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Review Article

A decade of perinatal mortality in Pakistan: Systematic review of patterns and challenges (2013–2022)

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الملخص

أهداف البحث: تعرف منظمة الصحة العالمية الوفيات حول الولادة بأنها "وفاة طفل بين 28 أسبوعا من الحمل فصاعدا وحتى الأيام السبعة الأولى من حياته". تعد الوفيات حول الولادة مؤشرا رئيسيا لجودة الرعاية المقدمة للمواليد الجدد وتعكس بشكل مباشر فئة الرعاية قبل الولادة وأثناء الولادة وبعد الولادة المقدمة للمولود الجديد. ووفقا لتقرير نشرته منظمة الصحة العالمية، توفي ٢،٣ مليون طفل في غضون أول ٢٠ يوما من حياتهم في عام ٢٠٢٢. يوجد ما يقرب من ٦٥٠٠ حالة وفاة بين حديثي الولادة كل يوم، وهو ما يمثل ٤٧٪ من جميع وفيات الأطفال دون سن ٥ سنوات. تعد الوفيات حول الولادة مصدر قلق للصحة العامة في البلدان المنخفضة والمتوسطة الدخل. ووفقا لمسح الصحة والديموغرافي الباكستاني ٢٠١٧-٢٠١٨، فإن الوفيات حول الولادة ظل معدل الوفيات مرتفعا باستمرار في باكستان (٧٥ لكل ١٠٠٠ ولادة) خلال العقد الماضي. هدفت الدراسة لمراقبة تواتر وفيات ما حول الولادة والوفيات المبكرة للمواليد بين السكان الباكستانيين خلال العقد الماضي واستكشاف عوامل الخطر الإضافية لوفيات ما حول الولادة.

طريقة البحث: تم البحث في الدراسات باستخدام كلمات رئيسية مثل وفيات ما حول الولادة، وفيات حديثي الولادة، والمواليد الموتى، ومعدل المخاطر، والفترة المحيطة بالولادة وتركيبتها على محركات بحث مختلفة مثل "ساينس دايركت"، و "سكوبس"، و "ببميد"، و "قوقل العلمي". لقد استخدمنا عناصر التقارير المفضلة للمراجعة المنهجية والتحليل التلوي "بريزما" للوصول إلى عدد محدد من المقالات. لقد اخترنا ١٨ مقالا ذا صلة للمراجعة المنهجية. أفادت جميع الدراسات التي تمت مراجعتها إما بمعدل وفيات ما حول الولادة، أو ولادة جنين ميت أو ولادة حية.

النتائج: أظهرت المراجعة المنهجية أن معدل الوفيات حول الولادة في باكستان ظل مرتفعا من عام ٢٠١٣ إلى عام ٢٠٢٢. تزيد اضطرابات ارتفاع ضغط الدم والنزيف قبل الولادة والعدوى الوليدية من خطر الوفيات حول الولادة والوفيات حديثي الولادة بشكل عام. كانت العوامل الأخرى التي ساهمت في ارتفاع معدل الوفيات حول الولادة هي تقدم سن الأم وانخفاض الوزن عند الولادة والتشوهات الخلقية والحمل المتعدد والظروف الاجتماعية والاقتصادية السيئة ومشاكل طبية أخرى مثل سكري الحمل.

الاستنتاجات: وجد أن معدل الوفيات حول الولادة في باكستان مرتفع بشكل ملحوظ بناء على المراجعة المنهجية، ومع ذلك لوحظت تناقضات عند مقارنتها بأرقام منظمة الصحة العالمية للوفيات حول الولادة. توصي هذه المراجعة بإجراء المزيد من الأبحاث الأصلية لتقييم معدل الوفيات حول الولادة بدقة في باكستان، وهو أمر ضروري لصنع سياسات مستنيرة وفعالة.

الكلمات المفتاحية: الوفيات حول الولادة؛ ولادة جنين ميت؛ ولادة حية؛ وفيات حديثي الولادة.

Abstract

Background: The World Health Organization (WHO) defines perinatal mortality (PNM) as the "death of a baby between 28 weeks of gestation onwards till the first 7 days of life." PNM is a key indicator of the quality of care for newborns and directly reflects the category of prenatal, intrapartum, and postpartum care given to a newborn. According to a report published by the WHO, 2.3 million children died within their first 20 days of life in 2022. Approximately 6500 newborn deaths occur every day, accounting for 47% of all child deaths under the age of five years. PNM is a public health concern in low and middle-income countries. According to the Pakistan Health and Demographic Survey 2017–18, the PNM rate has remained consistently high in Pakistan (75 per 1000 births) during the last decade.

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Aims: To observe the frequency of PNM and early neonatal mortality (ENM) among the Pakistani population within the last decade and to identify additional risk factors for PNM and ENM.

Methods: Published studies were searched using keywords comprising PNM, ENM, stillbirths, risk rate, perinatal period, and their combinations with search engines such as Science Direct, SCOPUS, PubMed, and Google Scholar. We followed Preferred Reporting Items for Systematic review and Meta-Analyses (PRISMA) guidelines to filter articles and selected 18 relevant articles for systematic review. All studies reported either the PNM, ENM, stillbirth, or live birth rate.

Results: Systematic review showed that the PNM rate in Pakistan remained high from 2013 to 2022. Hypertensive disorders, antepartum hemorrhage, and neonatal infections increased the overall risk of PNM and ENM. Other factors that contributed to the high PNM rate were advanced maternal age, low birth weight, congenital abnormalities, multigravida, poor socioeconomic conditions, and other medical problems such as gestational diabetes.

Conclusion: The PNM rate in Pakistan was found to be high according to the systematic review, but discrepancies were observed when compared with the WHO figures for PNM. We recommend conducting more original research to accurately assess the PNM rate in Pakistan, which is essential for informed and effective policy making.

Keywords: Live birth; Neonatal mortality; Perinatal mortality; Stillbirth

Introduction

The World Health Organization (WHO) defines perinatal mortality (PNM) as the "death of a baby between 28 weeks of gestation till the first 7 days of life".[1] The PNM is a key indicator of health outcomes for newborns and directly reflects the quality of prenatal, intrapartum, and postpartum care given to a newborn.[2] According to the WHO report, about 2.4 million children died within their first 30 days of life in 2019 and approximately 6700 newborn deaths occurred every day in the same year.[3] PNM is a public health concern in low and middle-income countries.[4] In 2019, 4.3 million perinatal deaths were reported worldwide, which means that one perinatal death occurred every 7 s.[5]

The PNM rate (PNMR) is comparatively high in low- and middle-income countries. The PNMR was recorded as 10 per 1000 births in high-income countries compared with 50 per 1000 births in low- and middle-income countries.[6] A study in Northern Iran from 2011 to 2018 determined a PNMR of 29.01 per 1000 live births, and the most common causes of PNM were prematurity and low birth weight.[7] Based on the Nepal Demographic and Health Survey data sets for 2001–2016, a sample of 23,335 pregnancies with a gestational age greater than 28 weeks was examined, and the PNMR was 42 per 1000 births during the five-year study period. A higher risk of PNM was found for women who resided in mountainous regions, did not use contraception, were aged 15–18 or 19–24 years, and were not formally educated. Moreover, this study also found that women who lived in homes that used biomass for cooking had a considerably higher likelihood of experiencing PNM, as well as those in households that reported open defecation or inadequate sanitation.[8]

A study carried out in Bangladesh using data from the four rounds of the Bangladesh Demographic and Health Surveys in 2004, 2007, 2011, and 2014 showed that the PNMR dropped significantly from 64 to 41 per 1000 pregnancies, but the number was still high.[9] According to a systematic review of observational studies conducted by Ghimire et al., in 2018, low socioeconomic status, requirement for high-quality healthcare services, pregnancy and/or obstetric complications, and lack of prenatal care were the most frequently cited factors linked to PNM in South Asia.[10] Kumsa et al. conducted a systematic review and meta-analysis by utilizing the International Classification of Diseases for Perinatal Mortality (ICD-PM), and found that the combined stillbirth rate was reported as 23 per 1000 births in high-income countries, but it was twice as high in low-income countries. Approximately 58.2% of the deaths were classified as having undetermined causes. Among the 54.6% of deaths reported during the antepartum period, the most common causes of PNM included low birth weight, prematurity, congenital malformations, and genetic abnormalities. According to UNICEF data, the second-highest stillbirth rate of 17.0 per 1000 live births was found in South Asia.[11,12]

Utilizing data from three Pakistan Demographic and Health Surveys (2017–18, 2012–13, and 2006–07), Dawood et al. showed that the overall neo-natal mortality decreased from 63 to 42 per 1000 live births according to the surveys in 2012–13 and 2017–18.[13] However, the 2006–07 survey showed that 59% of neo-natal deaths occurred in Punjab, 25% in Sindh, 13% in Khyber Pakhtunkhwa (KPK), and 5% in Baluchistan compared with 62% in Punjab, 22% in Sindh, 11% in KPK, and 5% in Baluchistan during 2017–18, thereby demonstrating that the stillbirth rate declined in Sindh and KPK, but increased in Punjab and Baluchistan.[13]

The PNMR was significantly higher when assessed by enhanced surveillance compared with routine monitoring systems in Pakistan, with an overall rate of 60 per 1000 total births. The early neonatal mortality (ENM) rate was 30 per 1000 live births and stillbirths accounted for 32 per 1000 total births. The surveillance system allows healthcare to utilize resources more efficiently and to maximize the influence of focused intervention by reducing mortality rates.[14] Another study conducted using Pakistan Demographic and Health Survey data from 2012 to 2013 reported that the PNMR was 75 per 1000 live births.[15]

The PNMR is fairly high in Pakistan due to inequitable preventive health facilities and their utilization across the country. These inequalities are more intensified across various geographical regions, such as from urban to rural areas, as well as from richest to poorest strata and among differences in literacy levels, income, and socio-economic status.[16] Studies conducted in India also found that poor literacy, rural life, limited healthcare facilities, and poor financial status led to poor health outcomes.[17,18] The high burden of PNM in Pakistan is attributed to multiple factors, where the key contributors include maternal health disorders, such as hypertension, intra-uterine hemorrhage, intrapartum hypoxia, preterm labor, and intrapartum infections, and inadequate health services.[15]

In the present systematic review, we aimed to examine the prevalence of PNM and ENM within the Pakistani population over the past decade. In addition, we aimed to investigate the risk factors associated with PNM and ENM. This study contributes to the evaluation of Target 3.2 of the Sustainable Development Goals (SDGs), which focuses on ending preventable deaths of newborns and children aged under five years and reducing neonatal mortality.

Methodology

A systematic review was carried out to observe the incidence of PNM and ENM, and the risk factors related to their high incidence in Pakistan. Therefore, we selected original research articles published within the last decade, i.e., from January 1, 2013 to December 31, 2022. The methodology was based on the following six literature search steps to select the final articles.

Literature Search Strategy, Sources, and Terms: All authors searched for data using the keywords in the initial stage. The data extraction process was conducted before the initial assessment. In the data extraction process, a structured search strategy was applied using the selected keywords for each database. The authors searched for data independently using one assigned search engine. Research studies were searched for using keywords comprising "PNM," "ENM," "still births", "risk rate," and "perinatal period." Combinations of these words were also used in the literature search. A pilot test was conducted based on a subset of studies searched in the database to ensure that the strategy retrieved relevant articles. Literature was searched using search engines comprising "PubMed," "ScienceDirect," "SCOPUS," and "Google Scholar." Records were maintained of all search-related activities, including databases used, dates of searches, and keywords. Further studies were accessed using the snowball technique or retrieved from relevant references. Records were initially identified by titles and skim reading the abstracts. Before assessment, the data records were cross-verified once again to ensure unbiased data selection. During revision of the present article, a librarian was consulted about data extraction and quality assessment of studies.

1. **Inclusion criteria:** Original research articles with any of the keywords PNM, ENM, and stillbirths were included. Only articles written in the English language, published within the last decade, and conducted in Pakistan were included.
2. **Exclusion criteria:** Studies of mothers with obstructed labor were excluded due to high maternal and neonatal mortality. Obstructed labor often leads to severe complications such as fetal distress, hypoxia, or other mechanical issues that could significantly skew the results. Qualitative studies, systematic reviews, and meta-analyses were also excluded from the review.
3. **Data abstraction:** The review period was from January 1, 2023 to February 28, 2023. We assessed the study design, objectives, population, time duration and period, location, and study setting. We also assessed the statistical analysis tool or model and significant variables for the subject addressed. We followed the Preferred Reporting Items for Systematic review and Meta-Analyses (PRISMA) method to filter articles for inclusion.
4. **PRISMA flowchart and data extraction procedure:** PRISMA is based on three principal steps, i.e., identification, screening, and inclusion. In the identification step, we extracted 126 articles based on the title and abstract. We then removed duplicates, irrelevant articles, and ineligible articles. Studies were considered ineligible if they were not conducted in the past decade, not performed in Pakistan, or written in a language other than English, as well as systematic reviews or meta-analyses (Figure 1). **A 27-item PRISMA checklist used for quality assessment in the systematic review process is available in the supplementary material.**

Screening was conducted for the remaining articles. During the selection process, we excluded studies that focused on COVID-19 or involving populations of recovered coronavirus patients. In addition, during the screening stage, articles were excluded if the full text could not be retrieved and if the study was not an original article. We excluded one letter to the editor and one qualitative study during the screening process.

5. **Records identified:** In the final assessment of the articles, we excluded those based on maternal mortality and neonatal mortality. We also excluded articles based on perinatal morbidity. We obtained 18 articles for inclusion in the review.

Results

All of the studies included in the review reported PNM, ENM, stillbirth or live births, and the risk factors related to these incidences were also considered. Details of the articles included are given in Table 1. Among the selected articles, 16 articles were from the last five years. Articles on various risk factors related to PNM, stillbirth, and ENM were also included. Two studies used secondary data from the Pakistan Demographic and Health Survey, one study was conducted in Islamabad, a federal tertiary, and one study was conducted in Azad Jammu and Kashmir. Among the remaining articles, equal numbers were performed in Sindh, Punjab, and KPK.

Five articles considered PNM, stillbirth, and ENM, four only considered PNM, three reported the outcome as ENM, and one reported stillbirth. Among the remaining studies,

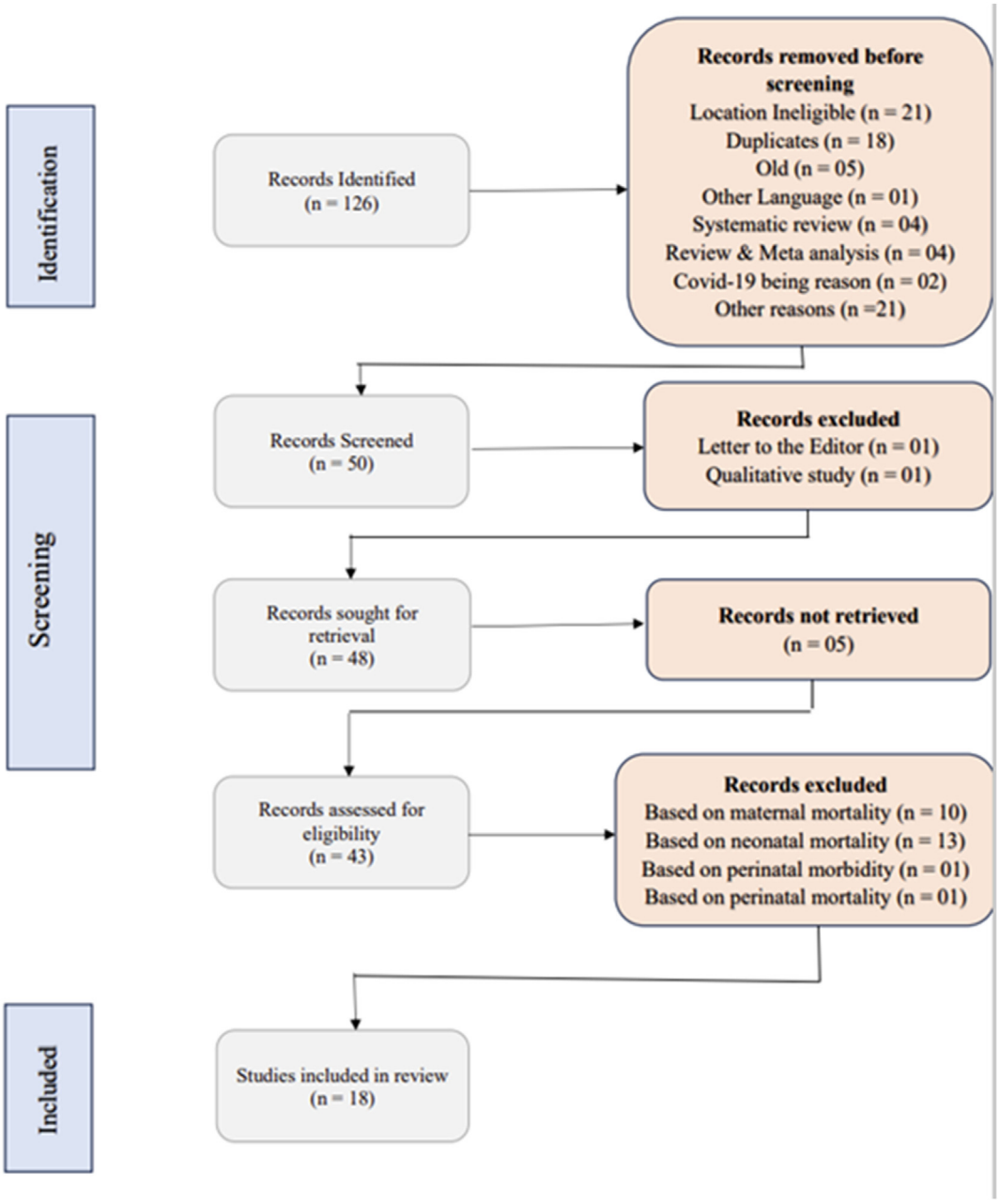

Figure 1: PRISMA flowchart showing the process followed to identify articles for inclusion in the review.

equal numbers reported the combination of stillbirth and ENM, and the combination of PNM and stillbirth.

Some of the selected studies reported PNM per 1000 total births, stillbirths per 1000 total births, and ENM per 1000 live births, whereas other reported the frequency, count, or percentages (Table 1). Thus, to facilitate comparisons, we converted the frequencies and percentages of PNM and stillbirths to those per 1000 total births and of ENM to those per 1000 live births.

Table 2 shows the different risk factors associated with PNM. In the articles selected, the most common risk factors identified for PNM, including ENM and stillbirths, were: hypertensive disorders (such as pregnancy-induced hypertension, pre-eclampsia, or eclampsia), antepartum hemorrhage, neonatal sepsis or different neonatal infections, birth asphyxia, advanced maternal age or age >34 years, congenital anomalies, low birth weight, prematurity, preterm labor, and gestational diabetes.

Discussion

The primary objective of this systematic review was to evaluate PNM trends in Pakistan, as well as associated maternal and socio-economic factors. The outcomes varied in the studies included in this review, where some reported stillbirths and others focused on ENM. Therefore, we considered studies that reported PNM, but also included those that investigated stillbirth and ENM rates. A study

Table 1: List of selected articles on PNM, stillbirth, and ENM.

Author (Year)	Determinant	Region	Study population; sample size	Population (community based/hospital based)	Study design	PNM per 1000 total births	Stillbirths per 1000 total births	ENM per 1000 live births
Ahmed et al.[15] (2018)	Stillbirth and ENM	Pakistan demographic and health survey 2011−12	Pakistan demographic and health survey (2012−13); 11985 singleton births, 11596 live births	Community based	Descriptive cross-sectional		34.4	43
Wasim et al.[19] (2021)	PNM, stillbirth and ENM	Lahore, Punjab	Females who visited services institute of medical Sciences, services hospital, Lahore; 11850	Hospital based	Prospective cohort study	58.2	20	38
Waheed et al.[20] (2018)	PNM, stillbirth and ENM	Rawalpindi, Punjab	Females who visited the Department of Gynecology and obstetrics, unit II, Holy family hospital, Rawalpindi; 20231	Hospital based	Retrospective	67.8	42.9	25.0
Qadir et al.[21] (2018)	PNM and stillbirth	Peshawar, Khyber Pakhtunkhwa	Females who visited the Department of Gynecology and obstetrics, Khyber teaching hospital, Peshawar; 4508	Hospital based	Cross-sectional	63.8	50.6	13.2
Qadir[22] (2018)	PNM	Mardan, Khyber Pakhtunkhwa	Females who visited the Department of Gynecology and obstetrics, Mardan medical Complex, Mardan; 21	Hospital based	Prospective cross-sectional	520	430	95
Anwar et al.[23] (2018)	PNM	Havelian, Khyber Pakhtunkhwa	Females residing in tehsil Havelian, Khyber Pakhtunkhwa; 1228 households	Community based	Stratified cross-sectional study	63	32	32
Ali et al.[24] (2020)	PNM and stillbirth	Karachi, Sindh	Females who visited the Department of obstetrics and Gynecology and	Hospital based	Descriptive case series	105	115	94

(*continued on next page*)

Table 1 (*continued*)

Author (Year)	Determinant	Region	Study population; sample size	Population (community based/hospital based)	Study design	PNM per 1000 total births	Stillbirths per 1000 total births	ENM per 1000 live births
			obstetrics unit II, Jinnah medical and Dental College, Karachi; 287					
Khawaja et al.[25] (2021)	PNM	Khairpur, Sindh	Females who visited Gambat institute of medical Sciences, Sindh; 175	Hospital based	Descriptive case series	217		
Memon et al.[26] (2015)	PNM, stillbirth and ENM	Gilgit-Baltistan	The mountainous population of Gilgit; Intervention group: 137781 Control group: 145543	Community based	Quasi-experimental	51.4 in pre-intervention in control area. 47.1 in pre-intervention area in intervention area. 55.6 in post-intervention in control area. 35.3 in post-intervention area in intervention area.	23.3 in pre-intervention in control area. 28.1 in pre-intervention in intervention area. 23.5 in post-intervention in the control area. 18.5 in post-intervention in intervention area.	28.1 in pre-intervention in control area. 19.0 in pre-intervention area in intervention area. 32.1 in post-intervention in control area. 16.8 in post-intervention area in intervention area.
Aziz et al.[27] (2018)	Stillbirth	Islamabad, federal	Females who visited the obstetrics and Gynecology department of MCH Centre FGPC islamabad; 109	Hospital based	Descriptive cross-sectional		11.9	
Soofi et al.[28] (2017)	PNM, stillbirth and ENM	Naushahro Feroze, Sindh	Females residing in subdistricts of Naushahro Feroze in rural Sindh, Pakistan; Intervention group: 242749 Control group: 256985	Community based	Clustered randomized controlled trial	96 in control group. 78 in intervention group.	53 in control group. 45 in intervention group.	45 in control group. 34 in intervention group.

Pathan et al.[29] (2021)	PNM, stillbirth and ENM	Khairpur, Sindh	Females who visited obstetrics and Gynecology Department at KMC Khairpur Mirs, Sindh; 7200	Hospital based	Descriptive case series	204.8- Twin 1 253.0- Twin 2	60.2- Twin 1 84.3- Twin 2	144.6- Twin 1 168.7- Twin 2
Afshan et al.[30] (2019)	Stillbirth/PNM	Pakistan demographic and health survey 1990 −2013	Pakistan demographic and health survey (1990 −2013)	Community based	Cross-sectional		159 in 2006−7 75 in 2012−13 About 12.52 reduction	
Basta et al.[31] (2022)	Stillbirth and ENM	Karachi, Sindh	Females who visited Aga Khan hospital (AKU) and Liaquat National hospital (LNH) 840	Hospital based	Retrospective cohort study		50 in normotensive 136.7 in hypertensive	24.4 in normotensive 110.7 in hypertensive
Fahim et al.[32] (2022)	ENM and stillbirth	Peshawar, Khyber Pakhtunkhwa	Records from the medical teaching institute, lady reading hospital Peshawar; 49283	Hospital based	Cohort study		329.4	12
Ajmal et al.[33] (2022)	PNM	Peshawar, Khyber Pakhtunkhwa	Females who visited Department of obstetrics and Gynecology, lady reading hospital, Peshawar; 165	Hospital based	Descriptive cross-sectional	60		
Choudry et al.[34] (2020)	ENM	Rawalpindi, Punjab	Females who visited Department of obstetrics and Gynecology, Pak Emirates Military hospital, Rawalpindi; 1381	Hospital based	Cross-sectional comparative			39
Asghar et al.[35] (2020)	ENM	Rawalpindi, Punjab	Neonates at Benazir Bhutto hospital, Rawalpindi; 24459	Hospital based	Cross-sectional			163

Table 2: Risk factors for PNM in selected articles (n = 18).

Author (Year)	Region	Study Design	Risk Factors
Ahmed et al.[15] (2018)	Pakistan demographic and health survey 2011 −12	Descriptive cross-sectional	• Never used any family planning method • Mother performing manual labor • Blood relation with husband • Socioeconomic status • Malnourished mother • Pregnancy earlier than expected
Wasim et al.[19] (2021)	Lahore, Punjab	Prospective cohort study	• Hypoxia • Low birth weight • Prematurity • Acute intrapartum event • Neonatal infections • Maternal hypertensive disorders • Gestational diabetes • Preterm labor • Malpresentations • Maternal complications of placenta, cord, and membranes
Waheed et al.[20] (2018)	Rawalpindi, Punjab	Retrospective	• Congenital anomalies • Maternal hypertensive disorders • Antepartum hemorrhage • Obstructed/prolonged labor • Intra-uterine growth restriction • Cord prolapse • Meconium aspiration syndrome • Ruptured uterus • Transverse lie, breech presentation • Birth asphyxia • Maternal heart disease • Maternal diabetes
Qadir et al.[21] (2018)	Peshawar, Khyber Pakhtunkhwa	Cross-sectional	• Maternal hypertensive disorders • Antepartum hemorrhage • Congenital anomalies • Obstructed labor • Uterine rupture • Breech presentation, transverse lie • Nuchal cord, cord prolapse • Meconium aspiration syndrome • Respiratory distress syndrome • Neonatal septicemia • Maternal diabetes, hepatitis, chorioamnionitis
Qadir[22] (2018)	Mardan, Khyber Pakhtunkhwa	Prospective cross-sectional	• Hemorrhage • Shock • Uterine rupture • Uterine atony • Placental abruption • Placenta previa • Extension of uterine incision
Anwar et al.[23] (2018)	Havelian, Khyber Pakhtunkhwa	Stratified cross-sectional study	• Rural districts of Pakistan
Ali et al.[24] (2020)	Karachi, Sindh	Descriptive case series	• Advanced maternal age • Low birth weight
Khawaja et al.[25] (2021)	Khairpur, Sindh	Descriptive case series	• Hemorrhage • Anemia • Dystocia • Pre-eclampsia • Eclampsia • Neonatal sepsis • Maternal age
Memon et al.[26] (2015)	Gilgit-Baltistan	Quasi-experimental	• Prematurity • Neonatal sepsis • Birth asphyxia • Tetanus • Birth injury • Congenital abnormality

Table 2 (*continued*)

Author (Year)	Region	Study Design	Risk Factors
			• Unexplained deaths
Aziz et al.[27] (2018)	Islamabad, federal	Descriptive cross-sectional	• Congenital anomalies • Pre-eclampsia • Antepartum hemorrhage
Soofi et al.[28] (2017)	Naushahro Feroze, Sindh	Clustered randomized controlled trial	• Preterm birth complications • Perinatal asphyxia • Neonatal infections • Obstructed labor and its complications • Suspected infection in neonates
Pathan et al.[29] (2021)	Khairpur, Sindh	Descriptive case series	• Advanced maternal age • Multiple pregnancies
Afshan et al.[30] (2019)	Pakistan demographic and health surveys 1990−2013	Cross-sectional	• Antepartum and intrapartum asphyxia • Antepartum maternal disorders • Mothers with age >34 • Birth order >3
Basta et al.[31] (2022)	Karachi, Sindh	Retrospective cohort study	• Hypertensive disorders • Low birth weight
Fahim et al.[32] (2022)	Peshawar, Khyber Pakhtunkhwa	Cohort study	• Hemorrhage • Hypertensive disorders • Thromboembolism
Ajmal et al.[33] (2022)	Peshawar, Khyber Pakhtunkhwa	Descriptive cross-sectional	• Not receiving antenatal care
Choudry et al.[34] (2020)	Rawalpindi, Punjab	Cross-sectional comparative	• Cousin marriage • Threatened pre-term labor • Preterm delivery • Chronic obstructive pulmonary disease
Asghar et al.[35] (2020)	Rawalpindi, Punjab	Cross-sectional	• Prematurity • Low birth weight • Suspected sepsis in neonates • Birth asphyxia • Neonatal jaundice • Meconium aspiration syndrome

conducted in Lahore, Punjab reported a PNMR of 58.2 per 1000 live births, which was the lowest observed in cross-sectional studies.[19] Another study in Rawalpindi, Punjab found a PNMR of 67.8 per 1000 births.[20] Other studies in Peshawar, KPK, reported rates of 63.8 per 1000 live births.[21] However, significantly higher PNMRs were observed in other cities in KPK. For instance, a study in Mardan, KPK reported a rate of 520 per 1000 births,[22] while another in Havelian, KPK determined a rate of 63 per 1000.[23] In addition, the PNMRs were notably higher in Sindh than Punjab. In Karachi, Sindh, the PNMR was 105 per 1000 live births,[24] whereas another study in Khairpur, Sindh, reported a PNMR of 217 per 1000.[25]

The highest PNM was reported by Qadir (2018),[22] followed by those determined by Khawaja et al. (2021) and Pathan et al. (2021).[25,29] The minimum observed PNMR was found in the post-intervention group among the intervention cohort. Post-intervention was statistically significantly associated with PNM and ENM.[26] Another study also found a lower PNMR in the intervention group. Moreover, PNM and ENM were significantly associated with control and intervention clusters.[28]

Most of the studies included in this systematic review were conducted in hospital settings, and only 5/18 were community-based surveys. Significant differences were observed in the rates reported in community surveys and hospital surveys. Hospital-based studies reported comparatively higher rates of PNM, stillbirth, and ENM. By contrast, studies based on demographic and health surveys reported lower rates compared with other community-based survey results.

Low birth weight was found to be associated with PNM.[19,35] Another risk factor for PNM was advanced maternal age. Maternal age was significantly associated with PNM.[22] The group aged 31−40 years accounted for the highest proportion of PNM, stillbirths, and ENM,[24] and the highest mortality rate was observed among mothers aged 31−35 years.[29] A statistically significant relationship was identified between PNM and place of residence, where the odds were 1.72 times higher.[30]

Maternal education was significantly associated with PNM. The odds of PNM decreased as the level of education increased beyond secondary school, where the highest odds were found among mothers with only primary education. Similarly, a significant link was observed between wealth quintiles and PNM, where the lowest wealth quintile had higher odds of PNM.[30]

Other prevalent risk factors included hypertension, where Basta et al. found that mothers with hypertensive disorders had a fivefold increased risk of early neonatal deaths and were two times more likely to have stillbirths compared with mothers who had normal blood pressure.[31] Hemorrhage was

present in 35% of PNM cases, followed by hypertension in 21% and mechanical factors in 13.88%. Maternal medical disorders such as thromboembolism were also found in 21% of cases.[32] It should be noted that maternal age had no significant effect on ENM, but it was significant for stillbirth.[24]

Women from Baluchi families had higher odds of stillbirth. Those engaged in manual labor had 1.60 times greater odds of stillbirth compared with those who were not working. Women living in rural areas had 1.8 times higher odds of stillbirth, and those whose husbands had a higher level of education had 1.73 times greater odds. A blood relationship with the husband also increased the odds of stillbirth by 1.73 times. Women who had never used any form of family planning were more likely to experience stillbirths. Women who considered three boys to be the ideal number had increased odds of stillbirth. In addition, women engaged in labor work were 1.55 times more likely to have stillbirths. Moreover, a mother with a body mass index less than normal (<18.5) had 1.68 odds for ENM. Higher gravida (> five pregnancies) was associated with higher odds of ENM.[15] A comparison of PNM between mothers who were booked and un-booked for obstetric care showed that PNM was 230 per 1000 total births for booked mothers compared with 770 per 1000 total births for un-booked mothers.[33]

ENM was most common in 1.9% of cases with first-cousin marriages, 1.0% in second-cousin marriages, and 5.8% in marriages without consanguinity. The likelihood of ENM was twice as high in consanguineous marriages compared with non-cousin marriages.[34] Moreover, according to Ahmed et al., women who had a blood relationship with their husbands had a 1.45 times higher risk of stillbirth than women who were married to a non-blood relation.[15]

Conclusion

The findings obtained in this systematic review demonstrate that PNMRs were still high in Pakistan, especially in Sindh and KPK provinces. In addition, the PNMRs were also two times higher in Baluchi families. By contrast, the lowest PNMRs were reported from Gilgit and Punjab provinces. The PNMRs were higher in hospital-based studies than community-based studies. The most commonly identified risk factors linked to PNM included hypertensive disorders, antepartum hemorrhage, low birth weight, and neonatal sepsis.

Based on the findings obtained in this review, we conclude that there is a pressing need to update healthcare policy regarding prenatal care and to provide better facilities. Improving the standard and availability of prenatal care should be a major priority for policymakers, particularly in marginalized and rural areas. PNM can be reduced by providing home visits, encouraging maternal and child health education, and ensuring access to clean birth kits. Interventions such as community health initiatives involving lady health workers should be strengthened and maintained. Pregnant women should be screened for high-risk conditions such as hypertension and preeclampsia, receive routine checkups, and receive early and appropriate treatment for neonatal infections as well as for antepartum hemorrhage and other pregnancy-related medical disorders.

Recommendations

This review primarily focused on PNM and ENM rates, but we also assessed risk factors as a key aspect of the present study. However, we strongly recommend that future research in the area of perinatal and neonatal mortality (PNM and ENM) in Pakistan should focus on several targeted areas to deepen understanding and improve interventions. Researchers should investigate how cultural beliefs, traditional practices, and societal norms influence maternal and neonatal health behaviors. Understanding how practices like delayed healthcare seeking, home births, and reliance on traditional birth attendants affect PNM could help to improve the design of culturally sensitive interventions. Moreover, we recommend that government healthcare centers ensure the provision of quality healthcare services for maternal care because they should never be compromised. Furthermore, increased training for healthcare workers in PNM prevention, mobile healthcare units, or policies that address the identified determinants could be beneficial for reducing the PNMR.

Limitations

The authors made extensive efforts to search the literature using multiple search engines and included all relevant studies conducted in Pakistan over the past decade. However, incorporating studies from earlier years could have provided additional details and highlighted socioeconomic factors that contribute to PNM and ENM. We could not exclude the studies conducted in community settings from our systematic review but there might have been some ambiguity due to the use of secondary data. Another challenge was the format of the rates reported in different studies. Moreover, this study was a systematic review rather than a meta-analysis, which might provide more precise insights into the determinants of PNM in Pakistan.

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Conflict of interest

The author(s) have no conflict of interest to declare.

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Authors' contributions

NS: Conceptualization, Literature search, Manuscript writing, Data analysis.

TK: Conceptualization, Literature search, Review of article, Editing, visualization.

SF: Literature search, Methodology writing, Review of article.

SZN: Introduction writing, Literature search, Visualization.
HA: Review of article, Methodology writing, Visualization.

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