Determinants of Under-Five Child Mortality in Iran: A Systematic Review

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Abstract

Background: The under-five child mortality is considered as one of the indicators of development and health of a population. The death of many children during this period is preventable. This study reviewed the determinants of child death in Iran.

Methods: A systematic search in seven electronic databases and two search engines of all the studies that identified determinants of child mortality in any part of Iran or in the whole country were included, without any restriction of time or language of studies. To identify the studies, a combination of hand searching, gray literatures and bibliographies was also conducted. These sources and citations yielded a total of 512 articles; nevertheless, finally 32 articles fulfilled the inclusion criteria, then were reviewed and analyzed.

Results: Amongst the 32 studies published between 2000 and 2019 in Iran, 22 studies were cross-sectional and 14 published in Farsi language. The associations between several factors (n=57) and the child mortality were examined. Factors such as 'birth weight', 'mother's literacy', 'socioeconomic status', 'delivery type', 'gestational age', 'pregnancy interval', 'place of residence', 'Immaturity', 'type of nutrition', 'father's literacy' and 'child gender' were the most important determinants of child mortality.

Conclusions: Effective efforts with emphasis on identifying and managing the determinants of child mortality are essential to improve their health indicators.

Background

Health indicators represent the level of population health and child mortality as one of the most important indicators in health assessment shows not only the number of deaths, but also the quality of life, well-being and overall development in countries (1, 2). This index has also been widely regarded as a main part of the Millennium Development Goals (MDGs), to reduce child mortality by two-thirds between 1990 and 2015-will only be achieved by a limited number of countries (3, 4). So, increasing child survival has been set again as a critical aim in the Sustainable Development Goals (SDGs) by 2030 (5).

More than 15,000 children die every day worldwide (6) and there is a significant inequality in child mortality between high and low income countries (7). In 2017, the under-five mortality rate (U5MR) in Middle East and North Africa countries was 23 per 1,000 live births-more than 6 times the average rate in Western Europe countries. However, Sub-Saharan Africa with 76 deaths per 1,000 live births still has the highest child mortality rate in the world (8).

Interventions in child survival and socioeconomic development have led to a drop in child mortality (9). The world has demonstrated tremendous progress in declining child mortality, with the global U5MR dropping from 93 per 1000 live births in 1990 to 39 per 1000 live births in 2017 (8). Also, in Iran, due to the expansion of health networks and increasing access to primary health care, U5MR have fallen from

56 deaths per 1,000 live births in 1990 to 16 deaths in 2015 (8, 10). Despite the dramatic decline in child mortality, more than half of these deaths seem to be preventable (11, 12).

Several studies have shown that child survival is influenced by various risk factors. Demographic and socio-economic factors including maternal education, rates of polygamous, birth spacing, early marriage, utilization of modern healthcare facilities, residency, gender-based disparities, Unhygienic and unsafe environments, unsafe water, health-seeking behaviors, sanitation,, socio-economic inequalities public sector health workforce and government health financing are the most important factors (13–24).

Therefore, understanding and assessing the factors affecting the child mortality could be the first step in planning to reduce the mortality and promoting the society health and life expectancy. In addition, with identifying these determinants, health policy makers can take more effective program and policies to reduce child mortality in each country or regions. Therefore, the goal of this study is to provide insights into some of determinants affecting mortality in Iran. The results of this study may provide additional information regarding modifiable factors that may be useful in planning of intervention to promote child survival in country.

Methods

Criteria for considering studies for this review

We conducted a systematic literature review to identify all studies that assessed under-five mortality determinants in Iran. Based on WHO definition, data are presented in 3-year age groups: 0-28 days (neonatal mortality rate), younger than 1 year (infant mortality rate) and <5 years (Under-five mortality rate) (25).

Since the determinants of mortality may be different in the under-five age groups, and some existing studies have examined the determinants of mortality in the one to five year age groups, researchers added another group (1-5 years as pre-school) to this classification (25).

Search strategy

Based on the inclusion criteria, we searched electronic databases: “PubMed”, “Scopus”, “Cochrane library databases”, “Web of Science” “Google” and “Google scholar” on July 19, 2019. In the PubMed and Cochrane library databases, we initially searched by Meshing terms as: (“Child Mortality”[Mesh]) OR (“Infant Mortality”[Mesh]) OR (“Neonatal Mortality”[Mesh]) OR (“Post neonatal Mortality”[Mesh]) AND determinant [Title/Abstract] AND Iran [Title/Abstract]. In other databases, all the synonyms of “under-five child mortality” were searched and afterward “Iran” was added to the search terms. This method was the most appropriate search in the present review, because of the well-known and comprehensive nature of the child mortality term.

To ensure that all the relevant studies including those published in Farsi (formal language of Iran) was identified; an electronic search in Farsi was conducted in Google and “Google scholar” as well as in the

main national databases including “SID”, “Magiran”, using the translation of “under-five mortality” and its various synonyms in Farsi and “Iran” as keywords. Additional searches for the bibliographies of the included studies were made. Reference lists of selected articles were also screened for additional publications and identification of the main experienced authors in the field of study and connection with them to find the most relevant surveys.

In a similar way, hand searching was conducted among highly relevant journals, grey literature, informal reports and documentation by the government or other agencies, thesis, research project, etc. All studies from different sources imported into EndNote x9.

Study selection

The Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) Flow diagram shows the process of identifying, reviewing, and selecting articles (Fig. 1). Studies that only examined the determinants of child mortality on a smaller place than a city, or only reported descriptive statistics on child mortality were excluded from the study.

At first, 512 surveys were obtained through electronic and hand searching. All duplicate records (n=82) were deleted before the title and abstract screening process and 430 Records remained for further review. We reviewed the titles and abstracts of remaining papers and unrelated articles. Finally, 80 were obtained for the full text review to assess for eligibility. 28 studies that only reported a frequency for child mortality, examined the child mortality on a smaller scale than city, dissertations of published papers, articles without using the national databases, meeting abstract and editorial letter were excluded. Finally, 52 studies met the inclusion criteria for this review study, hence were utilized.

Quality assessment

Articles selected for analysis were assessed by two independent reviewers. For methodological validity, STROBE checklist were used. The checklist used in this study includes 22 items (score range: 0–22) which assess lucidity of the objectives and research questions of cohort, case-control, and cross-sectional (combined) studies. Any disagreements that arose between reviewers were resolved through discussion. We exclude papers that scored lower than 16 in quality assessment. Since the number of articles in this field was high, it seems possible to achieve high quality articles by selecting this cut point. Meeting abstracts and editorial letters were excluded, too.

Data extraction and analysis strategy

Data extraction included specific details about the study design, the sample size, analysis, findings including factors associated with child mortality such as demographic, socioeconomic and health related factors and quality scores were extracted from the articles using a purposefully designed data extraction form (table 1). The studies included were developed for a diversity of objectives, used a variety of measures and methods and included study participants with different characteristics. This diversity made formal meta-analysis impossible. Therefore, the results of similar dimensions or aspects of social

support were identified and grouped together and then the findings were reported, compared and examined descriptively.

Results

Description of the included studies

As shown in Table 2, of the 32 included studies, 22 studies (68.7%) were cross-sectional while 7 studies (22%) were case control design. In addition, two studies were performed as a time series (6.2%) and one ecological study (3.1%). Similarly, 14 out of the 32 papers (43.7%) were written in Farsi and the others in English. As figure2 shows the publication date of the included studies ranged from 2001 to 2019. Most studies conducted by data from years 2009-2014.

Moreover, out of the 32 studies, 8 studies were conducted at the country level and 24 studies at the provincial level. Most studies have examined determinants in age groups less than one year. The following figure 3 shows the number of studies by different age groups.

Determinant Of Child Deaths In Iran

The associations between several factors (n=57) and the child mortality were examined in reviewed studies. A summary of the results and their references are shown in Table 1. The association of 'birth weight' with mortality was examined in 14 studies, of which 1 studies did not find a significant effect. In contrast, 'mother's literacy', which was examined in 15 studies, was discovered to be a significant factor associated with mortality in 10 studies. The 'socioeconomic status', was another factor which was examined frequently in the Iranian studies (n = 8 studies) and in 3 studies did not find a significant relationship. Delivery type, which also was examined frequently (n = 13 studies), so as in 7 studies associations were significant but in 6 studies were not significant. The association between 'gestational ages' of the mothers with child mortality was also examined in 9 studies; in 2 studies didn't find association with mortality. About 'pregnancy interval' in 50% of studies association were significant. Contrarily, 'mother's age' was not associated with child mortality in more than 45.5% of the studies.

In addition, 'place of residence' in 6 studies were significant and in 5 studies didn't find association. 'Immaturity' has been studied in only 6 studies, all of which have a significant relationship with child mortality. Also in all studies in which the relationship between the type of nutrition and child death has been reviewed, no significant relationship has been found between them. The association of 'father's literacy' in 6 studies were significant but in 4 studies weren't significant. 'Stillbirth' in 4 studies were examined and in all of them weren't significant. Thirteen studies have examined the relationship between 'child gender' and mortality; in 10 studies, this relationship has been significant. The relationship between 'abortion' (in 4 studies in total), 'birth rank' (in 7 studies in total) and 'multiple pregnancies' (in 3 studies in total) with child death in 3 studies of reviewed studies for each factor were significant. However, the relationship between birth rank and child mortality was not significant in 4 studies.

It is noteworthy that the relationship between some factors such as: father's smoking, mother's addiction, child age, father's age, mother's job, father's job, maternal care, total delivery beds, mother's BMI, housing ownership, health index settlement, high risk pregnancy, immaturity and child mortality has not been significant in all studies that have examined them.

Other factors discovered to be associated or not associated with child mortality in this review study, but studied less frequently in Iran were as follows were summarized in Table 2.

Table 1

Frequency (%) results of analyses on factors associated or not associated with child death in Iran

Determinants	Findings			
	Studies found associations		Studies found NO association	
	N (%)	Ref.	N (%)	Ref.
Birth weight	13(92.9)	(26-38)	1(7.1)	(39)
Mother's literacy	10(66.6)	(26, 27, 29, 33, 37, 38, 40-43)	5(33.4)	(32, 36, 44-46)
Socioeconomic status	8(72.7)	(29, 33, 40, 42, 43, 47-49)	3(27.3)	(26, 44, 46)
Delivery type	7(53.8)	(26, 27, 29, 31, 34, 36, 44)	6(46.2)	(28, 30, 32, 33, 35, 38)
Gestational age	7(77.8)	(30, 31, 34, 35, 37, 50, 51)	2(22.2)	(39, 52)
Pregnancy interval	6(50)	(26, 27, 34, 36, 43, 44)	6(50)	(32, 33, 38, 39, 45, 52)
Mother's age	6(54.5)	(27, 35, 43, 44, 46, 51)	10(45.5)	(28, 32-34, 36-39, 45, 52)
Place of residence	6(54.6)	(27, 41-43, 48, 51)	5(45.4)	(28, 33, 35, 44, 53)
Immaturity	6(100)	(28, 32, 34-36, 38)		
Type of nutrition	5(100)	(26, 27, 32, 33, 38)		
Father's literacy	4(40)	(26, 29, 36, 41)	6(60)	(27, 32, 33, 40, 44, 46)
Stillbirths	4(100)	(27, 36, 43, 46)		
Child gender	3(23)	(28, 36, 43)	10(77)	(26, 32-35, 38, 45, 51, 53, 54)
Abortion	3(75)	(27, 43, 46)	1(25)	(44)
Birth rank	3(42.8)	(27, 29, 34)	4(57.2)	(32, 36, 38, 45)
Multiple pregnancies	3(100)	(27, 36, 51)		
Human development index (HDI)	2(100)	(55, 56)		

Determinants	Findings			
	Studies found associations		Studies found NO association	
	N (%)	Ref.	N (%)	Ref.
GDP per capita	2(100)	(41, 48)		
History of child mortality	2(100)	(27, 42)		
Gravid number	2(33.3)	(39, 52)	4(66.7)	(28, 33, 37, 38)
Consanguinity of parents	2(100)	(33, 45)		
Father's addiction	1(100)	(40)		
Mother's smoking	1(20)	(27)	4(80)	(26, 37, 40, 45)
Family size	1(50)	(40)	1(50)	(45)
Maternal mortality rate (MMR)	1(100)	(55)		
Type of birth	1(3.1)	(26)		
Previous maternal disease	1(100)	(51)	1(100)	(26)
Marriage duration	1(25)	(44)	3(75)	(45, 46, 52)
Spouse age gap	1(50)	(44)	1(50)	(52)
Ethnicity	1(100)	(44)		
Child care	1(50)	(38)	1(50)	(32)
Mother's field activity	1(100)	(44)		
Number of nursing and midwifery personnel in delivery wards	1(50)	(57)	1(50)	(57)
Total number of Ob/Gyn specialists	1(50)	(57)	1(50)	(57)
Implementing the rural family physician program	1(50)	(49)	1(50)	(49)
Placental abruption	1(100)	(27)		
Birth place	1(33.3)	(36)	2(66.7)	(28, 32)
History of hospitalization	1(100)	(27)		
Domestic violence to the mother during pregnancy	1(100)	(45)		
Total Fertility Rate (TFR)	1(100)	(41)		

Determinants	Findings			
	Studies found associations		Studies found NO association	
	N (%)	Ref.	N (%)	Ref.
Female labor force participation rate	1(100)	(41)		
Number of physician per 1000 populations	1(100)	(41)		
Number of children	1(50)	(46)	1(50)	(32)
Adverse growth	1(100)	(32)		
Pregnancy weight gain	1(100)	(51)		
Father's smoking			2(100)	(26, 40)
Mother's addiction			1(100)	(40)
Child age			1(100)	(31)
Father's age			2(100)	(33, 52)
Mother's job			4(100)	(27, 28, 32, 33)
Father's job			3(100)	(27, 32, 44)
Maternal care			4(100)	(32, 33, 38, 44)
Total delivery beds			1(100)	(57)
Mother's BMI			1(100)	(28)
Housing ownership			1(100)	(29)
Health index settlement			1(100)	(46)
High risk pregnancy			1(100)	(33)

Table 2
Number and details of funded studies

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Nakhzari- Moghaddam, et al (40). 2019 English	N=2001 children Dead children included 351 boys and 316 girls Zabol, Sistan & Baluchistan 2011 – 2016 Descriptive cross sectional Chi-squared, t test, logistic regression	Under 5	Father's addiction (P=0.01, OR=2.6) Mother's literacy (P< 0.001, OR=2.2) Socioeconomic status (P< 0.001, OR=7.8) Family size (P< 0.001, OR=2.6)	Mother's addiction (P= 0.09, OR=2.9) Father's smoking (P= 0.1, OR=1.8) Mother's smoking (P= 0.9, OR=1.0) Father's literacy (P= 0.2, OR=1.2)	18
Alimohamadi, et al (55). 2019 English	N= None declared (data extracted from the gap minder site) Certain West Asian Countries 1980 – 2010 Ecological study Spearman correlation	Under 5	Human development index (HDI) (P= 0.001, r=-0.97) Maternal mortality rate (MMR) (P< 0.001, r=0.97)		18

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Dadipoor, et al (26). 2018 English	N= 342 children Dead children included 190 boys and 152 girls Bandar Abbas 2015, 2016 Retrospective and cross sectional descriptive-analytic Chi-squared	<1 year	Birth weight (P< 0.001) Delivery type (P= 0.04) Type of nutrition (P< 0.001) Type of birth (P= 0.002) Pregnancy interval (P< 0.05) Parents' literacy (P< 0.05)	Child gender (P> 0.05) Socioeconomic status (P> 0.05) Previous maternal disease (P> 0.05) Father's smoking (P> 0.05) Mother's smoking (P> 0.05)	16
Anafcheh, et al (44). 2018 English	N=320 families with at least one under-five mortality, (1973 children) Dead children included boys and girls Khuzestan 2011–2015 Cross-sectional Chi-squared, ANOVA, logistic regression	Under 5	Mother's age (P< 0.05, OR=3.5) Marriage duration (P< 0.05, OR=1.8) Spouse age gap (P< 0.05, OR=2.3) Pregnancy interval (P< 0.05, OR=2.8) Delivery type (P< 0.05, OR=3.8) Ethnicity (P< 0.05, OR=2.6) Mother's field activity (P< 0.05, OR=3.9)	Father's literacy (P= 0.6, OR=1.1) Mother's literacy (P= 0.5, OR=1.2) Father's job (P= 0.3, OR=1.5) Socioeconomic status (P=0.1, OR=1.6) Maternal care (P= 0.3, OR=1.6) Abortion (P= 0.5, OR=1.2) Place of residence (P= 0.9, OR=1.0)	18

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Tourani, et al (57). 2017 English	N= 159387 delivery (357 infant mortality/ 750 under one mortality/ 4526 under 5 mortality)	<28 days	Number of nursing and midwifery personnel in delivery wards (P= 0.023)	Total delivery beds (P= 0.331)	17
	Dead children included boys and girls		Total number of Ob/Gyn specialists (P=0.007)		
	30 provinces of Iran	<1 year		Number of nursing and midwifery personnel in delivery wards (P= 0.402)	
	2014, 2015			Total number of Ob/Gyn specialists(P=0.692)	
	Descriptive- analytical study Linear regression test			Total delivery beds (P= 0.653)	
		Under 5		Number of nursing and midwifery personnel in delivery wards (P= 0.380)	
				Total number of Ob/Gyn specialists(P=0.750)	
				Total delivery beds (P= 0.601)	

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Amini Rarani, et al (47). 2018 English	N= 113957 households in 2000 and 30870 households in 2010 (to measure inequality, 45646 live births from DHS 2000 and 10604 live births from MIDHS 2010 were analyzed) 28 provinces of Iran 2000, 2010 Secondary study Normalized concentration index Oaxaca-type decomposition technique	Under 5	Socioeconomic status ($P < 0.05$)		16
Panahi, et al (48). 2015 Farsi	N= None declared (data extracted from Central Bank of the Islamic Republic of Iran) Iran 1969-2010 Analytical descriptive study Johansen-Juselius method	<1 year	Socioeconomic status ($P < 0.05$) Place of residence ($P < 0.05$) GDP per capita ($P < 0.05$)		16

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Naderimagham, et al (49). 2017 English	N= None declared 25 provinces of Iran 1995-2011 time-series analysis regression models	<28 days	Implementing the rural family physician program ($\beta = -0.341$. p - value = 0.003)		19
			Socioeconomic status ($\beta = -0.889$. p - value = 0.001)		
		<1 year	Implementing the rural family physician program ($\beta = -0.016$. p - value = 0.009)		
			Socioeconomic status ($\beta = -0.052$. p - value < 0.001)		
		Under 5	Socioeconomic status ($\beta = -0.055$. p - value < 0.001)	Implementing the rural family physician ($\beta = -0.003$. p -value = 0.542).	
Ghotbi, et al (27). 2017 English	N= 198 neonates died (181 cases were case and 17 neonates were excluded and the control group had twice the size of the case group) Kurdistan province 2013 population-based case-control study Chi-square, Fisher exact test, and logistic regression	<28 days	Place of residence ($P = 0.027$)	Mother's job ($P = 0.7$)	18
			Mother's literacy ($P = 0.04$)	Father's literacy ($P = 0.1$)	
			Mother's smoking ($P = 0.002$, OR = 2.1)	Father's job ($P = 0.7$)	
			Pregnancy interval ($P = 0.004$, OR = 2.5)		
			Birth weight ($P = 0.004$, OR = 1.709)		

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
			Placental abruption (P <0.001, OR = 13.9) Mother's age (P = 0.04, OR = 1.79) Birth rank (P=0.005, OR = 4.6) Multiple pregnancies (P=0.000, OR = 8.1) History of child mortality (P= 0.005, OR = 3.4) Stillbirths (P =0.002, OR = 5.8) Abortion (P =0.05, OR = 1.6) History of hospitalization (P =0.02, OR = 1.7) Delivery type (P = 0.004, OR = 1.709) Type of nutrition (breast or formula milk) (P < 0.001, OR = 7.9)		
Behnampoor, et al (54). 2017 English	N= 1252 dead children (683 boys and 571 girls) Zahedan villages 2012-2015	<28 days		Child gender (P>0.005)	20

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
	cross-sectional study Chi-square Test	Under 5		Child gender (P>0.005)	
Izadi, et al (53). 2016 Farsi	N= 435 Kermanshah province 2011-2014 cross-sectional study descriptive statistics and chi- square test	Under 5		Child gender (P>0.05) Place of residence (P>0.05)	18
Ghorat, et al (50). 2016 English	N= 282 Sabzevar 2011-2012 descriptive, cross- sectional study independent sample t-test, and Chi T square/Fisher's exact test	<28 days	Gestational age (P<0.001)		17

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Kose Gharavi, et al (58). 2016 Farsi	N=52 neonates (death or live in 28th day after birth) as case group and 201 neonates as control group Maraveh Tapeh County in Golestan 2011-2013 case-control study chi square and logistic regression	<28 days	Birth weight (P< 0.05) Child gender (P< 0.05) Immaturity (P< 0.05)	Birth place (P = 0.965) Delivery type (P=0.118) Mother's age (P=0.567) Mother's job (P=0.13) Place of residence (P=0.820) Gravid number (P=0.629) Mother's BMI (P=0.23)	16
Evazpoor, et al (45). 2016 English	N=186 2011,2012 Kohgiluyeh and Boyerahmad Province descriptive- analytical and cross sectional study Student's t and chi- squared tests, respectively. Multivariate logistic	Under 5	Consanguinity of parents (P < 0.001, OR =3.92) Domestic violence to the mother during pregnancy (P < 0.01, OR = 3.13)	Child gender (P= 1.00) Birth rank (P=0.09) Pregnancy interval (P=0.18) Family size (P=52) Mother's age (P=0.12) Marriage duration (years) (P= 0.24) Mother's literacy (P=0.22) Mother's smoking (P= 1.00)	18

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Ghasemi, et al (39). 2015 Farsi	N= 390 2012 Yazd province descriptive cross sectional study Regression	<28 days	Gravid number (P=0.00)	Birth weight (P=0.95) Gestational age (P=0.93) Pregnancy interval (P=0.39) Mother's Age (P=0.06)	16
Seperdoust, et al (56). 2015 Farsi	N= None declared Iran 1981-2011 Descriptive analytical study chi square and logistic regression	Under 5	Human development index (HDI)		16
Rezaei, et al (41). 2015 English	N= None declared Iran 1967 - 2012 Time series study Econometrics model	<1 year	Total Fertility Rate (TFR) (P<0.05) Gross Domestic Product (GDP) per capita (P<0.05) Number of physician per 1000 populations (P<0.05) Female labor force participation rate (P< 0.05) Place of residence (P<0.05) Parents literacy (P< 0.05)		17

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Naghibi, et al (29). 2015 Farsi	N= 184 Mazandaran province 2011 cross-sectional study Chi-square test	Under 5	Birth weight (p<0.001) Birth rank (p<0.001) Delivery type (p<0.001) Parents literacy (p<0.001) Socioeconomic status (p<0.001)	Housing ownership (P> 0.05)	17
Deihim, et al (30). 2015 Farsi	N=297 Dezful in Khuzestan province 2009-2014 Descriptive cross- sectional study Fisher & Chi-square test	<1 year	Birth weight (P=0.001) Gestational age (P=0.001)	Delivery type (P= 0.07)	17
Boskabadi, et al (31). 2015 Farsi	N=162 Mashhad 2009-2014 Descriptive analytical study Chi-square test	<28 days	Delivery type (P=0.001) Gestational age (P=0.001) Birth weight (P=0.001)	Child age (P= 0.673)	16

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Nodoushan, et al (52). 2015 English	N=116 Yazd province 2011 - 2013 Descriptive-analytical Study Statistical tests	<1 year	Gravid number (P=0.017)	Father's age (P=0.448) Mother's age (P=881) Gestational age (P=0.589) Marriage duration (P=0.746) Spouse age gap (P=0.381) Pregnancy interval (P=0.946)	17
Ahmadi, et al (46). 2015 Farsi	N= None declared Fars province 2001-2011 Secondary quantitative study Logistic regression	<1 year	Mother's age (p<0.001) Stillbirth (p<0.001) Abortion (p<0.001) Number of children (p<0.001)	Parents literacy (P>0.05) Marriage duration (P>0.05) Health index settlement (P>0.05) Socioeconomic status (P>0.05)	17

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Safari, et al (32). 2014 Farsi	N= 65 cases (included 35 dead girls and 30 dead boys) and 130 control (included 60 girls and 70 boys) Semnan villages 2002-2012 A nested case- control study odds ratio, conditional logistic regression	28 day-5 year	Type of nutrition ($P<0.001$, OR=4.14) Birth weight ($P=0.02$, OR=2.83) Adverse growth ($P<0.001$, OR=7.04) Immaturity ($P=0.02$, OR=5.08)	Child gender ($P=0.3$) Delivery type ($P=0.09$) Birth place ($P=0.4$) Pregnancy interval ($P=0.7$) Birth rank ($P=0.2$) Number of children ($P=0.1$) Father's literacy ($P=0.4$) Mother's literacy ($P=0.2$) Mother's age ($P=0.06$) Father's job ($P=0.9$) Mother's job ($P=0.4$) Maternal care ($P=0.4$) Child care($P=0.4$)	16

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Damghanian, et al (33). 2014 English	N= 3297 (72 dead Childs included 26 girls and 46 boys and 3225 alive included 1565 girls and 1660 boys) Shahrud in Semnan province 2010-2011 cross-sectional study Blinder- Oaxaca decomposition method	<1 year	Birth weight (P< 0.001, OR=21.6) Type of nutrition (P< 0.03, OR=2.27) Mother's literacy (P= 0.04, OR=0.92) Consanguinity of parents (P <0.002, OR=2.37) Socioeconomic status (P= 0.02), OR=1.91)	Child gender (P= 0.2, OR=1.33) Mother's age (P= 0.82, OR=0.99) Father's age (P= 0.1, OR=0.96) Father's literacy (P= 0.11, OR=0.95) Mother's job (P= 0.27) Place of residence (P= 0.6, OR=1.12) Pregnancy interval (P= 0.87, OR=1.00) Gravid number (P= 0.82, OR=1.01) Maternal care (P= 0.74, OR=0.91) High risk pregnancy (P= 0.16, OR=1.48) Delivery type (P= 0.85, OR=0.95)	16

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Chaman, et al (34). 2014 English	N= 97 cases (included 43girls and 54boys) and 97 controls included 52girls and 45boys) rural areas of Kohgiluyeh and Boyerahmad province nested case- control study and the study cohort univariate and multivariate conditional logistic regression	<28 days	Immaturity (P<0.05, OR= 5.57) Birth weight (P=0.01, OR= 7.68) Gestational age (P=0.03, OR=5.57) Delivery type (P=0.03, OR= 7.27) birth rank (P=0.003, OR= 6.95) Pregnancy interval (P=0.002, OR= 4.65)	Child's gender (P= 0.21, OR=1.43) Mother's age (P= 0.37, OR=1.5)	19
Motlagh, et al (42). 2013 English	N=5712 dead Childs (included 2734 girls and 2978 boys) 40 medical universities (in 30 provinces) Iranian. National survey 2008-2010 Chi-square test Analysis of variance (ANOVA) Student t-tests	28 day-5 year	Socioeconomic status (p<0.001) Place of residence (p<0.001) Mother's literacy (p<0.001) History of child mortality (p<0.001)		18

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Hadavi, et al (51). 2011 English	N=321cases (included 181 boys and 140 girls) and 321 control Rafsanjan, Kerman. Case control prospective study 2006-2007 χ^2 test and independent sample t test	<28 days	Multiple pregnancies (P= 0.001) Mother's age (P= 0.04) Previous maternal disease (P= 0.003) Pregnancy weight gain (P< 0.001) Place of residence (P< 0.001) Gestational age (P< 0.001)	Child gender (P= 0.13)	18

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Hosseinpour, et al (43). 2006 English	N= 108875 (live births) (3908 infant death) Iranian Demographic and Health Survey (DHS) conducted in 2000. National survey 1990-1999 principal component analysis, concentration index	<1 year	Child gender (P< 0.001, OR=1.16) Mother's age (P< 0.001) Stillbirth (P< 0.001, OR=1.75) Abortion (P= 0.02, OR=1.14) Pregnancy interval (P< 0.001, OR=2.22) Socioeconomic status (Quintile 3,4,5) P< 0.05) Mother's literacy (P< 0.001) Place of residence (P< 0.005, OR=1.17)	Socioeconomic status (Quintile 2) (P= 0.51, OR=1.05)	17
Oshvandi, et al (35). 2014 Farsi	N=333) included 150 girls and 183 boys) Hamedan province Analytical-descriptive study 2011 χ^2 and Fisher test	<28 days	Gestational age (P< 0.001) Mother's age (P< 0.001) Birth weight (P< 0.002) Immaturity (P< 0.001)	Child's gender (P= 0.06) Place of residence (P= 0.44) Maternal care (P= 0.06) Delivery type (P= 0.32)	17

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Namakin, et al (36). 2012 Farsi	N= 118 case (include 50 boys and 68 girls) and 236 control (include 130 boys and 106 girls) Birjand city Prospective case control study 2005 Logistic regression analysis	<1 year	Child gender (P=0.02, OR=1.67) Father's literacy (P=0.002, OR=0.25) Pregnancy interval (under 18 months) (P< 0.001, OR=28.8) Stillbirth (P= 0.03, OR=2.1) Birth place (house) (P< 0.001, OR=0.51) Delivery type (P< 0.001, OR=2.86) Immaturity (P= 0.002, OR=2.03) Birth weight (P< 0.001, OR=29.9) Multiple pregnancy (P= 0.007, OR=3.5)	Mother's literacy (P> 0.05) Birth rank (P> 0.05) Mother's age (P> 0.05)	16
Bahman Bijari, et al (37). 2011 Farsi	N=535 (included 228 girls and 307 boys) Kerman province Cross sectional study 2008	<28 days	Gestational age (P< 0.05) Birth weight (P< 0.05) Father's literacy (P< 0.05) Mother's literacy (P< 0.05)	Mother's age (P= 0.7) Gravid number (P= 0.42) Mother's smoking (P= 0.36)	17

Ref. Langu	Sample, setting, time, design, analysis	Age group	Findings		Quality Score (0–22)
			Significant relationship	No significant relationship	
Navidian, et al (38). 2001 Farsi	N= 100 case (included 59 boys and 41 girls) and 100 control (included 45boys and 55girls) Zabol Case control study 1998,1999 T test and chi square	<1 year	Birth weight (P= 0.002) Immaturity (P= 0.005) Type of Nutrition (P= 0.000) Child care (P= 0.001) Mother's literacy (P= 0.02)	Child gender (P= 0.07) Birth rank (P= 0.34) Mother's age (P= 0.1) Gravid number (P= 0.9) Prenatal care (P= 0.8) Delivery type (P= 0.43) Pregnancy interval (P= 0.41)	16

Discussion

The aim of this study was to investigate the determinants of under-5 mortalities in Iran. Overall, 43 original studies examined the determinants of under-5 children death in different age groups. Understanding these determinants is of particular importance for implementing specific interventions for each age group in order to effectively reduce the burden of mortalities in the country.

We found that birth weight exhibited more associations with child mortality. One of the indicators of a community's health status is the birth weight of newborns. This indicator is not only related to the quality of nutrition, health, care during pregnancy and the mother's social environment, but also to the process of normal growth of the child (59). Birth weight, as well as the gestational age, has a significant relationship with infant mortality and its components including malnutrition in the first year of life, susceptibility to infections, respiratory distress and traumas during childbirth, and development of chronic non-communicable diseases (NCDs). The lower the birth weight and the gestational age, the greater the chance of child death (60, 61). Numerous factors lead to low birth weight, including poor socioeconomic status, poor nutrition, anemia, various diseases, medications, obstetric complications, miscarriage and intermittent pregnancy (62, 63). The results of a study showed that some of the biological and psychological characteristics of mothers include maternal height, bleeding and poisoning during pregnancy, lack of maternal awareness of prenatal care, marital dissatisfaction, abnormal blood pressure, employment and weight gain less than 5 kg during pregnancy and pregnancy under the age of 20, lack of proper rest and mobility of the mother during pregnancy have a significant effect on low birth weight and need to be given more attention in birth control programs for low birth weight infants (64).

Mother's literacy, was discovered to be a significant factor associated with mortality in 67% of studies. Findings from Terra and Choe studies have shown an inverse relationship between maternal education and infant mortality (65, 66). A study in India showed that women's education through the variables of health awareness and determinants of reproductive behavior, such as the use of preventive health services, child nutrition, and child care, which are directly related to child death (67). Mothers with higher educational experience and better economic autonomy are likely to enjoy the resources required to maintain a healthy lifestyle and have better access to health services. Since promoting the level of education increases the level of employment, this increases the social status and increases the income and welfare of the family, and promotes family health. Therefore, it is suggested that special attention be paid to the education of young people, especially girls, as a primary solution to children's health in the form of long-term programs. The constructive role of women in raising and ensuring the health of children should always be considered. In addition, in order to encourage parents to study science, education planners should take appropriate measures.

We also found that socio-economic status and mother's literacy presented more associations with child mortality. Good socio-economic status reduces mortality by increasing access to available resources. In particular, parental education and family income are important indicators of the quality and quantity of resources that families can use to maintain their children's safety and health. Previous studies have shown that the appropriate socio-economic status and its elements increase the health and well-being of the child (68, 69). Many studies have also shown that poor socioeconomic status will increase child mortality (70–72). In a study on the determinants of infant mortality, the relationship between per capita incomes, per capita health expenditure, the rate of pediatric diarrhea treatment, maternal literacy rate and inequality based on the Gini coefficient showed an inverse relationship with infant mortality. According to this study, economic growth is the most important determining factor in child mortality and then the provision of health services is the second most important factor (73).

Iran's economy has entered its third consecutive year of recession due to a shock caused by three factors: sanctions, the oil market crisis and Covid-19. Iran's GDP in the end of 2019 has decreased due to the removal of US sanctions exemptions on the country's oil exports. High inflation due to the sharp devaluation of the national currency has put double economic pressure on low-income households. Many years of recession and high inflation have hampered household livelihoods. In 2018, the poverty rate in the country, according to the global poverty line, which is equivalent to purchasing power parity with the US \$ 5.5, was 12.3 percent, which was 1.5 percent higher than the previous year. Inequality (in terms of Gini coefficient) was equal to 35.6 and its value has always been increasing after 2016. Socio-economic inequality also seems to be one of the most prominent factors influencing the increase in child mortality in Iran. Extensive population-based policies (focusing on education, social welfare, the labor market, and tax policies) are needed to reduce inequalities, and in particular to improve the health of mothers and children (74).

Delivery type, which also was examined frequently, so as in 54% of studies associations were significant but in others were not. Cesarean delivery leads to potential injuries to the child and mother during surgery.

Doubling maternal mortality, the possibility of uterine rupture, increased postpartum hemorrhage and infection, prolonging the postpartum recovery period, and readmission are complications of this surgery for the mother. As well, repeated cesarean section are accompanied with complications such as adhesions abnormal placenta, Placenta Previa, hysterectomy, need to get more than 4 units of blood and mother's hospitalization in intensive care units (75, 76). In addition, neonates born by cesarean section are more likely to be in the neonatal intensive care unit due to drastic complications. Their problems may even spread to childhood and they are more likely to develop diabetes, asthma, sepsis, thromboembolism, amniotic fluid embolism autism and overweight (77, 78). The rate of cesarean delivery in Iran increased from 35% in 2000 to 56.1% in 2013. This year, more than eight hundred thousand cesarean sections were performed in the country. At the same time, the Health Transformation Plan with the aim of increasing justice and access to health services, reducing out-of-pocket payments and improving the quality of health services was on the agenda of the Ministry of Health and Medical Education. Considering the importance of maternal and neonatal health, the program of promoting natural childbirth was considered as one of the programs of this project. The overall goal of this program was to promote the health of mothers and infants and its specific goals include reducing cesarean section by 10% in 2014. In this program, free vaginal delivery in public hospitals, training courses for delivery of pregnant mothers in public hospitals, enabling service providers, increasing the vaginal delivery tariffs, culture making, the use of private midwifery services in public centers and continuous monitoring to reduce cesarean were on the agenda (79). The cesarean index in Iran decreased by 6% immediately after the implementation of the "Promotion of Normal Delivery Program" in "Health Transformation Plan" and then remained at the same level. This program has been effective in reducing cesarean section of educational hospitals (9.5%), non-educational (11.7%), private hospitals (18.1%), charity hospitals (27.1%) and Islamic Azad University (31%), but there was an increase in cesarean in social security hospitals (7%). If the program was not implemented, the country's cesarean section would reach 58.5% in 2016 (80).

The result of this study showed that birth interval had a negative association with under-five mortality in half of the studies. A similar study based on DHS data from Bolivia, Guatemala, and Peru suggested that under five mortalities in children born after birth intervals of 24–29 months was higher by 70–90% than in children born after intervals of 36–41 months. This may be due to the fact that shorter birth intervals are associated with maternal nutritional depletion, particularly folate deficiency (81). Birth spacing is an important indicator for promoting maternal and child health. Short birth spacing has an important effect on general health, and in contrast, proper birth spacing can be considered as an alternative strategy for controlling childbearing and women's fertility preferences (82, 83). Overall, studies in this area have shown that an inappropriate interval between births can have consequences such as bleeding, underweight and malnutrition in mothers, and stillbirth, low weight, and reduced physical growth and intelligence for infants (84, 85). Birth spacing among women is affected by various demographic and economic factors. The effect of age, employment, level of education and location on the appropriate interval between births has been shown in various studies (86–88). It is necessary to have the right tools to maintain the right interval between births in the future, which is the continuation of family planning

programs and free and public access to contraceptives so that women can give birth to the number of children of their choice at appropriate intervals.

Mother's age was associated with child mortality in approximately 50% of the studies. According to Patel et al., The median age of marriage for mothers was 18, and more than half of mothers were married before reaching legal age. The high risk of neonatal death among young pregnant mothers is due to biological and psychosocial immaturity, as well as the chances of low birth weight babies being born (89). The results of another study showed that child mortality in mothers who married under the age of 15 was more than twice as high as that of married mothers between the ages of 20 and 24 (90).

All of reviewed studies revealed a significant relationship between immaturity and child mortality. A study conducted at the Department of Obstetrics and Gynecology at the University of London named premature birth as one of the leading causes of death and disease in developing countries (91). Today, despite the advances in medical science, the birth of premature infants is still considered as one of the major problems in our society. The birth of a premature baby, in addition to creating economic and psychological problems in the family, causes the loss of financial and human resources and the death of children (92).

Also in all studies in which the relationships between the type of nutrition and stillbirth with child death have been reviewed, no significant relationships have been found between them. Despite the lack of correlation between these variables, it should be said that breastfeeding is the best choice for neonates. Milk contains substances that are absorbable in terms of quality and quantity for the infants, provide energy and growth of the baby, breastfeeding reduces the incidence of hospitalization for the treatment of respiratory diseases and protects the infant from diarrhea due to enterococci, middle ear infections, allergies and type 2 diabetes (93, 94). Regarding the factors related to the continuation of breastfeeding, studies showed that there is a relationship between the duration of breastfeeding and immaturity of the child. The breast milk of those mothers whose baby is born before 37 weeks of gestation is specific to the premature baby and has a higher content of protein, minerals such as iron and defense factors than the milk of the newborn and is therefore more suitable for the premature baby (95).

Conclusion

Based on the results of this review, many studies have been conducted in Iran, but no study has systematically reviewed the results of those. The aim of this study was to investigate determinants of death of children under 5 years old in Iran. Based on the 32 final studies reviewed, 57 factors have been identified as influencing the mortality of under five children. Among these factors, factors such as 'birth weight', 'mother's literacy', 'socioeconomic status', 'delivery type', 'gestational age', 'pregnancy interval', 'place of residence', 'immaturity', 'type of nutrition', 'father's literacy' and 'child gender' were the most important determinants of child mortality.

Among these factors, birth weight, delivery type, gestational age, immaturity are among the factors related to prenatal care and through regular visits by doctor or trained and skilled nurse midwife during

pregnancy, this can be controlled the determinants and prevented deaths due to the involvement of these factors.

Parents' education through the variables of health awareness and determinants of reproductive behavior such as the use of preventive health services, child nutrition, child care of the patient that are directly related to child death. Parents' education reduces the risk of infant mortality, both directly and through other factors. Women's education is known to influence child mortality due to health awareness and determinants of reproductive behavior such as the use of preventive health services, child nutrition, and sick childcare.

Boys' deaths are higher than girls in most parts of the world due to gender differences in genetic and biological structure. Boys are biologically weaker than girls and are more prone to disease and premature death. Therefore, special care in boys seems necessary.

Measures to improve the quality of education for young mothers and increase their awareness and quality of care for mothers, especially mothers who have experienced stillbirth or married at a young age, will be fruitful. In addition, with regard to accommodation, it seems that access to health facilities and facilities has increased, especially in recent years in rural areas, and this can be effective as a factor in reducing child mortality. Improvements in economic growth, education, housing, nutrition, health care and health measures also reduce child mortality.

According to the results of the study, it is suggested that measures be taken to improve the quality of education for mothers and young girls, increase their awareness, and improve the quality of maternal care, especially mothers who have experienced stillbirth or married at a young age. Considering the impact of those socio-economic factors that have the potential for change and intervention, such as parents' education, maternal age at marriage, housing hygiene, and maternal age at childbirth can be of great help in further reducing the figure. Planning to improve the quality of maternal and neonatal care, as well as the provision of advanced medical services can be effective in reducing infant mortality.

Limitations

To our knowledge, this is the first systematic review determinants of death among under-5 mortality and covered the whole country. In addition, all studies conducted in the country were reviewed for this survey, but to select the highest quality articles, quality assessment was performed and poor quality articles were excluded. Despite these strengths, issues such as the classification of age groups under 5 years were the most important limitations of this study and to overcome these issues, appropriate measures were taken as mentioned before.

Abbreviations

MDGs: Millennium Development Goals; **SDGs:** Sustainable Development Goals; **NMR:** the neonatal mortality rate; **IMR:** infant mortality rate; **U5MR:** under five mortality rate; **NCDs:** non-communicable

diseases; **XS**: Cross sectional;

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

M.A., B.K. developed the review protocol and designed search criteria and strategy. M.A. and B.K. contributed searching, performing the title/abstract screening of the records, extracting data and to the writing up of the manuscript. M.T. provided general supervision on all the stages and commented on the paper draft.

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Figures

Figure 1
PRISMA flow diagram illustrating article selection and elimination

Figure 2

Distribution of data usage in different years in the reviewed articles

Figure 3

Number of studies by age group