



## Estimation of economic burden of preterm and premature births in Iran

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### Abstract

**Background:** Tremendous difficulties are imposed on families with preterm and premature babies, both at birth and during their lifetime. The present study aimed at evaluating the potential economic impact of preterm and premature birth in Iran.

**Methods:** In this descriptive cross-sectional study (2014-2015), we studied preterm and premature newborns, who have been subjected to hospitalization in Ali-Asghar hospital. We followed social perspective to estimate the economic consequences of preterm and premature birth in 3 categories of direct medical, direct non-medical, and indirect costs. Required data were collected from documents in the NICU, and studying medical records, and interviewing their parents. Data were analyzed by Microsoft Excel.

**Results:** Direct medical, direct non-medical and indirect affairs were 84%, 6%, and 10% of the total cost, respectively. The estimated social costs were 373, 529, 189; 508, 774, 181; and 529, 481, 996 US dollars (according to their corresponding incidence of 5.8%, 7.9%, and 9.9%). We also found that 75% of the direct medical costs of initial hospitalization were due to intensive care beds.

**Conclusion:** The economic burden of preterm and premature birth in Iran is considerable and to decrease the costs, it is necessary to implement preventive programs for preterm and premature newborns and to provide management care and support for families dealing with this problem.

**Keywords:** Premature and preterm infants, Neonatal Intensive Care Unit (NICU), Economic burden

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### Introduction

Prematurity is characterized by gestational age and is defined as childbirth occurring at less than 37 weeks(1). The rate of preterm births ranges from 12% to 13% in the U.S. and 5% to 9% in other developed countries (2, 3); and in Iran, it ranges from 5.5% in Shiraz to 8.21% in Arak (1). Depending on the condition and age at birth and birth weight, the premature and preterm neonates might suffer from a spectrum of defects. In general, preterm newborns have more medical issues and hospitalization costs than the full term (4, 5). They are also prone to a broad range of adverse consequences including chronic lung disease, severe brain injury, retinopathy of prematurity, and neonatal sepsis(6). Compared to those with normal births, premature

newborns are more likely to suffer from temperature instability, respiratory distress, apnea, hypoglycemia, seizures, jaundice, kernicterus, feeding difficulties, periventricular leukomalacia, and rehospitalizations (7-9).

Although advances in technology and intervention approaches during the past two decades have led to substantial improvements in the antenatal and infant cares and survival of even the most premature newborns (10, 11), there is still a great concern about costs of hospitalization and intensive care for prematurity (11, 12). Health systems not only play a critical and important role in improving health, but also are responsible to protect individuals against the financial costs of illnesses and diseases (13). Regarding the fact that financial management is one of the basic principles in the

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#### ↑What is “already known” in this topic:

Prematurity is a term coined to refer to birth at less than 37 weeks of gestation. Preterm birth may lead to mortality and is the most common reason for neonatal hospitalization.

#### →What this article adds:

Our study estimated the medical and non-medical costs of hospitalization in premature infants. In this study, we found that most of the economic burden of prematurity was due to direct medical costs.

health sector, providing and managing financial resources is critical (14). Studies have shown increases in hospitalization costs during the first year of life for the infants suffering from some early defects such as bronchopulmonary dysplasia and intraventricular hemorrhage (15, 16). In studies on the clinical consequences of children under one-year-old with prematurity (born between 35 and 36 weeks of gestation), some investigators found more clinical problems and costs of hospitalization for the premature newborns than full term babies (10). Premature birth is also a strong predictor of the amount of money spent for hospital services by an individual in the first 5 years of life (17). Thus, beyond its large extent of socioeconomic impact on families, prematurity causes wide economical and humanoid consumption (1). Thus, it is highly important that stakeholders gain knowledge about different categories of domestic and national initial hospitalization costs (ie, age) to be able to match their health care policies.

This study was conducted to assess the costs of initial hospitalization, as the most expensive phase of intensive care (18), of premature and preterm neonates in Iran. This is vitally important as it may help the policy-makers to decide on new policies based on the measured facet of care, and hence, upgrade their strategies in consuming the financial and humanoid resources to provide better services. Also, it might help to gain the stakeholders' attention to the importance of prevention strategies.

## Methods

All the preterm and premature neonates, who have been born and subjected to initial hospitalization in the NICU section of Ali-Asghar hospital in Tehran during a year (referred from the first to the last day of the year 2014-2015;  $n=116$ ), were included in this cross-sectional study. To assess the economic burden of these cases and to extend the results of this study to the Iranian population, a social approach was applied. Direct medical costs, which included the costs of visit and consultation, medicines, diagnostic tests, surgery, medical devices, accommodation, and hospital bed, were collected from the medical records of the neonates with predesigned forms. We used the WHO's guidance (19) to measure the costs of the cases within different age groups. Accordingly, 5.2%, 10.4%, and 83.4% of the cases were, respectively, attributed to age groups of <28, 28 - <32, and >32 weeks of gestation. To obtain an assessment of the average cost per neonate in the private hospitals, the average cost of public hospitals was multiplied to

the tariff difference between public and private hospitals (2.32) (20). Because 15% and 85% of NICU beds are, respectively, ascribed to private and public hospitals (20), distribution of the premature neonates receiving benefits from either hospital was accordingly considered as 15% and 85%.

The direct non-medical costs were measured by conducting telephone interviews with parents. We asked the parents about their expenses on travelling, accommodation of the parent, and their entourage at the time of early hospitalization.

To measure the indirect costs, we applied the human capital approach, taking into account the estimated costs of parents and other family members' (entourage) absence from their works. Notably, informal caretaking costs were not included as part of the indirect costs. For those families/family members, who were not willing to give information about their income and also the housekeeping wives, we considered the lowest wages issued by Department of Labor in the same year (2014-2015) as their income (21).

To estimate the incidence of premature and preterm birth in Iran, we used the factsheet issues by WHO, which estimated that the incidence of premature newborns in Iran was 7.9% (5.8–9.9%; 95% CI) of all births (22). This statistic is consistent with some other reports from Iran (23–26). The total births rate in Iran in the same year was obtained from the website of Department of Statistics of Iran. Therefore, direct medical costs were estimated based on different incidence rates of 5.8%, 7.9%, and 9.9%. The data were analyzed by Microsoft Excel.

## Results

In this study, 116 premature and preterm neonates, who were subjected to initial hospitalization in the NICU section of Ali-Asghar hospital in Tehran, were included. More than half of the cases (54.7%) were female and more than half (61.2%) of the births were from 32 to less than 37 weeks of gestation, and on average they had 22.1 days of hospitalization (Table 1). Only 8.6% of the newborns had normal weight at birth (Table 1).

We found that on average, 75% of the direct medical costs were due to length of stay in special ward, followed by 8% and 6% for medicine and diagnostic tests, respectively. The least costs (with only 1% of the costs) belonged to physician visit, consultation, and surgery (Fig. 1).

Neonates with 28 weeks gestational age had the most and

Table 1. Demographic (Quality) Distribution of the Sample

Variable		Frequency (No.)	Frequency (%)	Mean	Standard Deviation	Least	Most
Gender	Male	53	45.7	*	*	*	*
	Female	63	54.3				
	Normal	10	8.6	1667.3	547.4	680	3030
Birth Weight (gr)	LBW	57	49.1				
	VLBW	38	32.8				
	ELBW	11	9.5				
Gestational Age (Week)	extremely preterm (<28 weeks)	13	11.2	31.87	0.78	26	37
	very preterm (28 to <32 weeks)	32	27.6				
	Moderate to late preterm (32 to <37 weeks).	71	61.2				
Hospitalization (Day)		*	*	22.1	19.16	1	107

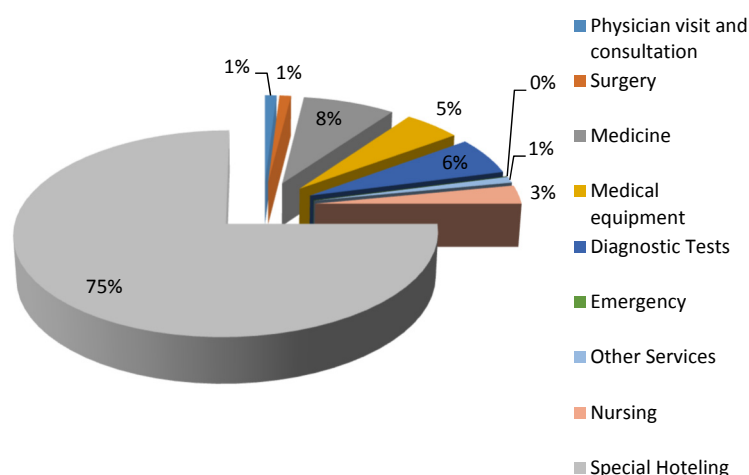


Fig. 1. Proportion of different parts from total direct medical costs for premature or preterm neonates

Table 2. Direct medical costs based on gestational age

Gestational Age (Weeks)	Neonates (No.)	Cost of Hospitalization (Total)	% of Total Cost	Cost of hospitalization (per Day) in dollars	Medical Cost per Neonate in public Hospitals (Mean) in dollars	Medical Cost per Neonate in Private Hospitals (Mean) in dollars
28<	13	82274.55	%44	248.42	8465.52	19640.01
28-32	32	135009.10	%30	166.419	4727.35	10967.45
32<37	71	180252.26	%26	139.40	2379.67	5520.85
Total	116	397535.92	100	554.24	15572.55	36128.32

Table 3. Direct non-medical costs in the studied population

Direct Non-Medical Costs	Total Cost	Cost per Neonate (Mean)	Percent
Cost of item bought by parents	9476.23	43.58	20
Cost of feeding and accommodation of parents during the hospitalization	5055.52	81.69	38
Cost of transportation	10588.16	112.64	42
Total	25119.92	237.91	100

those with 32 to 37 weeks had the least direct medical costs (Table 2). The average direct non-medical costs of each neonate was around \$237.91 (US Dollars), from which almost half was due to traveling of the parents and/or entourage during the hospitalization period (Table 3).

Results revealed that during hospitalization in NICU, parents lost 35 work days on average. The number of working days that mothers lost was almost two times more than that of the fathers. Indirect cost per neonate is presented in (Table 4). Based on the assessments, the average cost due

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Table 4. Different parts of indirect costs in the studied population

	Total Days of Absence	Days of Absence per Neonate (Mean)	Total Cost Due to Absence	Cost Due to Absence (Mean)
Mother	2145	22	18776.68	199.75
Father	1227	13	22291.30	237.14
Total	3372	35	41067.99	436.89

Table 5. Cost of initial hospitalization per neonate in the private vs. public hospital (mean)

Type of Cost	Cost of All the Studied Cases	Cost per Neonate in Public Hospital (Mean)	Cost per Neonate in Private Hospital (Mean)	%
Direct costs				
Direct Medical Costs	397535.92	3515.53	8156.04	86
Direct Non-Medical Costs	25119.92	237.91	551.96	5
Indirect Costs	41067.99	436.89	873.78	9
Total	463723.84	4190.34	9721.59	100

**Table 6.** Direct medical costs of premature and preterm neonates hospitalized in NICU based on different incidences (US Dollars)

Table 3: Direct Medical Cost of Premature and Preterm Neonates Hospitalized in ICU Based on Gestational Age (US Dollars)							
Number of All Premature and Preterm Births in the Year 1393		Estimated of Gestational Age-specific Number of Neonates in Iran	Estimated Number of Premature/Preterm Neonates (Private vs. Public)	Direct Medical Cost of Premature Neonates Based on Gestational Age (Public vs. Private; Mean)	Direct Medical Cost of Premature Neonates Based on Gestational Age (Public vs. Private)	Total Direct Medical Cost of Premature Neonates Based on Gestational Age in the Year 1393	Total Direct Medical Cost of Premature Neonates in Iran
5.8%	88993	28<	4,628	3,933	8465.52	33299050.41	46932073.40
				694	19640.01	13633022.99	
		28-<32	9,255	7,867	4727.35	37189990.17	52416009.67
				1,388	10967.45	15226019.50	
7.9%	121215	32-<37	75,110	63,844	2379.67	151927190.72	214127969.98
				11,267	5520.85	62200779.26	
		28<	6,303	5,358	8465.52	45355751.53	63924929.80
				945	19640.01	18569178.27	
9.9%	151,902	28-<33	12,606	10,715	4727.35	50655497.1	71394453.64
				1,891	10967.45	20738956.48	291658016.71
		32<38	102,305	86,960	2379.67	206935988.48	
				15,346	5520.85	84722028.22	
		28<	7,899	6,714	8465.52	56838092.39	
				1,185	19640.01	23270183.70	80108276.09
		28-<34	15,798	13,428	4727.35	63479530.82	
				2,370	10967.45	25989266.73	89468797.56
		32<39	128,205	108,974	2379.67	259324262.86	
				19,231	5520.85	106170404.09	365494666.95

**Table 7.** Estimated costs of premature and preterm neonates hospitalized in NICU based on Rial (Iranian Currency) and US Dollars in 2014

Prevalence of prematurity		(5%/8) n=88993	(7%/9) n=121215	(9%/9) n=151902	%
Direct Costs	Direct Medical Costs	10,191,106,485,301	13,881,035,279,356	13,881,035,279,356	84
		313,476,053	426,977,400	426,977,400	
	Direct Non-Medical Costs	688,323,388,947	937,546,993,485	1,174,898,019,258	6
Indirect Costs		21,172,667	28,838,726	36,139,588	
		1,264,004,066,130	1,721,666,343,150	2,157,526,385,820	10
		38,880,470	52,958,054	66,365,007	
Economic Burden		12,143,433,940,378	16,540,248,615,991	17,213,459,684,434	100
		373529189	508,774,181	529,481,996	

to initial hospitalization per neonate in public and private hospitals was \$4190.34 and \$9721.60, respectively, of which 86% was due to direct medical, 5% to direct non-medical, and 9% to indirect expenses (Table 5).

Next, based on the 5.8, 7.9, and 9.9 age-specific percentiles of the nationwide prematurity, the number of age-specific premature and preterm neonates in Iran was estimated to be 88,993; 121,215; and 151,902 during 2014 and 2015. Accordingly, we obtained significant differences in direct medical costs for diverse gestational age, among which the most cost was related to the ages younger than 28 weeks, and the least to the age group of 32 to 38 weeks (Table 6).

These data strongly suggest that the economic burden of prematurity was mainly due to direct medical costs during 2014 and 2015, and the age-specific costs were \$373,529,189; \$508,774,181; and \$529,481,996 with respect to their nationwide 5.8, 7.9, and 9.9 percentiles of incidences (Table 7).

## Discussion

In this study, we estimated the potential economic burden of initial hospitalization of premature and preterm births in Iran. Our assessment suggests a major economic burden for prematurity in Iran. We found that 86% of the expenses for prematurity were due to direct medical costs (collectively \$397535.9283 a year; \$3515.5363 per affected neonate per

year), and this amount was for initial hospitalization only. We estimated a much larger economic burden from prematurity, as it can cause long-term health problems and long-lasting financial effects (18). A study in the U.S. has revealed that the average costs of the initial hospitalization for normal births is about \$2061, whereas this goes up to \$26054 for premature births (11). Kirk by et al. (10) have reported an average cost of \$31 000 per premature neonate of 32 to 37 weeks for initial hospitalization in the U.S., which constitutes 21.6% of all the costs attributed to NICU; another study has estimated \$30. 527 per neonate of 32 to 34 weeks old. Another study from the U.S. has conceived \$15 100 per neonate on average (9). A report from India (for neonates hospitalized in NICU) estimated this cost as 4.345 per neonate (27), and a study in Turkey has documented the cost of \$4 345 (\$23 215-7 035) (28). One more study from Turkey examined the costs of 211 premature neonates in a 12-month period, and they found that the per day collective hospitalization and per neonate costs were \$4,187 and \$308, respectively (29), whereas another study reported the collective cost per neonate as \$7,036 per day of hospitalization in 2015 (30). In our study, the cost per day per neonate was \$554.2469.

Regarding the age-related differences in initial hospitalization costs, we split our samples into different age groups: (i) <28, (ii) 28 - <32 and (iii) >32 weeks of gestation. We



found that 44% of the direct medical expenses are due to the first age group (under 28 weeks), while encompassing only 11% of the cases. Thus, the average per day cost of each neonate of this group would be \$8,076,261, which is almost twice that of a neonate aged 32 to under 37 weeks (\$4,532,011). This is in agreement with the previous data wherein duration and costs of initial hospitalization for premature neonates have negatively been correlated with age and weight at birth (9, 31). In 2006, Smith and Pgibbs also demonstrated that for each two weeks increase in gestational age, there would be about \$28,870 to \$64,021 (on average) saving for premature newborns under 33 weeks and \$206,000 for those under 26 weeks (16).

To have a more realistic assessment of the prematurity costs, we also attempted to calculate the direct non-medical expenses including accommodation and feeding of parents as well as clothing and feeding of other children (ie, siblings of the affected one). Tongo et al. have also indicated direct non-medical costs (\$101 - \$ 1128.1; \$257.2 on Ave.) (32). Furthermore, the absence days of parents (related to prematurity initial hospitalization) were also calculated as indirect costs. As demonstrated in Table 7, indirect costs comprise a major portion of all costs (10%) during initial hospitalization. In a study, the parents' average wage loss due to absence from prematurity initial hospitalization was €5,990 and €8,175 in the first and second years (following preterm born), respectively (33).

Noticeably, there are variations between the results of these studies, which can be due to various factors including year and geographical region of study, inflation rates in the corresponding countries, salary and benefits, tariff, and costs in the studied region/hospitals. Also, the costs of medicine and other expenses can be affected by the severity of the disease, birth weight, and NICU- or hospital-specific guidelines.

Because we have no information on the real incidence of prematurity at national level in Iran, we only made an estimation based on the statistics issued by WHO, and thus this might have influenced our results. Similar studies in other hospitals and regions of Iran would be helpful in obtaining a more precise statistic from the costs of prematurity. Therefore, this problem should be managed more efficiently for better cost assessment; moreover, preventive programs should also be implemented.

## Conclusion

The economic burden of initial hospitalization in the NICU of premature newborns is estimated to be significant in Iran. We found that 44% of the direct medical costs belong to the age group younger than 28 weeks of gestation, while encompassing only 11% of the cases. To reduce these costs, the healthcare policy-makers might implement two strategies: first, improving educational programs, especially for mothers both before and during pregnancy, to attend to pregnancy hygiene and regular screening programs during pregnancy to prevent or reduce the severity of prematurity; second, updating the facilities of NICU sections to provide better services to the patients, and hence, improve their condition, which would substantially affect their long term lifestyle, education, and socioeconomic situation.

## Conflict of Interests

The authors declare that they have no competing interests.

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