6)	56(26.4)	3.5(2.1-5.8)
20–35 years	41(38.7)	133(62.7)	1
≥ 35 years	5(4.7)	23(10.8)	0.7(0.3-2)
Maternal parity			
≤ 3	97(91.5)	175(82.5)	1
≥ 4	9(8.5)	37(17.5)	2.3(1.1- 4.9)
Place of residence			
Urban	100(94.3)	184(86.8)	1
Rural	6(5.7)	28(13.2)	2.5(1.1 -6.3)

Table 5. Association of Prenatal Care and Delivery Factors with Neonatal Mortality at David Bernardino Pediatric Hospital, Angola (May 1, 2022 – June 30, 2023).

Variable	Cases (number/%)	Controls (number/%)	OR (95% CI)
Type of delivery			
- Cesarean	8(7.5)	14(6.6)	1.2 (0.5-2.8)
- Vaginal	98(92.5)	198(93.4)	1
Place of delivery			
- Home	50(47.2)	75(35.4)	1.6(1-2.6)
- Hospital	56(52.8)	137(64.6)	1
Number of prenatal visits			
< 4	70(66.0)	141(66.5)	1.0(0.6-1.6)

 doi:10.20944/preprints202410.0434.v1

≥ 4	36(34.0)	71(33.5)	1
Length of hospital stay			
≤48 h	17(16.0)	12(5.7)	3.1(1.5-6.9)
>48 h	89(84.0)	200(94.3)	1

Table 6. Association of Exposures and Health Conditions with Neonatal Mortality at David Bernardino Pediatric Hospital, Angola: May 1, 2022 – June 30, 2023.

Variable	Cases (number/%)	Controls (number/%)	OR (95% CI)
Mother HIV status			
- Yes	6(5.7)	5(2.4)	2.5(0.7-8.3)
- No	100(94.3)	207(97.6)	1
Breastfeeding			
- No	6(5.7)	3(1.4)	4.2(1.0-17.1)
- Yes	100(94.3)	209(98.6)	1
Vaccinations			
- No	55(51.9)	79(37.3)	1.8(1.1-2.9)
- Yes	51(48.1)	133(62.7)	1
Umbilical cord treatment			
-Not correct	57(53.8)	78(36.8)	2(1.2-3.2)
- Correct	49(46.2)	134(63.2)	1

Table 7. Results of Logistic Regression Analysis Using the Forward Stepwise Method.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step1[a]	Maternal age			26,814	2	,000			
	<20 years	1,246	,258	23,361	1	,000	3,476	2,097	5,760
	≥ 35 years	-,349	,525	,443	1	,506	,705	,252	1,972
	Constant	-1,177	,179	43,398	1	,000	,308		
Step 2[b]	Apgar at 1 minute(< 7)	,841	,287	8,599	1	,003	2,319	1,322	4,068
	Maternal age			28,457	2	,000			
	<20 years	1,329	,265	25,128	1	,000	3,776	2,246	6,349
	≥ 35 years	-,311	,531	,342	1	,558	,733	,259	2,075
	Constant	-1,434	,207	48,147	1	,000	,238		
Step 3[c]	Apgar at 1 minute (< 7)	,860	,290	8,787	1	,003	2,364	1,338	4,176
	Maternal age			26,853	2	,000			
	<20 years	1,324	,269	24,289	1	,000	3,759	2,220	6,366
	≥ 35 years	-,193	,535	,131	1	,718	,824	,289	2,350

 doi:10.20944/preprints202410.0434.v1

	Length of hospital stay(≤48 h)	1,108	,425	6,797	1	,009	3,028	1,317	6,965
	Constant	-1,558	,217	51,753	1	,000	,211		
Step 4[d]	Apgar at 1 minute (< 7)	,902	,293	9,469	1	,002	2,464	1,387	4,375
	Maternal age			23,812	2	,000			
	<20 years	1,267	,271	21,796	1	,000	3,550	2,086	6,042
	≥ 35 years	-,142	,539	,070	1	,792	,867	,301	2,497
	Length of hospital stay(≤48 h)	1,079	,424	6,460	1	,011	2,941	1,280	6,756
	Umbilical cord treatment(Not correct)	,578	,260	4,928	1	,026	1,782	1,070	2,969
	Constant	-1,811	,252	51,477	1	,000	,163		
Step 5[e]	Apgar at 1 minute (< 7)	,852	,297	8,252	1	,004	2,344	1,311	4,191
	Maternal age			25,040	2	,000			
	<20 years	1,326	,275	23,175	1	,000	3,764	2,194	6,458
	≥ 35 years	-,087	,539	,026	1	,872	,917	,319	2,637
	Place of residence(Rural)	-,959	,488	3,857	1	,050	,383	,147	,998
	Length of hospital stay(≤48 h)	1,016	,429	5,608	1	,018	2,763	1,191	6,408
	Umbilical cord treatment(Not correct)	,567	,263	4,663	1	,031	1,763	1,054	2,949
	Constant	-1,723	,255	45,689	1	,000	,179		
Step 6[f]	**Apgar at 1 minute (< 7)**	**,958**	**,304**	**9,923**	**1**	**,002**	**2,607**	**1,436**	**4,731**
	Maternal age			24,314	2	,000			
	<20 years	**1,321**	**,278**	**22,566**	**1**	**,000**	**3,746**	**2,172**	**6,459**
	≥ 35 years	-,072	,540	,018	1	,894	,930	,323	2,679
	Place of residence(Rural)	**-1,024**	**,492**	**4,339**	**1**	**,037**	**,359**	**,137**	**,941**
	Place of delivery (Home)	**,570**	**,274**	**4,327**	**1**	**,038**	**1,769**	**1,034**	**3,027**
	Length of hospital stay(≤48 h)	**1,026**	**,438**	**5,488**	**1**	**,019**	**2,791**	**1,183**	**6,587**
	Umbilical cord treatment(Not correct)	,498	,266	3,498	1	,061	1,646	,976	2,775
	Constant	-1,944	,282	47,490	1	,000	,143		

a. Variables included in step 1: maternal age; b. Variables included in step 2: APGAR at 1 minute; c. Variables included in step 3: Length of hospital stay; d. Variables included in step 4: umbilical cord treatment; e. Variables included in step 5: place of residence; f. Variables included in step 6: place of delivery.

4. Discussion

This case-control study conducted at DBPH in Angola identified neonatal tetanus as the primary cause of neonatal mortality, with a Proportionate Mortality Ratio (PMR) of 33.0. Neonatal tetanus, preventable through proper umbilical cord care and vaccination, remains a critical issue due to insufficient vaccination coverage and inadequate hygiene practices [2,17,29]. Addressing these

 doi:10.20944/preprints202410.0434.v1

factors by improving vaccination rates and hygiene practices is essential to reducing neonatal mortality from tetanus.

Prematurity was also a significant cause of neonatal deaths, with a PMR of 17.9. Premature infants are at increased risk of severe complications and mortality, highlighting the need for enhanced neonatal intensive care and postnatal support [30,31]. Recent literature emphasizes that interventions to improve intensive care capabilities and promote full-term deliveries are crucial for better outcomes [31,32]. Additionally, birth complications, such as perinatal asphyxia and trauma (PMR of 6.6), and congenital malformations (PMR of 17.0), significantly contributed to neonatal mortality. This underscores the importance of implementing safe delivery practices and early diagnosis and management of congenital conditions [33–35].

Neonatal sepsis, with a PMR of 11.3, and neonatal jaundice, with a PMR of 3.8, were other major causes of mortality. Sepsis, associated with severe infections, necessitates improvements in infection control and treatment protocols. Although less prevalent, neonatal jaundice requires timely monitoring and treatment to prevent severe outcomes [36]. Implementing effective protocols and enhancing neonatal care practices are vital for reducing mortality rates and improving neonatal outcomes.

Determinants of neonatal mortality were organised into logical groups according to the theoretical frameworks employed. Among the demographic and biological factors, only an Apgar score of less than 7 was significantly associated with increased neonatal deaths. Infants with an Apgar score of < 7 at 1 minute had a twofold higher risk of mortality compared to those with a score of ≥ 7. This finding aligns with existing literature, which correlates low Apgar scores with adverse outcomes such as perinatal asphyxia and respiratory complications, which are associated with higher mortality rates [37–39].

Although low birth weight (LBW) is a recognised predictor of mortality and morbidity, particularly in resource-limited settings where care may be suboptimal [40–42], this study found that the risk of neonatal death was 1.6 times higher in infants with LBW (95% CI: 1.0-2.7), underscoring the urgent need for targeted interventions. In contrast, the association with macrosomia was not statistically significant, with an odds ratio of 0.5 (95% CI: 0.1-1.9), although it still warrants monitoring. These findings highlight the importance of public health policies focused on reducing LBW and improving neonatal care to mitigate mortality and promote better health outcomes in vulnerable populations. Future research should continue to explore these links to inform clinical practices and intervention strategies.

Intersectionality Theory and the Social Determinants of Health (SDOH) Framework were used to explore disparities in healthcare access between urban and rural areas, as well as the impact of maternal socioeconomic status on newborn health. Maternal age emerged as a significant determinant of neonatal mortality. Mothers under 20 years of age faced a risk of neonatal mortality 3.5 times higher compared to those aged 20 to 35 years. This finding is consistent with literature linking adolescent pregnancies to higher rates of neonatal complications due to factors such as biological immaturity and limited access to prenatal care [3,43–46]. In contrast, mothers aged 35 years or older had an Odds Ratio (OR) of 0.7 (95% CI: 0.3-2.0), suggesting a reduced risk relative to the reference group. Although advanced maternal age may be associated with specific risks, the magnitude of these risks was not significantly greater than that observed in the reference group, aligning with recent studies discussing the complexities of pregnancies at older ages [45,47–48].

Parity was also identified as a significant factor. Mothers with four or more children had a neonatal mortality risk 2.3 times higher compared to those with three or fewer children. This result is consistent with literature associating high parity with adverse neonatal outcomes. While some studies suggest that multiparity may be associated with lower risks for certain adverse birth outcomes [49], higher birth orders are frequently linked with complications such as prolonged gestation, increased likelihood of preterm birth, and reduced access to adequate prenatal care, all of which contribute to increased neonatal mortality [50,51]. Additionally, high parity may reflect lower resource availability and social support, which are crucial for healthy pregnancies and positive neonatal outcomes.

 doi:10.20944/preprints202410.0434.v1

Residential location, whether rural or urban, also demonstrated a significant association with neonatal mortality. The risk was 2.5 times higher for residents of rural areas compared to their urban counterparts. This increased risk can be attributed to several factors, including reduced access to quality healthcare, lower availability of emergency services, and limited resources in rural areas [52,53]. Disparities in healthcare access between urban and rural areas significantly impact neonatal outcomes, highlighting the need for health policies that address these inequalities [54,55].

Prenatal care and delivery conditions were also assessed. The type of delivery did not show a significant association with neonatal mortality, consistent with mixed results in the literature regarding delivery methods. While some studies suggest cesarean sections may be linked to increased neonatal complications, others indicate that appropriately indicated cesarean deliveries can mitigate these risks [56–59]**.**

Conversely, the place of delivery reveals a statistically significant association with neonatal mortality (p = 0.04), with home deliveries associated with a 1.6-fold higher risk compared to hospital deliveries. This underscores the importance of hospital settings, which provide essential medical resources and skilled personnel [60,61]**. Additionally, the odds of neonatal death were 3.1 times higher for infants with less than 48 hours of hospitalisation, reflecting the critical role of adequate hospital care in reducing mortality** [16]**.** Late presentation from home or alternative treatments may have contributed to these outcomes, highlighting the need for improved primary healthcare strategies and referral systems.

The association between maternal HIV status and neonatal mortality yielded an Odds Ratio (OR) of 2.5 (95% CI: 0.7-8.3), suggesting a potential increased risk for infants born to HIV-positive mothers. Although this finding did not reach statistical significance, it is consistent with existing literature linking maternal HIV infection to adverse neonatal outcomes, such as vertical transmission and compromised maternal health [62,63]. This underscores the critical need for enhanced maternal healthcare interventions to mitigate these risks and improve neonatal survival rates.

The likelihood of neonatal death was 4.2 times higher among non-breastfed infants. Current research highlights the substantial protective effect of breastfeeding against neonatal mortality, due to its provision of essential nutrients and antibodies critical for newborn health [64,65].

Vaccination status also revealed a significant association with neonatal mortality, with unvaccinated neonates exhibiting an OR of 1.8 (95% CI: 1.1-2.9), indicating that they are 1.8 times more likely to die compared to their vaccinated counterparts. The absence of vaccination increases the vulnerability of these infants to severe, preventable infectious diseases, including tuberculosis meningitis, miliary tuberculosis, and poliomyelitis, which are major contributors to neonatal mortality [66–69]. In addition, inadequate umbilical cord care was linked to a twofold increased risk of neonatal death. Proper care of the umbilical cord is vital for preventing infections like sepsis and other complications. Effective management requires collaboration between healthcare providers and mothers to ensure optimal neonatal outcomes [70,71].

Subsequently, a stepwise binary logistic regression analysis was conducted to identify the main predictors of neonatal mortality in the study population. The analysis evaluated the impact of the following variables: gestational age, birth weight, Apgar score at one minute, Apgar score at five minutes, neonate's age, maternal age, maternal parity, place of residence, place of delivery, length of hospital stay, maternal HIV status, breastfeeding, vaccinations, and umbilical cord treatment.

Prior to this, the model fit was assessed using the Hosmer-Lemeshow test, which indicated a good fit ($\chi^2 = 11.768$; df = 8; $p = 0.162$). The final model (step 6), which included the variables Apgar score at one minute, maternal age, place of residence, place of delivery, length of hospital stay, and umbilical cord treatment, was statistically significant in predicting neonatal mortality within the studied population [χ^2 (7) = 57.094; $p < 0.001$; Nagelkerke $R^2 = 0.228$].

The logistic regression analysis revealed that only the following factors collectively had a significant impact on predicting neonatal mortality during the study period: Apgar score at 1 minute (< 7), a biological factor, with an Odds Ratio (OR) of 2.172 (95% Confidence Interval [CI]: 1.436–4.731); maternal age under 20 years, a socioeconomic factor, with an OR of 3.746 (95% CI: 2.172–6.459); home

 doi:10.20944/preprints202410.0434.v1

delivery, a factor associated with delivery practices, with an OR of 1.769 (95% CI: 1.034–3.027); and hospital stay of ≤ 48 hours, a factor related to prenatal care, with an OR of 2.791 (95% CI: 1.183–6.587).

Factors such as gestational age, birth weight, Apgar score at five minutes, neonate's age, maternal parity, maternal HIV status, breastfeeding, vaccinations, and umbilical cord treatment were not statistically associated with neonatal mortality

Limitations

The retrospective design and reliance on available data constrained our ability to control for key confounding factors influencing neonatal mortality. Specific biological variables, such birth conditions, as well as sociodemographic factors like paternal age and family structure, were not fully accounted for. Additionally, elements related to the quality of neonatal intensive care and follow-up services were not controlled. These limitations restrict a comprehensive evaluation of how these variables impact neonatal mortality.

Furthermore, DBPH, which lacks a maternity unit, primarily manages severe neonatal cases transferred from other facilities. This may result in an inflated mortality rate that reflects case severity rather than care quality, potentially skewing the data and limiting its representativeness for the general neonatal population in Luanda. Variability in birth settings and care standards between home births and private and public maternity facilities further complicates mortality rate assessments. Despite these limitations, the study highlights the need for targeted educational and preventive strategies, as well as multi-sectoral interventions to improve neonatal health. Accurate contextualisation of DBPH data is essential for informing relevant health policies and practices.

5. Conclusions

This study, conducted at David Bernardino Paediatric Hospital (DBPH), has identified critical determinants of neonatal mortality based on a thorough analysis rooted in robust theoretical frameworks. The key predictors of neonatal mortality identified were: Apgar score at one minute (< 7), maternal age under 20 years, home delivery, and a hospital stay duration of 48 hours or less. These factors underscore the urgent need for specific interventions aimed at improving responses to low Apgar scores, supporting young mothers, ensuring deliveries occur in appropriate facilities, and enhancing patient referral and counter-referral systems.

5. Recommendations

To address these challenges, we recommend several strategies: (1) **Capacity Building for Healthcare Professionals:** Develop and implement training programmes focused on neonatal resuscitation and postnatal care to improve outcomes related to low Apgar scores. (2) **Intensified Maternal Education:** Initiate educational campaigns aimed at young pregnant women to highlight the importance of antenatal care and the risks associated with early pregnancies. (3) **Improvement of Access to Healthcare Services:** Invest in infrastructure to ensure all deliveries occur in hospital settings, including the establishment of community health centres and facilitation of transportation for pregnant women. (4) **Optimisation of the Healthcare System:** Integrate primary healthcare services, alternative treatment institutions, and hospitals to ensure efficient referrals and expand primary care for early detection of neonatal conditions. (5) **Evidence-Based Policy Formulation:** Utilise this study's findings to inform public policies that prioritise maternal and neonatal health, ensuring that interventions are grounded in data and contextually relevant. Implementing these recommendations can significantly reduce neonatal mortality and drive substantial improvements in maternal and child health in Angola.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org. File S1

Author Contributions: Authors I.C.A., L.V. and J.V.-D. worked on the conception, study design, and final article review. L.V. and J.V.-D. also contributed to refining the methodology, critical review of the article, as well as analysis and interpretation of the data. All authors have read and agreed to the final version of the manuscript.

 doi:10.20944/preprints202410.0434.v1

Funding: This research was partial funded by Fundação para a Ciência e Tecnologia (https://www. fct. pt/) project GHTM—UID/04413/2020 (https:// ghtm. ihmt. unl. pt/).

Institutional Review Board Statement: The study was approved by the Pedagogical Directorate of DBPH following approval from the Ethics Committee of the Angolan Institute of Health Research with opinion No. 19 C.E/MINSA.INIS/2022.

Data Availability Statement: The data used in this study belong to DBPH and are under the auspices of IHMT. They may be available upon request to researchers who meet the criteria for accessing confidential data. Data requests should be directed to Professor Luís Varandas, Supervisor of the lead researcher of this study and a Professor at IHMT, whose email address is varandas@ihmt.unl.pt. Requestors should provide details about the purpose of the request and must meet the requirements of the Scientific Council of IHMT. Data should only be used for the purpose defined in the request.

Acknowledgments: We thank the statistics department of DBPH and the healthcare professionals of that institution for their support.

Conflicts of Interest: The authors declare that they have no conflicting interests.

References

1. WHO. Infant mortality rate (IMR) Geneva: THE GLOBAL HEALTH OBSERVATORY; 2024 [cited 2024 10/April]. Available from: https://www.who.int/data/gho/indicator-metadata-registry/imr-details/1.
2. Estatística INd. Inquérito de Indicadores Múltiplos e de Saúde em Angola 2015–20162017 [cited 2024 June, 25]. Available from: https://dhsprogram.com/pubs/pdf/fr327/fr327.pdf.
3. Neal S, Channon AA, Chintsanya J. The impact of young maternal age at birth on neonatal mortality: Evidence from 45 low and middle income countries. PloS one [Internet]. 2018 [cited 2024 21/April]; 13(5):[e0195731 p.]. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0195731.
4. UNICEF, Organization WH. Levels and Trends Child Mortality-Report 2023: Estimates Developed by the United Nations Inter-agency Group for Child Mortality Estimation. 2024.
5. Sharaf MF, Rashad AS. Socioeconomic inequalities in infant mortality in Egypt: analyzing trends between 1995 and 2014. Social Indicators Research [Internet]. 2018 [cited 2023 18/March]; 137:[1185-99 pp.]. Available from: https://link.springer.com/article/10.1007/s11205-017-1631-3.
6. Shibre G. Social inequality in infant mortality in Angola: Evidence from a population based study. PloS one [Internet]. 2020 [cited 2024 10/April]; 15(10):[e0241049 p.]. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0241049.
7. Tura G, Fantahun M, Worku A. The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis. BMC Pregnancy Childbirth [Internet]. 2013 Jan 22 [cited 2024 17/April]; 13:[18 p.]. Available from: https://pubmed.ncbi.nlm.nih.gov/23339515/.
8. Newborns W. Improving survival and well-being 2020. Available from: https://www.who.int/news-room/fact-sheets/detail/newborns-reducing-mortality
9. Tamir TT, Mohammed Y, Kassie AT, Zegeye AF. Early neonatal mortality and determinants in sub-Saharan Africa: Findings from recent demographic and health survey data. PloS one [Internet]. 2024 [cited 2024 July 03]; 19(6):[e0304065 p.]. Available from: https://pubmed.ncbi.nlm.nih.gov/38848390/.
10. Moyer CA, Dako-Gyeke P, Adanu RM. Facility-based delivery and maternal and early neonatal mortality in sub-Saharan Africa: a regional review of the literature. African journal of reproductive health [Internet]. 2013 Sep [cited 2024 July 03]; 17(3):[30-43 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/24069765/.
11. Sudfeld CR, Fawzi WW. Importance of Innovations in Neonatal and Adolescent Health in Reaching the Sustainable Development Goals by 2030. JAMA pediatrics [Internet]. 2017 Jun 1 [cited 2024 July 03]; 171(6):[521-2 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/28384685/.
12. Hug L, Alexander M, You D, Alkema L. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. The Lancet Global health [Internet]. 2019 Jun [cited 2024 July 03]; 7(6):[e710-e20 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/31097275/.
13. Angola MdSd. Plano Nacional de Desenvolvimento Sanitário 2012-20252014 [cited 2024 June,25]. Available from: https://minsa.gov.ao/fotos/frontend_24/gov_documentos/relatorio_final_comissao_multissectorial_pnds_200663155760b0a64397ffa.pdf.
14. Rodrigues EC, Alves BdCA, Veiga GLd, Adami F, Carlesso JS, Figueiredo FWdS, et al. Neonatal mortality in Luanda, Angola: what can be done to reduce it? Journal of Human Growth and Development [Internet]. 2019 [cited 2024 25 June]; 29(2):[161-8 pp.]. Available from: http://pepsic.bvsalud.org/scielo.php?pid=S0104-12822019000200004&script=sci_arttext.

15. Rosário EVN, Gomes MC, Brito M, Costa D. Determinants of maternal health care and birth outcome in the Dande Health and Demographic Surveillance System area, Angola. PloS one [Internet]. 2019 [cited 2024 June, 27]; 14(8):[e0221280 p.]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6706050/.
16. Pinto EAE, Alves JG. The causes of death of hospitalized children in Angola. Tropical doctor [Internet]. 2008 [cited 2023 03/September]; 38(1):[66-7 pp.]. Available from: https://journals.sagepub.com/doi/abs/10.1258/td.2006.006352.
17. Simão R, Gallo PR. Mortes infantis em Cabinda, Angola: desafio para as políticas públicas de saúde. Revista Brasileira de Epidemiologia [Internet]. 2013 [cited 2023 03/September]; 16:[826-37 pp.]. Available from: https://www.scielo.br/j/rbepid/a/wGTtzSgJPvqXBqJjtm5kD4c/?lang=pt.
18. Crenshaw K. Demarginalizing the intersection of race and sex: a black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. Droit et société [Internet]. 2021 [cited 2024 July 10]; 108:[465 p.]. Available from: https://heinonline.org/HOL/LandingPage?handle=hein.journals/droitsc108&div=17&id=&page=.
19. Marmot M, Allen J, Goldblatt P, Boyce T, McNeish D, Grady M, et al. Fair society, healthy lives: strategic review of health inequalities in England post-2010: the Marmot review. London: University College London [Internet]. 2010 [cited 2024 21/April]:[242 p.]. Available from: http://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review/fair-society-healthy-lives-full-report-pdf.pdf.
20. Marmot M. Social determinants of health inequalities. Lancet (London, England) [Internet]. 2005 Mar 19-25 [cited 2024 July 10]; 365(9464):[1099-104 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/15781105/.
21. Krieger N. Epidemiology and the people's health: theory and context: Oxford University Press; 2024 [cited 2024 July 10]. Available from: https://books.google.co.ao/books?hl=pt-PT&lr=&id=qe78EAAAQBAJ&oi=fnd&pg=PP1&dq=Krieger,+N.+(2011).+Epidemiology+and+the+People%E2%80%99s+Health:+Theory+and+Context.+Oxford+University+Press.&ots=P6Vv8ldxus&sig=dhl9pv2LYX23TAFepNhArQXg4ec&redir_esc=y#v=onepage&q=Krieger%2C%20N.%20(2011).%20Epidemiology%20and%20the%20People%E2%80%99s%20Health%3A%20Theory%20and%20Context.%20Oxford%20University%20Press.&f=false.
22. Lethro P, Nishizawa Y, Dorjee K, Zangmo K, Dorji L, Tenzin K. Determinants of Neonatal Mortality in Bhutan: A Case-Control Study. Asia-Pacific journal of public health [Internet]. 2023 Nov [cited 2024 July 03]; 35(8):[486-93 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/37842840/.
23. Mangu CD, Rumisha SF, Lyimo EP, Mremi IR, Massawe IS, Bwana VM, et al. Trends, patterns and cause-specific neonatal mortality in Tanzania: a hospital-based retrospective survey. International health [Internet]. 2021 Jul 3 [cited 2024 July 03]; 13(4):[334-43 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/32975558/.
24. Oljira R, Merdassa E, Kejela G, Fentahun F, Tilahun T. Determinants of perinatal mortality at tertiary hospitals in East Wollega, Western Ethiopia: a case-control study. The Journal of international medical research [Internet]. 2023 Feb [cited 2024 July 03]; 51(2):[3000605231155782 p.]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9932761/.
25. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior research methods [Internet]. 2007 May [cited 2024 September 5]; 39(2):[175-91 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/17695343/.
26. Dupont WD. Power calculations for matched case-control studies. Biometrics [Internet]. 1988 Dec [cited 2024 June, 25]; 44(4):[1157-68 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/3233252/.
27. WHO. WHO Guidelines Approved by the Guidelines Review Committee. 2015 [cited 30 July 2024]. In: WHO Recommendations on Interventions to Improve Preterm Birth Outcomes [Internet]. Geneva: World Health Organization Copyright © World Health Organization 2015., [cited 30 July 2024]. Available from: https://pubmed.ncbi.nlm.nih.gov/26447264/.
28. Kozuki N, Lee AC, Silveira MF, Sania A, Vogel JP, Adair L, et al. The associations of parity and maternal age with small-for-gestational-age, preterm, and neonatal and infant mortality: a meta-analysis. BMC public health [Internet]. 2013 [cited 2024 July 17]; 13 Suppl 3(Suppl 3):[S2 p.]. Available from: https://pubmed.ncbi.nlm.nih.gov/24564800/.
29. Jones CE. Progress Toward Achieving and Sustaining Maternal and Neonatal Tetanus Elimination—Worldwide, 2000–2022. MMWR Morbidity and Mortality Weekly Report [Internet]. 2024 [cited 2024 03 August]; 73. Available from: https://www.cdc.gov/mmwr/volumes/73/wr/mm7328a1.htm.
30. Harrison MS, Goldenberg RL. Global burden of prematurity. Seminars in fetal and neonatal medicine [Internet]. 2016 [cited 2024 03, August]; 21(2):[74-9 pp.]. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1744165X15001468.
31. Crilly CJ, Haneuse S, Litt JS. Predicting the outcomes of preterm neonates beyond the neonatal intensive care unit: what are we missing? Pediatric research [Internet]. 2021 [cited 2024 03 August]; 89(3):[426-45 pp.]. Available from: https://www.nature.com/articles/s41390-020-0968-5.

32. Costa S, Menzella N, Vento G, Barnea ER, Childbirth F, Committee PH, et al. FIGO good practice recommendations: Bundle of care to reduce neonatal mortality and improve outcomes after preterm and term delivery. International Journal of Gynecology & Obstetrics [Internet]. 2023 [cited 2024 03 August]; 163:[68-73 pp.]. Available from: https://obgyn.onlinelibrary.wiley.com/doi/full/10.1002/ijgo.15116.
33. Kawase K, Iwata O. Birth Asphyxia. Cerebral Palsy: Perspective and Clinical Relation to Perinatal Complications/Events in Japan [Internet]. 2022 [cited 2020 02 August]:[245-51 pp.]. Available from: https://link.springer.com/chapter/10.1007/978-981-19-2217-6_26.
34. Sendeku FW, Azeze GG, Fenta SL. Perinatal asphyxia and its associated factors in Ethiopia: a systematic review and meta-analysis. BMC pediatrics [Internet]. 2020 [cited 2024 04 August]; 20:[1-11 pp.]. Available from: https://link.springer.com/article/10.1186/s12887-020-02039-3.
35. Verma RP. Evaluation and risk assessment of congenital anomalies in neonates. Children [Internet]. 2021 [cited 2024 03 August]; 8(10):[862 p.]. Available from: https://www.mdpi.com/2227-9067/8/10/862.
36. Ansong-Assoku B, Shah S, Adnan M, Ankola P. Neonatal jaundice. StatPearls [Internet]. 2024 [cited 2024 04 August]. Available from: https://www.statpearls.com/point-of-care/23803.
37. Michel A. Review of the Reliability and Validity of the Apgar Score. Advances in Neonatal Care [Internet]. 2022 [cited 2024 August, 01]; 22(1):[28-34 pp.]. Available from: https://journals.lww.com/advancesinneonatalcare/abstract/2022/02000/review_of_the_reliability_and_validity_of_the.7.aspx.
38. Cnattingius S, Johansson S, Razaz N. Apgar score and risk of neonatal death among preterm infants. New England Journal of Medicine [Internet]. 2020 [cited 2024 August, 01]; 383(1):[49-57 pp.]. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa1915075.
39. Abo El Naga AM, Hafez MO, El Bana EA, Shehata AMI. Study of Some Predictors of Neonatal Mortality among Preterm Newborn at Zagazig University Hospital. The Egyptian Journal of Hospital Medicine [Internet]. 2022 [cited 2024 August 03]; 88(1):[2677-82 pp.]. Available from: https://journals.ekb.eg/article_241116.html.
40. Pusdekar YV, Patel AB, Kurhe KG, Bhargav SR, Thorsten V, Garces A, et al. Rates and risk factors for preterm birth and low birthweight in the global network sites in six low-and low middle-income countries. Reproductive health [Internet]. 2020 [cited 2024 August, 03]; 17:[1-16 pp.]. Available from: https://link.springer.com/article/10.1186/s12978-020-01029-z.
41. Kleinhout MY, Stevens MM, Osman KA, Adu-Bonsaffoh K, Groenendaal F, Zepro NB, et al. Evidence-based interventions to reduce mortality among preterm and low-birthweight neonates in low-income and middle-income countries: a systematic review and meta-analysis. BMJ global health [Internet]. 2021 [cited 2024 August, 03]; 6(2):[e003618 p.]. Available from: https://gh.bmj.com/content/bmjgh/6/2/e003618.full.pdf.
42. Saleem S, Naqvi F, McClure EM, Nowak KJ, Tikmani SS, Garces AL, et al. Neonatal deaths in infants born weighing≥ 2500 g in low and middle-income countries. Reproductive health [Internet]. 2020 [cited 2024 August, 02]; 17:[1-14 pp.]. Available from: https://link.springer.com/article/10.1186/s12978-020-01013-7.
43. Maheshwari MV, Khalid N, Patel PD, Alghareeb R, Hussain A. Maternal and Neonatal Outcomes of Adolescent Pregnancy: A Narrative Review. Cureus [Internet]. 2022 Jun [cited 2024 August 04]; 14(6):[e25921 p.]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9282583/.
44. Mann L, Bateson D, Black KI. Teenage pregnancy. Australian journal of general practice [Internet]. 2020 [cited 2024 August 04]; 49(6):[310-6 pp.]. Available from: https://search.informit.org/doi/10.3316/informit.160523066015845. https://search.informit.org/doi/full/10.3316/informit.160523066015845.
45. Lima LCd. Idade materna e mortalidade infantil: efeitos nulos, biológicos ou socioeconômicos? Revista Brasileira de Estudos de População [Internet]. 2010 [cited 2024 21/April]; 27:[211-26 pp.]. Available from: https://pesquisa.bvsalud.org/portal/resource/pt/ens-26351.
46. WHO. Adolescent pregnancy Geneva 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/adolescent-pregnancy.
47. Frick AP. Advanced maternal age and adverse pregnancy outcomes. Best Practice & Research Clinical Obstetrics & Gynaecology [Internet]. 2021 2021/01/01/ [cited 2024 19/April]; 70:[92-100 pp.]. Available from: https://www.sciencedirect.com/science/article/pii/S1521693420301127.
48. Kortekaas JC, Kazemier BM, Keulen JK, Bruinsma A, Mol BW, Vandenbussche F, et al. Risk of adverse pregnancy outcomes of late-and postterm pregnancies in advanced maternal age: A national cohort study. Acta obstetricia et gynecologica Scandinavica [Internet]. 2020 [cited 2024 21/April]; 99(8):[1022-30 pp.]. Available from: https://obgyn.onlinelibrary.wiley.com/doi/full/10.1111/aogs.13828.
49. Lin L, Lu C, Chen W, Li C, Guo VY. Parity and the risks of adverse birth outcomes: a retrospective study among Chinese. BMC pregnancy and childbirth [Internet]. 2021 [cited 2024 August 03]; 21:[1-11 pp.]. Available from: https://link.springer.com/article/10.1186/s12884-021-03718-4.
50. Abdelmageed E, Bahaeldin H, Nadiah A, Abdelbagi A, Duria R, Ishag A. Maternal and neonatal outcomes of grand multiparity in Khartoum, Sudan. African health sciences [Internet]. 2022 Mar [cited 2024 August 04]; 22(1):[164-71 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/36032433/.

51. Peled T, Weiss A, Hochler H, Sela HY, Lipschuetz M, Karavani G, et al. Perinatal outcomes in grand multiparous women stratified by parity- A large multicenter study. European Journal of Obstetrics & Gynecology and Reproductive Biology [Internet]. 2024 2024/09/01/ [cited 2024 August 04]; 300:[164-70 pp.]. Available from: https://www.sciencedirect.com/science/article/pii/S0301211524003567.
52. Norris M, Klabbers G, Pembe AB, Hanson C, Baker U, Aung K, et al. A growing disadvantage of being born in an urban area? Analysing urban–rural disparities in neonatal mortality in 21 African countries with a focus on Tanzania. BMJ global health [Internet]. 2022 [cited 2024 August 03]; 7(1):[e007544 p.]. Available from: http://gh.bmj.com/content/7/1/e007544.abstract.
53. Workineh YA, Workie HM. Adverse neonatal outcomes and associated risk factors: A case-control study. Global Pediatric Health [Internet]. 2022 [cited 2024 August 03]; 9:[2333794X221084070 p.]. Available from: https://journals.sagepub.com/doi/full/10.1177/2333794X221084070.
54. Nuamah GB, Agyei-Baffour P, Mensah KA, Boateng D, Quansah DY, Dobin D, et al. Access and utilization of maternal healthcare in a rural district in the forest belt of Ghana. BMC Pregnancy and Childbirth [Internet]. 2019 2019/01/07 [cited 2024 August 05]; 19(1):[6 p.]. Available from: https://doi.org/10.1186/s12884-018-2159-5.
55. Mehrnoush V, Ranjbar A, Banihashemi F, Darsareh F, Shekari M, Shirzadfardjahromi M. Urban-rural differences in the pregnancy-related adverse outcome. Gynecology and Obstetrics Clinical Medicine [Internet]. 2023 2023/03/01/ [cited 2024 August 02]; 3(1):[51-5 pp.]. Available from: https://www.sciencedirect.com/science/article/pii/S2667164622001129.
56. Zahedi-Spung LD, Raghuraman N, Macones GA, Cahill AG, Rosenbloom JI. Neonatal morbidity and mortality by mode of delivery in very preterm neonates. American Journal of Obstetrics and Gynecology [Internet]. 2022 2022/01/01/ [cited 2024 August 04]; 226(1):[114.e1-.e7 pp.]. Available from: https://www.sciencedirect.com/science/article/pii/S0002937821008279.
57. Kongwattanakul K, Thamprayoch R, Kietpeerakool C, Lumbiganon P. Risk of Severe Adverse Maternal and Neonatal Outcomes in Deliveries with Repeated and Primary Cesarean Deliveries versus Vaginal Deliveries: A Cross-Sectional Study. Journal of Pregnancy [Internet]. 2020 [cited 2024 August 04]; 2020(1):[9207431 p.]. Available from: https://onlinelibrary.wiley.com/doi/full/10.1155/2020/9207431.
58. Wängberg Nordborg J, Svanberg T, Strandell A, Carlsson Y. Term breech presentation—Intended cesarean section versus intended vaginal delivery—A systematic review and meta-analysis. Acta Obstetricia et Gynecologica Scandinavica [Internet]. 2022 [cited 2024 August 04]; 101(6):[564-76 pp.]. Available from: https://obgyn.onlinelibrary.wiley.com/doi/full/10.1111/aogs.14333.
59. Adewale V, Varotsis D, Iyer N, Di Mascio D, Dupont A, Abramowitz L, et al. Planned cesarean delivery vs planned vaginal delivery: a systematic review and meta-analysis of randomized controlled trials. American journal of obstetrics & gynecology MFM [Internet]. 2023 Dec [cited 2024 16/April]; 5(12):[101186 p.]. Available from: https://pubmed.ncbi.nlm.nih.gov/37838013/.
60. Lee H-Y, Leslie HH, Oh J, Kim R, Kumar A, Subramanian S, et al. The association between institutional delivery and neonatal mortality based on the quality of maternal and newborn health system in India. Scientific reports [Internet]. 2022 [cited 2024 August 04]; 12(1):[6220 p.]. Available from: https://www.nature.com/articles/s41598-022-10214-y.
61. Das U, Chaplot B, Azamathulla HM. The role of place of delivery in preventing neonatal and infant mortality rate in India. Geographies [Internet]. 2021 [cited 2024 16/April]; 1(1):[47-62 pp.]. Available from: https://www.mdpi.com/2673-7086/1/1/4.
62. Twabi HS, Manda SO, Small DS. Assessing the effects of maternal HIV infection on pregnancy outcomes using cross-sectional data in Malawi. BMC public health [Internet]. 2020 [cited 2024 August 04]; 20(1):[974 p.]. Available from: https://link.springer.com/article/10.1186/s12889-020-09046-0.
63. Tukei VJ, Hoffman HJ, Greenberg L, Thabelo R, Nchephe M, Mots'oane T, et al. Adverse pregnancy outcomes among HIV-positive women in the era of universal antiretroviral therapy remain elevated compared with HIV-negative women. The Pediatric infectious disease journal [Internet]. 2021 [cited 2024 August 01]; 40(9):[821-6 pp.]. Available from: https://journals.lww.com/pidj/fulltext/2021/09000/adverse_pregnancy_outcomes_among_hiv_positive.8.aspx.
64. Victora CG, Barros AJ, França GV, Bahl R, Rollins NC, Horton S, et al. Amamentação no século 21: epidemiologia, mecanismos, e efeitos ao longo da vida. Epidemiol Serv Saúde [Internet]. 2016 [cited 2024 19/April]; 25(1):[1-24 pp.]. Available from: https://edisciplinas.usp.br/pluginfile.php/4108235/mod_resource/content/1/Amamenta%C3%A7%C3%A3o%20no%20s%C3%A9culo%2021%20-%20epidemiologia%2C%20mecanismos%2C%20e%20efeitos%20ao%20longo%20da%20vida.pdf.
65. Rollins NC, Lutter CK, Bhandari N, Hajeebhoy N, Horton S, Martines JC, et al. Por que investir e o que será necessário para melhorar as práticas de amamentação. Epidemiol serv saúde [Internet]. 2016 [cited 2024 19/April]; 387(21):[25-44 pp.]. Available from: https://maternidadesemneura.com.br/wp-content/uploads/2017/11/investimento.pdf.

 doi:10.20944/preprints202410.0434.v1

66. Bangura JB, Xiao S, Qiu D, Ouyang F, Chen L. Barriers to childhood immunization in sub-Saharan Africa: A systematic review. BMC public health [Internet]. 2020 Jul 14 [cited 2024 18/April]; 20(1):[1108 p.]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7362649/.
67. Dubé E, Vivion M, MacDonald NE. Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: influence, impact and implications. Expert review of vaccines [Internet]. 2015 [cited 2024 18/April]; 14(1):[99-117 pp.]. Available from: https://www.tandfonline.com/doi/abs/10.1586/14760584.2015.964212.
68. Thysen SM, Benn CS, Gomes VF, Rudolf F, Wejse C, Roth A, et al. Neonatal BCG vaccination and child survival in TB-exposed and TB-unexposed children: a prospective cohort study. BMJ open [Internet]. 2020 [cited 2024 August 03]; 10(2):[e035595 p.]. Available from: https://bmjopen.bmj.com/content/bmjopen/10/2/e035595.full.pdf.
69. Organization WH. Immunization coverage. Key facts. 2020 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/immunization-coverage.
70. Abua MA, Antor Odu N, Madubuattah LC, Ogunkola IO. Cultural patterns and outcome of umbilical cord care among caregivers in Africa: a systematic review. Annals of medicine and surgery (2012) [Internet]. 2023 Jul [cited 2023 August 02]; 85(7):[3553-62 pp.]. Available from: https://pubmed.ncbi.nlm.nih.gov/37427171/.
71. Owusu LB, Zakaria A-FS, Agyapong S, Akokre R, Adebanji AO. Care of the newborn's umbilical cord: The perspectives of mothers in a developing country. Journal of Neonatal Nursing [Internet]. 2023 2023/12/01/ [cited 2024 August 04]; 29(6):[832-8 pp.]. Available from: https://www.sciencedirect.com/science/article/pii/S1355184123000650.