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Review Article

Determinants of Neonatal, Infant and Child Mortalities in Iran: A Systematic Review

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Abstract

Background: Children mortality is considered as one of the main indicators of population development and health, while most of the children's deaths are preventable. This study systematically reviewed the determinants of children mortality in Iran.

Methods: This systematic review was conducted to summarize all the factors associated with children mortality in three age groups; Neonate (0-28 d), Infant (28 d-1 yr old) and children (<5 yr old), based on the PRISMA guideline. Many of the electronic international and national databases, in addition to hand searching of reference of selected articles, grey literature, formal and informal reports and government documents were screened to identify potential records up to Jan 2022. We included all studies that identified determinants of child mortality in any province of Iran or the whole country, without any restriction.

Results: Overall, 32 studies were included, published between 2000 and 2022, of which 23 were cross-sectional and 15 published in Farsi language. The associations between several risk factors (n=69) and the child mortality were examined. Among the identified factors, 'birth weight', 'mother's literacy', 'socioeconomic status', 'delivery type', 'gestational age', 'pregnancy interval', 'immaturity', 'type of nutrition', and 'stillbirth' were the most important mentioned determinants of child mortality in Iran.

Conclusion: Appropriate interventions and policies should be developed and implemented in Iran, addressing the main identified associated factors, resulting from this review study, with the aim of minimizing preventable child deaths, based on their age categories.

Keywords: Child mortality; Infant mortality; Neonatal mortality; Systematic review; Iran

Introduction

More than 15,000 children die every day worldwide (1), while the rate of this mortality and determinants varied by individual, cultural, biographical and socio-economic characteristics in different countries (2-4).Child survival is associated by various risk factors including maternal education, rates of polygamous, birth spacing, early marriage, utilization of modern healthcare facilities, gender-based disparities, environments, water, health-seeking behaviors, sanitation, socioeconomic status, public sector health workforce and health financing (5-15). In 2017, the under-

five mortality rate (U5MR) in Middle East and North Africa (MENA) countries was 23 per 1,000 live births; more than 6 times higher than the average rate in Western Europe countries (16).

Interventions in child survival and socioeconomic development have led to a decline in child mortality rate (17). 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 (16). In Iran, as a result of expansion of health networks and increasing access to primary health care, U5MR have also fallen from 56 deaths per 1,000 live births in 1990 to 16 deaths in 2015 (16, 18). Despite the dramatic decline in child mortality, more than half of these deaths seem to be preventable (19, 20).

Understanding factors associated with the child mortality could be the first step in reduction of child mortality and promoting health and life expectancy. In addition, with identifying the determinants of mortality in each country or region, health policy makers can take effective programs and policies to reduce child mortality in those regions.

We aimed to summarize available evidence on determinants of child mortality in Iran. The results of this systematic review provide valuable information on preventable factors that may be useful in planning of intervention to promote child survival in country.

Methods

This study was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline.

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 the WHO classification of under-five mortality, all deaths in three age groups are considered; 0-28 d (neonatal mortality rate), younger than 1 year (infant mortality rate) and 1-5 yr (child mortality rate) (21). We included all studies that identified determinants of child mortality in any province of Iran or in the whole country, without any restriction in language or date of publication. 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. A few studies have examined the determinants of child mortality in the age group of 28 d to 5 yr, but due to the inclusion of studies in the classification of the WHO, as mentioned above, we had to exclude these articles.

Search strategy

Based on the inclusion criteria, we searched electronic databases including "PubMed", "Scopus", "Cochrane library databases", "Web of Science" "Google" and "Google scholar" up to Jan 2022. This was the most conservative search to avoid missing the relevant articles and information. 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 relevant national databases including "SID" and "Magiran". In a similar way, hand searching was conducted among highly relevant journals and accredited national journals. The website of the Ministry of Health and Medical Education and other relevant organizations in Iran such as electronic libraries of the country's Medical Universities were also searched for any information and reports on national child mortality. Additional searches for the bibliographies of the included studies were also conducted 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. All studies from different sources imported into EndNote ×9.

Selection of studies

Figure 1 is the PRISMA Flow diagram, indicating the process of identifying, reviewing, and selecting articles in this study. At first, 515 surveys were obtained through electronic and hand

searching. All duplicate records (n=83) were deleted before the title and abstract screening process and 456 records remained for further review. We reviewed the titles and abstracts of remaining papers and unrelated articles. Finally, 102 papers were obtained for the full text review to assess for eligibility, of which, 34 studies that only reported a frequency for child mortality, examined the child mortality on a smaller scale than a city, articles without using the national databases, meeting abstract, editorial letter and articles without using the WHO classification were excluded. Overall, 32 studies met the inclusion criteria for this review study.

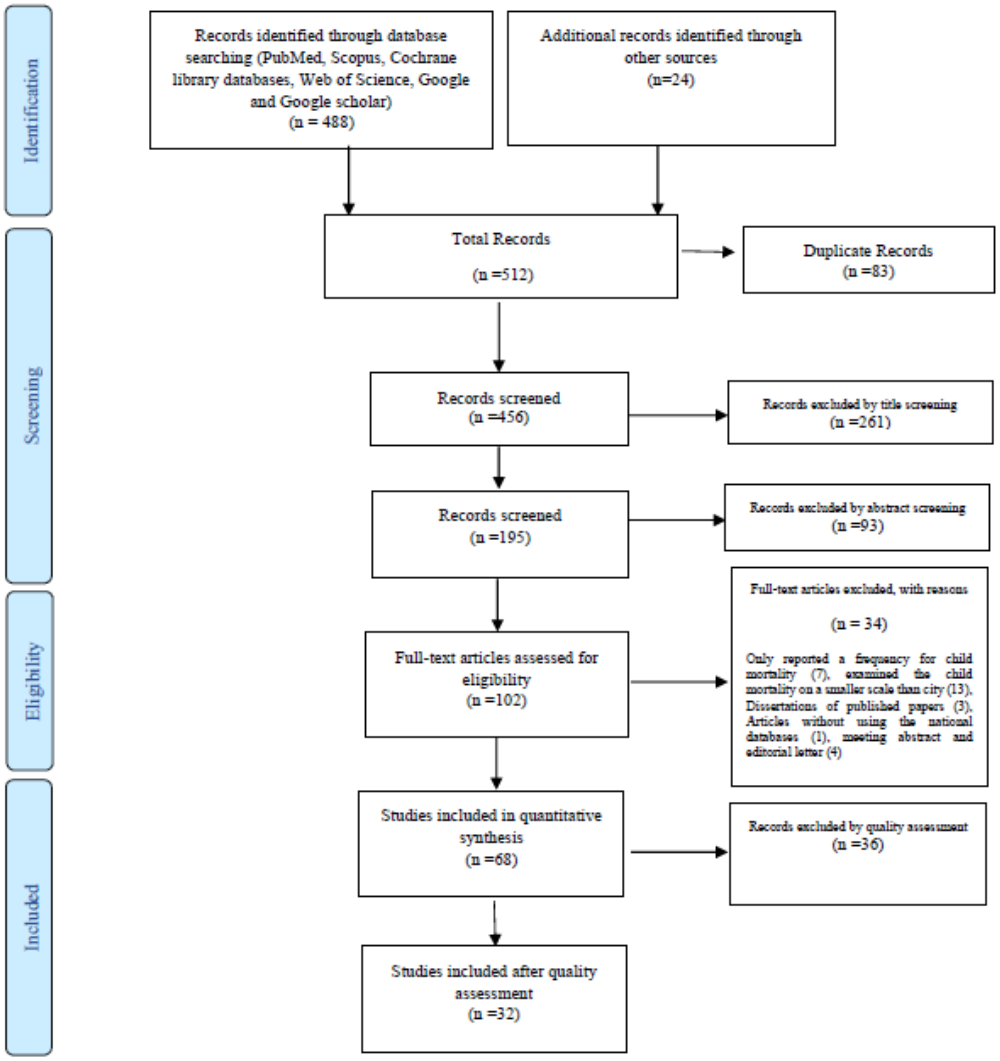

Fig. 1: The PRISMA flow diagram illustrating article selection and elimination

Quality assessment

Articles selected for analysis were assessed by two independent reviewers. For methodological validity, STROBE checklist was 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 excluded papers that scored lower than 16 out of 22 in quality assessment, by agreement. Meeting ab-

stracts and editorial letters were excluded, too. Finally, 32 studies were selected, hence were utilized.

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. The studies included were developed for a diversity of objectives. We 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 were identified and grouped together and then the findings were reported, compared and examined descriptively.

Results

Description of the included studies

Of the 32 included studies, 21 studies (65.7%) were cross-sectional while 8 studies (25.7%) were case-control design. In addition, two studies were performed as a time series (5.7%) and one ecological study (2.9%). Moreover, 15 (42.8%) studies were written in Farsi and the rest in English. As Fig. 2 shows, the publication date of the included studies ranged from 2001 to 2022. Most studies conducted by data from years 2010-2014.

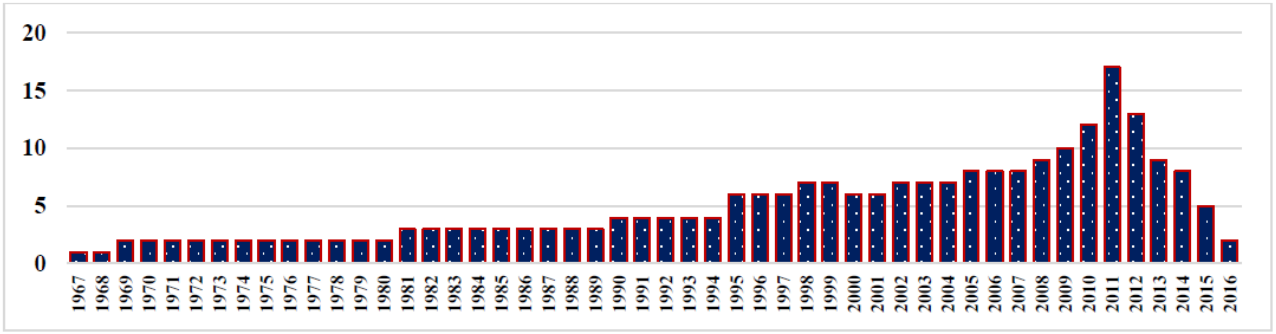

Fig. 2: Distribution of death cases by year of study in the reviewed articles

Moreover, out of the 32 studies, 8 studies were conducted at the country level and 24 studies at the provincial level. Out of all the studies, 9, 10, and 8 studies only reviewed the neonatal, infant and under 5 mortality death, respectively. Additionally, 2 studies, which focused on the determinants of death in 28 d-5 yr old, was added to the group of under-five mortality death. Further, another 2 studies considered all three age groups, and in one study the death of 2 age groups, neonatal and under 5 yr old, have been assessed (Details are provided in Supplementary table).

Determinant of child mortality in Iran

The associations between 69 factors or determinants and the child mortality were examined in the reviewed studies. Among these factors, 33 factors in the neonate age group, 26 factors in the infant age group, and 29 factors in the children age group were investigated at least in one study (Supplementary table). However, the associations of most of the factors have been examined sparsely. Table 1, indicates the list of the factors in three age groups, investigated at least in two studies and whether they have been found to be associated with death or not. Overall, 10 factors in neonate, 13 factors in infant, and 4 factors in children age groups have been identified.

Table 1: Number of death cases and frequency of studies found to be associated/ not associated with neonatal (aged 28-day or younger), infant (under 1 year old), and children (1-5 yr old) mortality from the original studies in Iran**

Factors	*Number of death cases*		*Findings*					
	Associated	**Not associated**	**Factors found to be associated (n)**			**Factors found to be NOT associated (n)**		
			Neonatal	Infant	Children	Neonatal	Infant	Children
Birth weight	1377	-	6	5	3	-	-	-
Mother's literacy	1895	Infant: 118 Children: 506	3	5	4	-	2	2
Socioeconomic status	Infant: 205 Children: 4141	662	-	4	4	-	3	-
Delivery type	457	Neonate: 630 Infant: 3694	3	2	2	2	3	-
Gestational age	1730	-	6	-	-	-	-	-
Pregnancy interval	Neonate: 295 Infant: 218	3513	2	3	-	-	3	-
Mother's age	519	Neonate: 987 Infant: 334 Children: 251	2	-	-	3	3	2
Place of residence	Neonate: 198 Infant: 108875	Neonate: 385 Children: 755	2	3	-	2	-	3
Immaturity	Neonate: 482 Infant: 218	-	3	2	-	-	-	-
Type of nutrition	3739	-	-	3	-	-	-	-
Father's literacy	2461	Infant: 3297 Children: 2321	-	3	-	-	2	2
Stillbirth	108993	-	-	3	-	-	-	-
Child gender	108993	Neonate: 853 Infant: 4072	-	2	-	4	3	-
Abortion	108875	-	-	2	-	-	-	-
Birth rank	295	218	2	-	-	-	2	-
Multiple pregnancies	519	-	2	-	-	-	-	-
GDP per capita	1252	-	-	2	-	-	-	-
Gravid number	-	Neonate: 168 Infant: 3397	-	-	-	2	2	-
Mother's smoking	-	2187	-	-	-	-	-	2
Marriage duration	-	168	-	-	-	-	2	-

** Factors have been examined just once have been removed from this table and table including all factors is available from the corresponding author upon request

Neonatal mortality

According to the results of reviewed studies, association of 'birth weight' with mortality was significant in 6 of studies ($P<0.05$). Mother's literacy', 'immaturity' and 'delivery type' were reviewed in 3 studies, results showed that 'pregnancy interval', 'mother's age', 'place of residence'. 'Birth rank', 'Multiple pregnancies' were significant in 2 studies ($P<0.05$).

Infant mortality

'Birth weight', and 'Mother's literacy' have been studied in 5 studies, and in all of them a significant association with child mortality has been found. Also, in 4 studies 'socioeconomic status' and in 3 studies the relationship between 'pregnancy interval', 'Place of residence', 'type of nutrition', 'father's literacy', 'still birth' and child death has been reviewed, respectively. In all 3 studies, the relationship was significant. In 2 studies, association between 'child gender', 'abortion', and GDP per capita and child death were significant.

Children mortality

In this age group, the association of 'birth weight' with mortality was examined in 3 studies, so that in all 3 studies this relationship was significant. The 'socioeconomic status', and 'mother's literacy' were another factors examined frequently in the Iranian studies (n=4 studies) and in these studies found a significant relationship. 'Delivery type' was discovered to be a significant factor associated with mortality in 2 studies.

Comparison between the determinant of death among the three age groups

As shown in Table 1, while "birth wright" and "gestational age" are the most important determinants for neonatal death, in addition to "birth wright", "mother's literacy" is another important factor for infant death. In children mortality age group "mother's literacy", "socioeconomic status", and "birth wright" have significant role in mortality.

"Mother's literacy", "delivery type", and immaturity are another important determinant in neonatal death. Besides, "socioeconomic status", "pregnancy interval", and "place of residence" are in the next orders of infant death.

Discussion

The aim of this study was to review systematically determinants of under-5 mortalities, in different age categories, in Iran. Overall, 32 original studies met the inclusion criteria. The results of systematic review of Bhusal, et al which examined factors associated with under-five child mortality till 2022 are very similar to results of current review study, indicating that mother's education, size of child at birth, age of mother at childbirth, place of residence, birth interval, sex of child, type of birth (single or multiple), and birth order, along with other socioeconomic, maternal, child, health facility utilization, and community level variables, were important covariates of under-five mortality in Iran (22).

In this study, low birth weight has a strong association with child mortality in all three age categories, compatibly with findings from other study in low- and middle-income countries (23). Gestational age as well as the birth weight, has a significant relationship with infant mortality and its components including malnutrition in the first 28 d of life, susceptibility to infections, respiratory distress and traumas during childbirth, and development of chronic non-communicable diseases (NCDs). Previous studies also showed an association between gestational age and neonatal mortality (24-26). Preterm and low birth weight infants are more susceptible to complications such as hypothermia, infections, and birth asphyxia (resulting in tissue hypoxia and multiorgan failure) (25). In addition, prematurity is associated with difficulty in extra uterine adaptation due to the immaturity of various organ systems (27). Numerous factors lead to low birth weight, including poor socioeconomic status, poor nutrition, anemia, various diseases, medications, obstetric complications, miscarriage and intermittent pregnancy (28, 29).

Mother's literacy, was also one of the important predictors of child mortality in all age groups, in line with other studies (30, 31). In India, 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 childcare, link to the child death (32). Mothers with higher educational level may have better economic autonomy and enjoy more resources required to maintain a healthy lifestyle and have better access to health services for themselves and their children. In various studies, maternal higher education has been especially associated with lower child mortality beyond economic and other determinants (33, 34). In addition, Lohla, et al reported early neonatal mortality for educated mothers compared with less educated mothers in 72 low- and middle-income countries (35).

Socio-economic status was also found in original studies to be significantly associated with child mortality in all the three age categories. High socio-economic status are linked with better health and well-being of children and lower child mortality by increasing access to resources (36, 37). In particular, parental education and family income are important indicators of the quality and quantity of resources that families may access to maintain their children's safety and health. 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 (38).

Socio-economic inequality also seems to be one of the most prominent factors related to 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 (39).

Delivery type, also examined frequently in all of studies performed in the under 5 age group, except under 1 year old age, and in half of the studies in under the age of 28 d, was a significant factor. 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 (40, 41).

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 (41). The rate of cesarean delivery in Iran increased from 35% in 2000 to 56.1% in 2013 (42) and then decreased by 6% reaching to about 50% after the implementation of the "Promotion of Normal Delivery Program" as a part of "Health Transformation Plan" then remained at the same level so far. If the program were not implemented, the country's cesarean section would reach 58.5% in 2016 (43). In Ethiopia, pregnancy induced hypertension; public hospital delivery, prematurity, being referred, and hypothermia were the most common determinants of neonatal mortality (44).

The result of current review study showed that pregnancy interval had an association with less than 28 d of life and under-five mortality in more than half of the studies. A 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 because shorter birth intervals are associated with maternal nutritional depletion, particularly folate deficiency (45). Pregnancy interval 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 (46, 47). Overall, studies in this field 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 (48). Pregnancy interval 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 (49). Therefore, educating mothers before pregnancy in order to respect the pregnancies interval, adapting the conditions and facilities for working pregnant mothers can be effective in reducing the death of children.

All of studies in 28 d and under 1-year age groups revealed a significant relationship between immaturities with child mortality. A study conducted at the Department of Obstetrics and Gynecology at the University of London reported premature birth as one of the leading causes of death and disease in developing countries (50). 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 (51). 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 wk of gestation is specific to the premature baby, 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 (52).

Another factor found to be associated with child mortality is place of residence. Meta-regression results of systematic review study of Forde in 2018 entitle "Association of Place of Residence and Under-Five Mortality in Middle- and Low-Income Countries: A Meta-Analysis" show that there is a positive association between the relative risk and the percentage of the rural population for the various regions/countries (53). Inequalities have been decreased between urban and rural place of residence (54-56). While results of some studies indicated that the rate of U5M decline was faster in urban areas (57, 58), others studies showed that there was less progress in urban areas (59, 60). Only one multi-country study showed that the urban poor had higher U5M than population living in rural region (61).

To our knowledge, this is the first systematic review determinants of death among under-5 mortality and covered the whole country. Similar studies was previously conducted primary (62) and reviewed systematically on maternal mortality in Iran (63), but for determinants of child mortality, this is the first systematic review. 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.

Conclusion

Improving pregnancy care due to the various effects on health status of children can be the most important intervention to reduce children death. In addition, as most of these factors and preventable and avoidable, many programs and strategies could be developed and implemented to reduce child mortality, as much as possible to reaching to the lowest possible rate and should be as a continue action in promoting Iranian children. Understanding these determinants is of particular importance for implementing specific interventions for each age group in order to reduce effectively the burden of mortalities in the country.

Based on the finding of study policymakers can use this information for planning, program intervention to reduce child. For example, efforts to carry out appropriate interventions to improve the nutritional status of mothers, increase health literacy during pregnancy, pay more attention to mothers with low socioeconomic status, promote natural childbirth and improve prenatal care can be useful in controlling child mortality.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that they have no competing interest.

Availability of data and materials

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

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