Review Paper

Risk Factors of Child Mortality in Iran: A Systematic Review and Narrative Synthesis

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ABSTRACT

Background: Child mortality remains a critical indicator of population health and development. While global under-5 mortality has declined significantly, disparities persist, particularly in low- and middle-income countries. In Iran, under-5 mortality remains a concern, with various social, maternal, and child-level factors contributing to regional and demographic disparities.

Objectives: This study aimed to systematically review and synthesize evidence on risk factors associated with mortality among children aged 1 to 59 months in Iran.

Methods: A systematic review was conducted using a narrative synthesis approach. Articles published between 2010 and 2023 were identified through a search of national and international databases, including IranDoc, SID, PubMed, Web of Science, and ScienceDirect. The inclusion criteria required studies to use multivariate regression, report odds ratios, and focus on children aged 1–59 months in Iran. The quality of included studies was assessed using the Newcastle-Ottawa Scale.

Results: Nine studies met the inclusion criteria: 6 case-control and 3 cross-sectional. Risk factors were categorized into 3 domains: Socioeconomic, maternal/pregnancy-related, and child-related. Significant risk factors included low maternal education, low socioeconomic status, paternal addiction, consanguinity, short interpregnancy intervals, history of abortion, inadequate prenatal care, low birth weight, preterm birth, and formula feeding. No significant associations were found with paternal education, parental employment, child sex, or multiple births.

Conclusions: Multiple modifiable risk factors are associated with mortality among children aged 1 to 59 months in Iran. Targeted interventions focusing on maternal education, poverty reduction, prenatal care, and newborn health can effectively reduce child mortality. Future research should address regional disparities and underexplored determinants to inform comprehensive policy responses.

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Introduction

Child mortality is widely recognized as a key indicator of population health, social welfare, and national development [1]. It was identified as one of the millennium development goals to reduce the child mortality rate by two-thirds between 1990 and 2015 [1]. The sustainable development goals further emphasize the importance of eliminating all preventable deaths among children under 5 years of age, aiming to reduce their mortality rate to no more than 25 per 1,000 live births by 2030 [2]. According to United Nations Children's Fund (UNICEF), children aged 1 to 59 months account for more than half of 4.8 million under-5 deaths globally, with pneumonia, diarrhea, and malaria as leading causes in 2023 [3]. While global child mortality has declined—from 77 per 1,000 in 2000 to 37 in 2023—disparities remain stark, particularly in low- and middle-income countries [3]. In high-income countries, this rate is as low as 5 per 1000 live births, whereas in low-income countries, child mortality is 13 times higher than in high-income nations [2]. Child mortality is not evenly distributed across the globe; 1.08 million of these deaths occurred in sub-Saharan Africa and South Asia alone [2].

These deaths are largely preventable and are strongly associated with social determinants such as limited access to health care, poor nutrition, unsafe water, inadequate sanitation, and maternal education [2, 3]. In many countries, child mortality is also influenced by structural inequalities and regional disparities in health service coverage [4]. Globally, well-documented risk factors include maternal age, birth spacing, family income, household education, and rural residence [3].

In Iran, the under-5 mortality rate has declined from earlier decades to 11.7 per 1000 live births in 2023 [5]. A substantial proportion of under-5 deaths in Iran occur among infants under one year of age [6]. Injuries have been identified as the leading cause of death among children aged 1 to 59 months in Iran, affecting both genders equally, though with varying distribution across provinces [4]. Globally, unintentional injuries are among the most prominent causes of child mortality, a trend also confirmed by studies conducted in Iran [7-10]. Poverty stands out as a major social determinant of child health, and poverty reduction programs have been linked to decreases in under-5 mortality in numerous countries [11]. The health and survival of children under 5 are also closely linked to the socioeconomic conditions of their families, with higher mortality rates observed in lower socioeconomic strata [12].

Within the Iranian health system, child health is administratively separated into neonates (0–28 days) and older children (1–59 months), with each managed by distinct departments within the Ministry of Health and Medical Education. While risk factors associated with neonatal mortality in Iran have been specifically addressed in a separate study [13], risk factors affecting children aged 1 to 59 months have received less consolidated attention, and existing research remains fragmented, with a comprehensive synthesis of risk factors specific to the post-neonatal period lacking. Thus, this study investigated the risk factors of children aged 1 to 59 months. Given that under-5 mortality is a multifactorial outcome encompassing the child, the mother, and pregnancy-related events [14], a systematic understanding of these contributors is critical for designing targeted and effective, evidence-based interventions to reduce child mortality. This study aimed to systematically review and synthesize the available evidence on risk factors for mortality among children aged 1 to 59 months in Iran.

Materials and Methods

This study was designed as a systematic review employing a narrative synthesis approach—all stages of the research and its reporting adhered to the PRISMA 2020 checklist. The timeframe for included studies was set to 2010-2023 to reflect the current situation better. The literature search was conducted in October 2023.

Given that Persian is the official language of Iran, Persian-language studies were included alongside English-language articles published in international journals. Search was conducted in Persian databases, including Iranian Research Institute for Information Science and Technology (IranDoc) and Scientific Information Database (SID), and in international databases of ScienceDirect, PubMed, and ISI Web of Science, using a combination of keywords for "child mortality," "child*," "infant," "under five," "under-5," "U5M," "mortalit*," "death," and "Iran*" and their Persian equivalents. Search strategy used for PubMed is presented here as an example: (((child*[Title/Abstract] OR infant[Title/Abstract] OR U5M[Title/Abstract] OR "under five" [Title/Abstract] OR "under 5"[Title/Abstract]) AND (mortalit*[Title/Abstract] OR death* [Title/Abstract]) AND (Iran*[Title/Abstract])) OR (("child mortality"[Mesh] OR "infant mortality"[Mesh]) AND "Iran"[Mesh])) AND (2010:2024[pdat]). Search strategies used for other databases are provided in the supplementary file. Additionally, Google Scholar citation check was used to identify potentially relevant studies. The reference lists of the included articles were manually reviewed for additional sources.

A highly sensitive search strategy was employed. Although this strategy resulted in the retrieval of some irrelevant material, efforts were made to screen and assess all potentially relevant articles. This search strategy was refined through multiple iterations of keyword combinations to capture the broadest possible range of literature on under-5 mortality risk factors.

The inclusion criteria for the study stipulated that the article must focus on mortality in children aged 1 to 59 months or under 5 years; be conducted within Iran or in one or more of its cities, provinces, or hospitals; utilize multivariate regression to analyze risk factors; report odds ratios (OR); and be published in either Persian or English. On the other hand, studies were excluded if they focused on a specific disease or a particular subgroup of children, examined deaths from a single cause, lacked full text, included stillbirths in under-5 mortality figures, or were duplicate publications from the same dataset.

The study population comprised all articles, theses, and reports related to mortality among children aged 1 to 59 months in Iran. In line with the aforementioned categorization, articles covering mortality in children under 1 year, under 5 years, and specifically aged 1 to 59 months were included. No restrictions were placed on study type, and all study designs, including cohort and case-control studies that reported OR, could have been included in the review.

All retrieved articles were stored and managed using EndNote software, version X20. Data extraction was carried out using a pre-designed table containing two sections: General and specific information. General information included the year of publication, author, and study location. Specific information included study period, objectives, study design, age group studied, data collection tools and methods, sample size, statistical analysis techniques, significant and non-significant findings, and reported limitations. Two researchers performed data extraction from the articles. In the event of any disagreement, the issue was resolved by a third party.

Ultimately, 6 case-control studies and 3 cross-sectional studies met the inclusion criteria. To assess their quality, the Newcastle-Ottawa scale was employed, following evidence from a systematic review and meta-analysis evaluating quality assessment tools [15]. This tool provides separate checklists for case-control and cross-sectional studies, with a maximum score of nine stars. Studies scoring 7 or higher were categorized as high-quality. All included studies in this review were assessed and determined to be of high quality (Table 1).

Heterogeneity assessment

Given the considerable heterogeneity among the included studies, conducting a meta-analysis was deemed inappropriate. This heterogeneity arose from several factors, including differences in target populations (e.g. age groups, geographic locations), variations in the classifica-

Table 1. Characteristics of the studies

Author (y)	Study Type	Language of Study	Age Range	Study Duration	Case Group	Control Group	Quality Assessment Score (Out of 9 Stars)
Nakhzari-Moghaddam et al. 2019 [12]	Cross sectional	EN	<5 year	5 years	667	1334	7
Evazpoor et al. 2016 [22]	Case control	EN	<5 year	1 year	186	372	9
Chaman et al. 2012 [18]	Case control	EN	1-59 months	10 years	65	130	9
Safari et al. 2013 [19]	Case control	PR	1-59 months	10 years	65	130	9
Ansari-Moghaddam et al. 2014 [21]	Case control	EN	<1 year	2 months	186	300	8
Hajipour et al. 2021 [14]	Case control	EN	<1 year	1 year	1,076	1310	7
Chaman et al. 2014 [17]	Case control	PR	<1 year	-	117	234	8
Damghanian et al. 2014 [16]	Cross sectional	EN	<1 year	1 years	72	3225	8
Gholami Taramsar, 2021 [20]	Cross sectional	EN	<1 year	1 year	21	4221	8

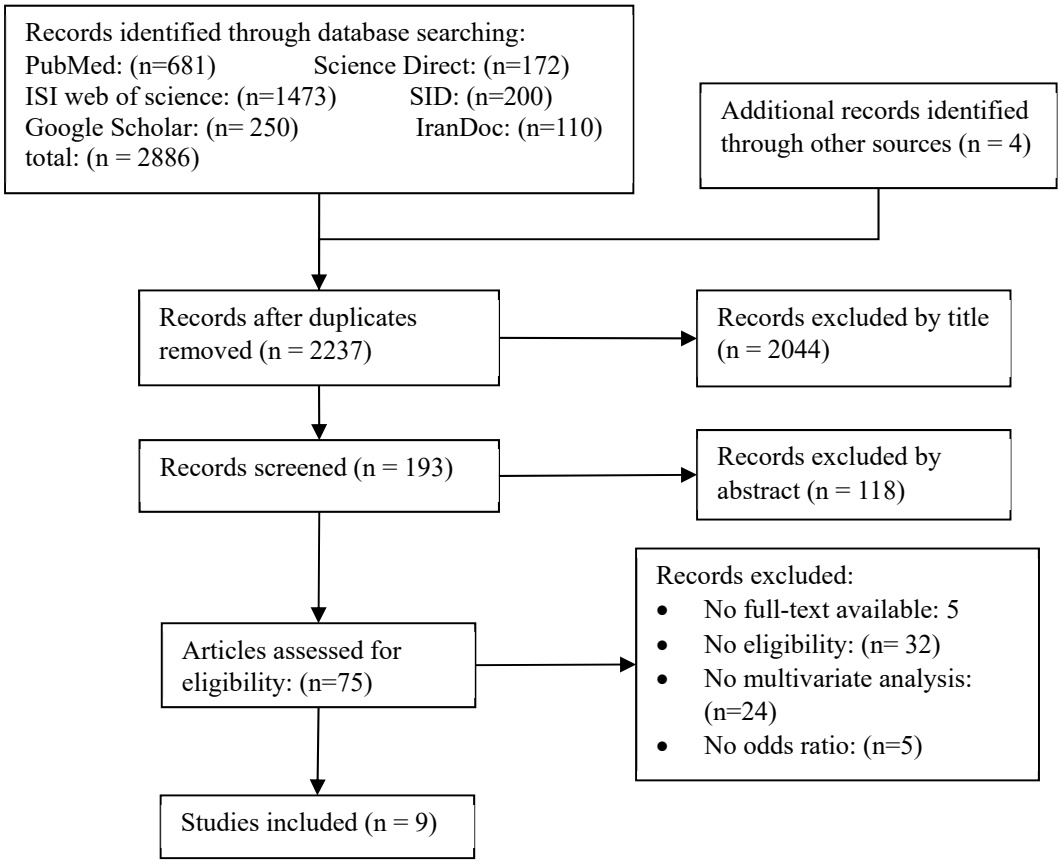

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Figure 1. Search and screening diagram of references for systematic review of risk factors of 1-59 months mortality in Iran

tion and definition of risk factors, and diverse methods for outcome measurement. These discrepancies limited the comparability of study findings and posed significant challenges for synthesizing data quantitatively.

Moreover, the number of studies available for each specific risk factor was relatively small (fewer than 9 in most cases), which further constrained the statistical power and reliability of any pooled analysis. Due to these qualitative and quantitative limitations, a formal heterogeneity assessment (e.g. I^2 statistic) and meta-analysis were not performed. Instead, a narrative synthesis approach was adopted to summarize and interpret the findings descriptively.

Results

Out of 2886 articles initially retrieved, 9 studies met the inclusion criteria and were included in this systematic review. The process of article selection and exclusion at each stage is illustrated in Figure 1. The included studies were grouped by child age into three categories: 5 studies focused on children under 1 year, 2 on children aged 1 to 59 months, and 2 on children under 5 years. Geographically, 4 studies were conducted in Shahroud. Others were conducted in Semnan, Zahedan, Zabol cities, and 1 multi-province study covering Hormozgan, Fars, Golestan, Kohgiluyeh and Boyer-Ahmad, South Khorasan, Kermanshah, Hamedan, and Yazd. Tables 2, 3 and 4 present the OR reported in the included studies, grouped by age.

The included studies identified a wide range of risk factors associated with child mortality, grouped into three domains: Socioeconomic factors, maternal and pregnancy-related factors, and child-related factors. These were analyzed based on statistical significance and the age group studied. Table 5 lists the child mortality investigated in the included studies in Iran.

Table 2. Risk factors of socioeconomic areas in the included articles

Subcategory	Risk Factors	Infant		1-59 Months		Under 5		% Significant Out of All Investigations*
		Sig.	Not Sig.	Sig.	Not Sig.	Sig.	Not Sig.	
Maternal education	Years of education	↓						50% (3 out of 6)
	Illiterate/primary		××			↑		
	Primary		×		×			
	Secondary education		××		×			
	High school	↑	×					
	University	↓						
Paternal education	Years of education		×					0% (0 out of 4)
	Illiterate/ primary						×	
	Primary				×			
	Secondary education				×			
Socioeconomic status	Low socioeconomic status	↑↑				↑		100% (3 out of 3)
Parental substance use	Mother's smoking		×				×	50% (1 out of 2)
	Addiction of the mother						×	
	Addiction of the father					↑		
	Father's smoking						×	
Parental employment	Employed mother		××		×			0% (0 out of 4)
	Clerical job of the mother		×					
	Labor job of the mother		×					
	Paternal unemployment				×			
	Administrative job of the father				×			
Place of residence and birth	Home delivery	↑			×			33% (2 out of 6)
	Out-of-hospital delivery				×			
	Residence at rural		××			↑		
Family size	Smaller family size					↑		66% (2 out of 3)
	Two or more children				×			
	Family size <5					↑		
Consanguineous marriage	Consanguinity of parent	↑↑						100% (3 out of 3)
	First-cousin					↑		
	Second-degree or distant						×	

Subcategory	Risk Factors	Infant		1-59 Months		Under 5		% Significant Out of All Investigations*
		Sig.	Not Sig.	Sig.	Not Sig.	Sig.	Not Sig.	
Psychological stress during pregnancy	Domestic violence					↑		100% (2 out of 2)
	Loss of a family member during pregnancy	↑						
	Psychological symptoms during pregnancy		×					

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*Percentage of statistically significant results among the total number of investigations in the studies. Since some studies referred to 1 category as 2 or 3 separate risk factors, each was assigned a separate number, but they were counted as a single study in the overall tally. For example, maternal education was divided into several groups (e.g. primary, secondary) in one paper, and ORs were reported separately, but it was still counted as 1 study; ↑: Increased risk of child mortality, ↓: Decreased risk of child mortality; Each symbol (↑, ↓, ×) represents one study.

Socioeconomic risk factors

This category comprised 9 specific risk factors, with a total frequency of 33 instances across studies, of which 16(48%) were statistically significant.

Among socioeconomic variables, maternal education was one of the most frequently reported and influential factors. In 6 studies, higher maternal education was significantly associated with lower child mortality. Higher years of maternal education were significantly associated with reduced mortality among children under 1 year (OR=0.92) [16]. For instance, university-level and high school education reduced infant mortality by 60% and 55%, respectively [14]. Additionally, mothers with no formal education or only primary education had more than double the odds of under-five child mortality (OR=2.20) [12]. However, in four studies, primary and middle school education levels did not show significant associations with mortality [14, 17-19].

In contrast, paternal education was not significantly associated with child mortality in any of the four studies that evaluated this factor [12, 16, 18, 19].

Low socioeconomic status consistently emerged as a strong risk factor. All three studies examining this variable reported significant associations, with increased odds of child mortality [16, 20], particularly in children under 5 (OR=7.80) [12].

Smoking and substance abuse by parents were evaluated in two studies. While maternal smoking did not show a significant association [14], paternal addiction increased the risk of under-5 mortality by 2.6 times [12].

Parental employment status, including maternal employment and occupation type (e.g. laborer or civil servant), was examined in four studies. None of them reported significant associations with mortality [14, 16, 17, 19].

The place of residence and the delivery location were investigated in 6 studies. Home delivery was significantly associated with increased infant mortality by 5.8 times in Zahedan City, Iran [21], but not in other cities [18], while living in rural areas was a risk factor for under-5 mortality (OR=1.79) [22], but not in all studies investigated [14, 16]. Out-of-hospital delivery was examined in one study, which found no significant effect [19].

Family size showed mixed results. One study found that smaller families (less than 5 members) had higher under-5 mortality rates (OR=2.60) [12], whereas others found no significant associations [19, 22].

Consanguineous marriage was identified as a risk factor in three studies. First-cousin marriage significantly increased mortality risk with OR of 1.44 [14], 2.37 [16], and 3.92 [22], while marriages among more distant relatives did not show significant effects [22].

Psychological stress during pregnancy, specifically domestic violence, tripled the risk of under-five mortality [22], and loss of a family member during pregnancy increased infant mortality by 1.6 times [14]. However, general psychological symptoms during pregnancy did not show significant associations [14].

Child-related risk factors

This domain included 7 subcategories, totaling 25 instances, of which 17(68%) were statistically significant.

Gestational age at birth was assessed in 4 studies. Preterm birth, especially before 34 weeks, significantly

Table 3. Risk factors of child-related risk factors in the included articles

Subcategory	Risk Factors	Infant		1-59 Months		Under 5		% Significant Out of all Investigations*
		Sig.	Not Sig.	Sig.	Not Sig.	Sig.	Not Sig.	
Gestational age	Under 37 weeks	↑	×					75% (3 out of 4)
	Preterm under 34 weeks			↑				
	Gestational age					↓		
Birth weight	<2500 g	↑↑↑↑		↑↑				100% (7 out of 7)
	Birth weight					↓		
	>4000 g		×					
Feeding practices	Months of breastfeeding			↓				100% (4 out of 4)
	Not exclusive breastfeeding	↑↑		↑				
Child's sex	Boy		××		×			0% (0 out of 4)
	Girl		×					
Health cares	Child's care				×			50% (1 out of 2)
	Incomplete vaccination	↑						
Physical health issues	Abnormal growth curves			↑	×			66% (2 out of 3)
	Congenital anomalies	↑						
Multiple birth	Twin or more		×					0% (0 out of 1)

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*Percentage of statistically significant results among the total number of investigations in the studies. Since some studies referred to 1 category as 2 or 3 separate risk factors, each was assigned a separate number, but they were counted as a single study in the overall tally. For example, maternal education was divided into several groups (e.g. primary, secondary) in one paper, and ORs were reported separately, but it was still counted as 1 study;↑: Increased risk of child mortality; ↓: Decreased risk of child mortality; Each symbol (↑, ↓, ×) represents one study.

increased the risk of mortality among children aged 1 to 59 months by 5 times [19]. Each additional week of gestation was associated with a 15% reduction in under-five mortality [22]. However, not all studies found statistically significant results for infants born at less than 37 weeks [21], but one did, showing a significant association with increased infant mortality (OR=3.50) [17].

Low birth weight (LBW) (<2500 g) was the most consistent and significant risk factor, with all seven studies reporting strong associations with increased mortality. [14, 16-19, 21, 22]. Each additional kilogram of birth weight was associated with an approximate 64% reduction in under-5 mortality [22]. LBW significantly increased child mortality with OR ranging from 2.83 [16] to 42.10 [21]. In contrast, high birth weight (>4000 g) did not show significant effects [14].

Feeding practices were evaluated in four studies. Exclusive breastfeeding reduced mortality among children aged 1 to 59 months [18], while the use of formula or other substitutes increased the risk by more than two [16] and four times in infant mortality [21].

The sex of the child did not show any significant association with mortality in any of the 4 studies that examined this variable [14, 16, 19, 21].

Healthcare access was evaluated in two studies. Incomplete vaccination was associated with a 14.9-fold increase in infant mortality in one study [21], while general child care access did not show consistent effects [19].

Abnormal physical growth and congenital anomalies were examined in three studies. One study found that abnormal growth was significantly associated with high-

Table 4. Risk factors of maternal and pregnancy-related risk factors from the included articles

Subcategory	Risk Factors	Infant		1-59 Months		Under 5		% Significant Out of all Investigations*
		Sig.	Not Sig.	Sig.	Not Sig.	Sig.	Not Sig.	
Interpregnancy intervals	Pregnancy interval		×				×	20% (1 out of 5)
	First pregnancy	↑						
	Under 1 year	↑						
	Under 2 years		×					
	1-3 years	↑						
	Under 3 years				×			
Maternal age (y)	Maternal age		×					25% (1 out of 4)
	<18 years		×					
	<20 years		×					
	>25 years				×			
	18<age <30	↓						
	30< age <35	↓						
	>35 years		×					
History of abortion	One					↑		100% (2 out of 2)
	At least one	↑						
	Two and more						×	
Number of pregnancies/ deliveries	First delivery		×					50% (2 out of 4)
	Second delivery				×			
	Second pregnancy		×					
	Third pregnancies	↑						
	Third or more deliveries		×		×			
	Fourth or more pregnancies	↑						
	Number of pregnancies		×					
Methods of delivery	Cesarian section		××		×			0% (0 out of 3)
High risk pregnancy	No		×					0% (0 out of 3)
	Yes		×		×			

Subcategory	Risk Factors	Infant		1-59 Months		Under 5		% Significant Out of all Investigations*
		Sig.	Not Sig.	Sig.	Not Sig.	Sig.	Not Sig.	
Physical conditions during pregnancy	Anemia		×					50% (3 out of 6)
	Dental issues	↑						
	Gestational diabetes		××					
	Maternal care during pregnancy	↑	×	↓	×		×	
	Gestational weight						×	
	Hypertension	↑						

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*Percentage of statistically significant results among the total number of investigations in the studies. Since some studies referred to 1 category as 2 or 3 separate risk factors, each was assigned a separate number, but they were counted as a single study in the overall tally. For example, maternal education was divided into several groups (e.g. primary, secondary) in one paper, and ORs were reported separately, but it was still counted as one study; ↑: Increased risk of child mortality ↓: Decreased risk of child mortality; Each symbol (↑, ↓, ×) represents one study.

er mortality among children aged 1-59 months (OR=7) [19], whereas another did not [18]. Congenital anomalies increased the risk of mortality among children under one year by 11.80 times [20].

Multiple births (e.g. twins) were not significantly associated with increased mortality [14].

Maternal and pregnancy-related risk factors

This group included 7 specific factors, with 30 mentions across studies, of which 11(36%) were statistically significant.

Short interpregnancy intervals were evaluated in 5 studies [14, 16, 17, 19, 22]. An interval of less than 1 year (OR=2.70) and 1 to 3 years (OR=1.40) was associated with increased infant mortality [14]. However, in another study, intervals of less than three years were not consistently statistically significant among children aged 1-59 months [19].

Maternal age was examined in 4 studies. Only one significant finding was reported: Mothers aged 18–35 had lower infant mortality than those younger than 18 or older than 35 [14]. Other studies did not find significant associations [16, 17, 19].

A history of abortion was evaluated in two studies, both of which found significant associations with increased mortality. A history of at least one abortion was associated with a 3-fold increase in infant mortality [21]. One abortion was associated with an increase in under-five mortality (OR=2.20), while multiple abortions did not show additional risk in the same study [22].

The number of pregnancies/deliveries was assessed in 5 studies. First parity (OR=1.53) [14] and higher parity, especially third (OR=11.25) and fourth pregnancies

Table 5. Summary list of risk factors of child mortality investigated in included studies

Domain	Socioeconomic Risk Factors	Child-related Risk Factors	Maternal and Pregnancy-related Risk Factors
Risk factors	Maternal education Paternal education Socioeconomic status Substance use by parents Parental employment Place of residence Family size Consanguineous marriage Psychological stress during pregnancy	Gestational age at birth Low birth weight Feeding practices Sex of the child Healthcare access Abnormal physical growth and congenital anomalies Multiple births	Interpregnancy intervals Maternal age History of abortion Number of pregnancies/ deliveries Route of delivery High-risk pregnancies Maternal physical health during pregnancy

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(OR=25), were associated with significantly increased infant mortality in some studies [20], though not all findings were statistically significant [16, 17, 19, 20].

Method of delivery (e.g. cesarean section) was not associated with mortality in any of the 3 studies that evaluated this factor [16, 19, 21].

High-risk pregnancies did not show significant associations with child mortality across the three studies that assessed them [16-18].

Maternal physical health during pregnancy was evaluated in 6 studies. Conditions such as dental issues (OR=2.49) and hypertension (OR=1.62) were significantly associated with increased infant mortality [14]. However, other conditions, including anemia [14], gestational weight gain [22], and gestational diabetes [14, 21], were not consistently significant. Antenatal care was also a critical factor; fewer than four visits during pregnancy increased mortality by over 15 times in one study [21], whereas more frequent care was associated with reduced child mortality (1-59 months) by 15% [18], though not all findings were statistically significant [16, 19].

Discussion

This systematic review aimed to identify and synthesize the risk factors associated with mortality among children aged 1 to 59 months in Iran, and identified a wide range of modifiable risk factors. Key findings highlighted the significant roles of LBW (<2500 g), low maternal education, lack of breastfeeding, and higher parity in increasing child mortality. The risk factors clustered into three domains: Socioeconomic, child-related, and maternal/pregnancy-related. Each domain contributes uniquely to child mortality, underscoring the multifactorial nature of under-five deaths. Among the three domains of risk factors, child-related factors emerged as the most influential. The findings are discussed below in the same framework used for the results.

Socioeconomic risk factors

Among the socioeconomic determinants, maternal education emerged as a consistently protective factor, consistent with the global literature linking higher maternal education to better health-seeking behavior, improved child care practices, and greater autonomy in accessing health services [3, 23, 24]. Its importance likely stems from the role of maternal knowledge in improving child care and hygiene practices, nutrition, immunization, and access to health services [14, 25]. Each additional year of maternal education reduced under-5 mortality by 3% [23]. UNICEF has identified low maternal education as a global determinant of under-5 mortality [3]. In Iran, although the female literacy rate (ages 15-24] exceeded 98.93% in 2022, regional disparities persist (42-98.93%), especially in rural and underserved provinces [26]. Provinces such as Sistan and Baluchestan report young female literacy rates as low as 69%, compared to nearly 100% in Semnan province [27]. Therefore, enhancing access to education for adolescent girls and mothers through targeted interventions could contribute meaningfully to reducing child mortality.

Although 4 studies included in this review found no significant association between paternal education and under-5 child mortality, this finding should be interpreted with caution. One possible explanation is the study design of the included studies, which were not cohort studies, making it difficult to establish a strong causal relationship. Future research should further investigate these mediating factors to clarify the role of paternal education in child survival in Iran. However, in another study, children whose fathers had completed 12 years of schooling experienced 17% lower under-5 mortality compared to those with illiterate fathers [23]. The influence of paternal education may also be reflected in income, as demonstrated in another study that found fathers' education and family income were important indicators of the resources available to ensure their children's health and safety [1]. Therefore, expanding access to secondary and tertiary education for girls, especially in rural and low-income communities, can yield long-term health dividends [28, 29].

Low socioeconomic status was another robust predictor of child mortality, with all studies reporting significant associations. This finding aligns with the literature, which shows that poverty limits access to nutrition, clean water, and healthcare, thereby increasing vulnerability to preventable diseases [3, 24]. Generally, children born in high-income countries face considerably lower mortality risks [3]. In Iran, although significant strides have been made in expanding health coverage, income inequality remains a major barrier to equity in child health outcomes [30-32]. Policymakers should expand poverty alleviation programs, such as conditional cash transfers, nutritional assistance, and reductions in out-of-pocket health expenditures through free child health services, in lower-income communities to mitigate structural disadvantage [33, 34].

As another socioeconomic risk factor, paternal substance abuse increased the risk of child mortality by more than two-fold, possibly due to reduced household income and caregiving capacity [35]. However, maternal smoking did not show a consistent or significant effect, aligning with some previous studies but contrasting with others that have found significant associations in different contexts [24, 36-38]. Integrated addiction prevention and treatment services and family support programs should be scaled up, particularly in provinces with high substance use prevalence [39, 40].

Meanwhile, first-cousin marriages significantly increased child mortality, likely due to genetic disorders and congenital anomalies [41]. Iran has one of the highest rates of consanguinity globally, estimated at 30% in some regions [42]. Premarital genetic counseling and community-based education programs could help mitigate this risk while respecting cultural norms [16].

Interestingly, parental employment and occupation were not significantly associated with child mortality. This result might be due to regional homogeneity. Most studies were conducted in rural settings where occupational variation is minimal. However, one study found that maternal employment reduced under-5 mortality, possibly because it was associated with higher levels of education and awareness among employed mothers [14]. A study in Ethiopia revealed that unemployed parents had a 40% higher likelihood of under-5 child mortality compared to those who were employed [43]. Parental employment also had a positive impact on skilled delivery and the number of antenatal care visits [43].

Place of residence showed mixed results. Only 2 of the 6 studies examining the place of birth and residence reported significant associations. Home delivery and rural residence were associated with increased mortality in some cases but were not universally significant across studies, likely reflecting regional differences in healthcare access and delivery systems [24]. Limited geographic variability in the study samples might explain this result. Moreover, home delivery was reported in studies conducted in Sistan and Baluchestan Province [21]. So, these findings cannot be generalized to the entire country. Promoting childbirth in health facilities can help lower under-5 mortality rates [25]. In line with this, a study in India found that home deliveries were more common among illiterate mothers, and neonatal and infant mortality rates were also higher in this group [44]. Nonetheless, UNICEF has reported that rural residence increases the risk of under-5 mortality by 1.5 times [3], and a study in China found substantial provincial disparities ranging from 4 to 34 deaths per 1000 live births [45]. To address health disparities across geographic regions and urban and rural areas, access to primary healthcare services must be equitable and fair [24, 25, 46].

Findings of this review showed that a family size of fewer than 5 members increased under-5 child mortality by 2.5 times, while studies in other countries have reported the opposite. A study in Ethiopia showed that families with 3 to 6 children had higher under-5 mortality compared to those with only 1 or 2 children [47]. This discrepancy may be related to contextual factors such as parental education level, economic status, or the distribution of caregiving resources within the household [48]. In addition, smaller families might have limited caregiving experience or lower social support.

Psychological stress during pregnancy, including exposure to domestic violence and loss of close family members, was also significantly associated with increased child mortality. These findings underscore the broader maternal psychosocial context of child health [24]. Mental health screening during antenatal care (ANC) and referral pathways for psychosocial support are embedded within maternal health services in Iran [49]. Other studies also reported the impact of violence on pregnant women on child mortality [50-52].

Child-related risk factors

LBW was the most consistent and significant child-related risk factor across all studies. Children weighing less than 2500 g at birth had substantially elevated risks of mortality, with OR reaching 42 in some studies. Similarly, preterm birth, particularly before 34 weeks of gestation, was associated with substantially increased mortality risk [1]. These findings are consistent with global evidence that prematurity and LBW are leading causes of neonatal and post-neonatal mortality due to increased susceptibility to infections, hypothermia, and poor growth, as well as impaired neurodevelopment and non-communicable diseases [1, 16, 53, 54]. In Iran, the prevalence of prematurity is around 10%, but rates reach nearly 20% in some provinces [55]. In response, targeted prenatal nutrition programs, better management of maternal infections and pregnancy complications, and improved monitoring of fetal growth are essential to reducing the burden of prematurity and LBW and associated mortality [56].

Feeding practices also showed a strong association with survival. Exclusive breastfeeding significantly reduced the risk of death, while formula feeding or early

introduction of other foods increased it. This finding aligns with World Health Organization (WHO) recommendations that exclusive breastfeeding for the first six months can prevent 13% of under-five deaths globally [57]. In Iran, exclusive breastfeeding rates have declined in recent years, mainly due to urbanization and marketing of formula milk [58]. Policy interventions may include promoting breastfeeding through baby-friendly hospital initiatives, maternity leave policies, and breastfeeding-friendly policies in workplaces and public spaces, especially targeting first-time and working mothers [48, 59].

No significant association was found between child sex and mortality in this study, which may reflect increasing gender equity in child care practices. With growing public awareness and maternal education, cultural preferences for one gender over the other are diminishing [19]. However, global data show that male children generally have higher under-5 mortality [60, 61], although the observed differences may be marginal in some regions [12].

While multiple births did not show significant associations with mortality in this review, incomplete vaccination did. Notably, infants with incomplete immunization had a 14-fold higher risk of death. Given Iran's historically strong immunization coverage [62], this condition may reflect emerging gaps in access or awareness in marginalized populations [63]. Ensuring universal immunization through outreach in nomadic, rural, and informal urban settlements is vital, as is combating misinformation about vaccines.

Maternal and pregnancy-related risk factors

Among maternal factors, short interpregnancy intervals (especially <12 months) significantly elevated the risk of child mortality. This result may reflect maternal nutrient depletion [25] and inadequate recovery time between pregnancies [48], both of which compromise fetal development and caregiving capacity [64, 65]. So, a birth spacing of at least 2 years is recommended [24]. Health workers should counsel couples on optimal birth spacing and ensure access to family planning resources in both urban and rural areas [66, 67].

Maternal age and number of pregnancies had mixed associations; first-time pregnancies and advanced parity (third or higher) were linked with increased mortality in some studies. The increased risk in primigravida women may be related to inexperience and lower confidence in infant care, while high parity could signal cumulative maternal health burdens [24]. Earlier studies have indicated that maternal age below 18 is associated with increased risk of preterm birth and LBW [14]. Another study showed that children of older mothers may have better nutrition and education [68]. Thus, antenatal education programs should be tailored for both first-time mothers and those with high parity to address specific knowledge and health gaps.

Notably, high-risk pregnancy and cesarean delivery were not significantly associated with child mortality, suggesting that their effects may be mediated through other conditions, such as prematurity or birth complications, rather than acting as independent predictors.

However, poor maternal physical health, especially dental problems and hypertension during pregnancy, was significantly associated with increased mortality risk. Routine screening and management of maternal conditions, including non-obstetric issues like oral health, should be incorporated into prenatal protocols. Similarly, antenatal care (ANC) was a critical protective factor. Inadequate ANC (fewer than four visits) was associated with more than a 15-fold increase in child mortality, echoing WHO guidelines that emphasize early and frequent antenatal visits [69]. This finding emphasizes the life-saving role of comprehensive pregnancy monitoring [24]. Although Iran's health system provides free ANC through its primary care network, service utilization varies. To improve the situation, universal, high-quality antenatal care coverage—especially for high-risk pregnancies—should be ensured through community health outreach and mobile clinics in underserved areas [69].

A history of abortion was another significant predictor of infant and under-five mortality in Iran. While this may reflect underlying maternal health risks or reproductive complications, it also underscores the need for post-abortion care and monitoring in subsequent pregnancies. The impact of abortion history on LBW and infection is reported in the literature, which contributes to child mortality [70]. Implications of this finding may be enhanced monitoring of women with previous abortions during prenatal care, and prioritizing them for early interventions can improve outcomes.

Conclusion

This systematic review identified a wide range of risk factors influencing child mortality in Iran, particularly among children aged 1 to 59 months. The most consistently significant determinants were modifiable and

included maternal education, socioeconomic status, birth outcomes (such as LBW and prematurity), and healthcare-related factors, such as breastfeeding and antenatal care. The challenges identified in this review, including high consanguinity rates and significant urban-rural disparities in health outcomes, reflect conditions in many low- and middle-income countries. Therefore, the findings have broader relevance and can inform child survival strategies in similar contexts. Moreover, addressing the modifiable risk factors outlined here contributes directly to achieving sustainable development goal 3.2, which aims to reduce under-5 mortality to at least 25 deaths per 1000 live births by 2030.

Strengths and limitations

This review is the first to systematically synthesize evidence on mortality risk factors among children aged 1 to 59 months in Iran, addressing a critical gap in national child health research. It followed preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines, applied rigorous quality assessment using the Newcastle-Ottawa scale, and included both Persian and English sources for broad coverage. Organizing findings into socioeconomic, maternal, and child-related domains enhanced clarity for policy use.

However, the study has limitations. The number of eligible studies for each particular risk factor was small, and heterogeneity in designs and variable definitions limited comparability and precluded meta-analysis. All included studies were observational, restricting causal inference. Additionally, potential publication bias and the exclusion of gray literature may have led to the omission of relevant data. Most studies were conducted in only a few regions, particularly Shahroud, which may limit generalizability. More regionally diverse, methodologically rigorous studies are needed to clarify causal pathways further and inform targeted interventions.

Policy implications

Based on these findings, we recommend integrating maternal literacy programs into Iran's primary healthcare system, prioritizing provinces with low female literacy rates. Enhancing baby-friendly hospital initiatives and promoting breastfeeding-friendly workplace policies can help increase exclusive breastfeeding rates. Expanding poverty alleviation efforts, such as conditional cash transfers and nutritional support targeted at low-income families, is essential. Effective implementation of these multifaceted strategies requires coordination among the Ministry of Health, the Ministry of Education, and Social Welfare organizations. Health policymakers should consider regional disparities when designing interventions and prioritize high-risk populations identified in this review.

Future research should aim to increase geographic and methodological diversity by including more provinces and employing longitudinal cohort studies. Investigating the impacts of emerging factors such as climate change, conflict, and migration on child mortality is essential. Furthermore, studies focused on the implementation, uptake, and scalability of interventions targeting maternal education, breastfeeding promotion, and poverty reduction will be critical for informing effective health policies.

This systematic review identified several modifiable risk factors associated with child mortality in Iran, many of which align with global findings. To advance child survival efforts, future studies should employ longitudinal designs and incorporate underexplored determinants. Additionally, implementation research evaluating the effectiveness of targeted interventions in diverse Iranian settings is needed to guide policy.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Research Ethics Committee of Iran University of Medical Sciences, Tehran, Iran (Code: IR.IUMS.REC.1400.137).

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Authors contributions

Conceptualisation and study design: Soudabeh Vatankhah and Leila Abdollahi Abed; Supervision: Soudabeh Vatankhah; Data collection and process: Azam Choopani, Leila Abdollahi Abed; Data analysis and interpretation: Azam Choopani and Leila Abdollahi Abed; Investigation and writing the original draft: Leila Abdollahi Abed; Review and editing: Soudabeh Vatankhah and Azam Choopani; Final approval: All authors.

Conflicts of interest

The authors declared no conflict of interest.

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