ORIGINAL ARTICLE

Contributing death factors in very low birth weight infants by path method analysis

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ABSTRACT

Background: Neonatal deaths account for 40% of deaths under the age of 5 years worldwide. Therefore, efforts to achieve the UN Millennium Development Goal 4 of reducing childhood mortality by two-thirds by 2015 are focused on reducing neonatal deaths in high-mortality countries. The aim of present study was to determine death factors among very low-birth-weight infants by path method analysis. **Materials and Methods:** In this study, medical records of 2,135 infants admitted between years 2008 and 2010 in neonatal intense care unit of Alzahra Educational-Medical centre (Tabriz, Iran) were analysed by path method using statistical software SPSS 18. **Results:** Variables such as duration of hospitalisation, birth weight, gestational age have negative effect on infant mortality, and gestational blood pressure has positive direct effect on infant mortality that at whole represented 66.5% of infant mortality variance ($F = 1018$, $P < 0.001$). Gestational age termination in the positive form through birth weight, and also gestational blood pressure in negative form through hospitalisation period had indirect effect on infant mortality. **Conclusion:** The results of the study indicated that the duration of low-birth-weight infant's hospitalisation is also associated with infant's mortality (coefficient -0.7; $P < 0.001$). This study revealed that among the maternal factors only gestational blood pressure was in relationship with infants' mortality.

Key words: Effective factors, infant mortality, path analysis, very low birth weight

INTRODUCTION

To address UN Millennium Development Goal 4 on reducing childhood mortality, there is a need for better population-based data on the rates and causes of neonatal death. Our prospective population-based study provided a rare opportunity to obtain reliable information on the rate, timing and direct cause of neonatal death. Because pregnant women from a defined population were enrolled at 20-26 weeks' gestation and followed with their infants to 28 days postpartum, data on antepartum history, delivery and events before neonatal death, in addition to maternal interview data, were available, so we could determine the causes of death quite reliably.

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Neonatal intense care unit (NICU) is an environment that a number of nurses, residents and fellowships are involved. These staff have unequal quality of skills on the other hand equipment in different NICUs are not the same so care quality are different and the factors effective on infant mortality can differ among different NICUs.[1] Neonatal care is formally regionalised, with assigned levels of care and specific guidelines that define the characteristics of infants who should be delivered, and cared for, at each level of care. Each NICU that offers a lower level of care must have a formal contractual relationship with a NICU that provides tertiary care.8 Higher levels of care are associated with lower neonatal mortality, particularly among infants with very low birth weight (below 1500 g). Newborns with a weight lower than 2500 g are categorised as low-weight infants.[2] These infants are at high risk of neonatal complications and death. The latter is 40 times more often in those with low weight compared to normal weight.[3] A birth weight below 1500 gr is categorised as very low,[4] accounts for the largest proportion of under-1-year infant mortality.[5] Its prevalence in the U.S. is about 1.1% of the live births, and includes about 13% of all death cases of infants.[6] In a recent study from Mazandaran, Northern Iran, the incidence of very low birth weight was 0.2%.[7]

The most important factors contributing to infants' death are: Maternal age, health and physical status; the Apgar score at birth; infant's weight at birth; and duration of hospital stay.[8-10]

Neonatal deaths account for 40% of deaths under the age of 5 years worldwide. Therefore, efforts to achieve the UN Millennium Development Goal 4 of reducing childhood mortality by two-thirds by 2015 are focused on reducing neonatal deaths in high-mortality countries. Despite improvements in primary and secondary care of pregnant mothers and newborns in the recent years in Iran, unfortunately there has not been a significant decrease in Infant Mortality Rate (IMR).[11,12] The latter necessitates more research on the determinants of infant mortality.

A few studies analysed the structure of low-weight (below 2,500 g) infant mortality in Iran,[13-15] but there has not been any report on factors contributing to death in very-low-weight newborns (below 1,500 g).

Therefore, the aim of the current study is to determine factors contributing to the mortality of very-low-birth-weight infants in Alzahra Educational-Medical Centre, Tabriz University of Medical Sciences - the largest referral centre in Northwestern Iran. Our aim in the present paper is to present a new statistical framework for analysing and visualising the impact contributing death factors in very low-birth-weight infants on later outcomes based on path analysis techniques.

MATERIALS AND METHODS

This descriptive-analytical study analysed the medical records of 2,135 infants, who were born in Alzahra Educational-Medical Center between years 2008 and 2010. Permission was obtained from Ethics Committee of Tabriz Medical university (Protocol Number: 5840) and a permission from hospital authorities to analyse the medical records.

To record relevant information, a checklist was developed and filled up for each infant. The checklist included two category of queries.

a. Queries about infants' birth date, weight, sex, type of delivery, the Apgar score values at first and fifth minutes and duration of hospitalisation. We considered neonatal complications due to prematurity as respiratory distress syndrome, emphysema, jaundice, etc., in our questioner.
b. Queries about maternal age, number of pregnancies, number of deliveries, gestational age and complications during pregnancy (e.g., gestational diabetes, hypertension, pre-eclampsia, eclampsia).

Infants were categorised into four groups: Below 1,000 gr (ELBW), 1,000 to 1,500 gr (VLBW), 1,500 to 2,500 gr (LBW), and above 2,500 gr. Those with genetic and chromosomal anomalies were excluded from the study.

Statistical analysis

Correlation coefficient (r) of the final data was determined by path analysis method and then data of checklist were analysed by SPSS 18.0 statistical software. Correlation of contributing factors was estimated as direct or indirect, positive or negative.

Though the path analysis does not establish causality, it distinguishes direct and indirect factors affecting mortality. It also reveals the implications of a set of causal assumptions imposed on a system of relationships. A direct risk factor has an immediate effect on the risk of mortality without involvement of intermediate variables. In contrast, an indirect risk factor does not have a direct effect on the risk of mortality but it facilitates effecting through an intermediate variable.[16]

Correlation between any two variables results from a series of paths that connect them. The size and significance of the correlation estimate the strength of the relationship between the risk factors and mortality. By using this correlation matrix we calculated the path coefficients for each of the risk factors influencing mortality. The direction of correlations between the risk factors was based on biological plausibility or on previous knowledge of the relationship. Seven path between the variables were calculated as follows: First determines the correlation metrics between risk factors and denotes it by A second find inverse of A and denotes it as B third determine the vector of correlation coefficients between the risk factors and mortality denoting it by V. The required path between the variables were calculated by B Multiple V. *P*-value below 0.05 was set as statistically significant.

RESULTS

We analysed medical records of 2,135 infants born in Alzahra Educational-Medical Center of Tabriz during 2008-2010. Demographic variables of mothers and infants and recorded maternal blood pressure values are in Table 1.

According to the checklist, 60 (2.8%) of mothers had previous history of infertility. One hundred and eighty-four patients (8.6%) were suffering from chronic gestational hypertension. Rate of VLBW was 8.84% (CI 95% 6.85-11.2%).

Based on path method, we analysed correlation between the recorded variables [Table 2]. The only significant value was the correlation between birth weight and duration of hospitalisation (r_s = −0.37, P = 0.031). Direct and indirect effects of various factors on VLBW infants' mortality rate are shown in Figure 1 with related correlation coefficients.

Table 1: Some variables of mothers and infants

Mothers (at hospitalisation)			Infants (at birth)		
Variable	Level	Results (%)	Variable	Level	*N* (%)
Age, y	Mean±SD	23.65±3.19	Gestational age, weeks	<37	308 (14.4)
	Min	16		37	1234 (57.8)
	Max	37		>37	593 (27.8)
Number of Previous Pregnancies	1	1302 (61)	Birth weight, g	<1000	188 (8.8)
	2	85 (4)		1000-1500	596 (27.9)
	3	171 (8)		1500-2500	813 (38.1)
	>3	277 (13)		>2500	538 (25.2)
Blood pressure (mmHg)	Systolic	140.21±2.7	Apgar score	First minute	7.38±1.14
	Diastolic	110.43±1.1		Fifth minute	8.01±1.3

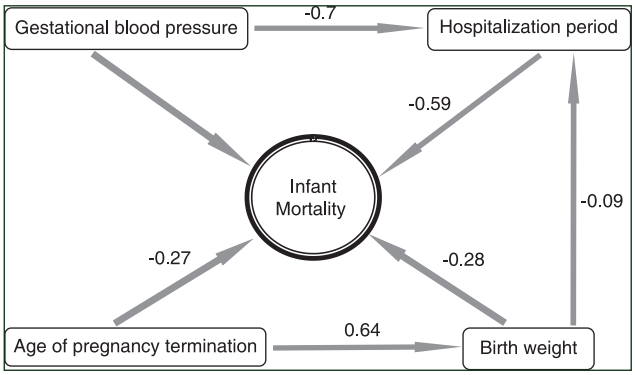

Figure 1: Path analysis and related variables' diagram in determining effective factors on very low weight infants' mortality

Table 2: Spearman correlation coefficient (r_s)

	GA	Birth weight	Maternal gestational BP	Duration of hospital stay
GA	1			
Birth weight	0.45	1		
Maternal gestational BP	0.18	0.24	1	
Duration of hospital Stay	−0.75	−0.37*	−0.14	1

*Correlation between birth weight and duration of hospital stay was significant ($P < 0.001$). GA – Gestational age; BP – Blood pressure

Birth weight induces indirect effect on mortality through affecting infant's hospitalisation period in NICU [Figure 1]. This effect is less than direct in the first stage effect but affects through hospitalisation period on infant's mortality with a higher correlation coefficient than birth weight itself. Birth weight varies with the age of pregnancy termination effecting on birth weight excessively.

Final results showed that, corresponding to the priority of β-coefficients of hospitalisation period variables, birth weight, age of pregnancy termination in negative form, and gestational blood pressure in the positive form have direct effect on infants mortality leading totally 66.5% of infant mortality ($F = 1018$, $P < 0.001$). The age of pregnancy termination in the positive form through birth weight, and also gestational blood pressure in negative form through hospitalisation period had indirect effect on infant mortality.

DISCUSSION

The results of this study suggest that factors influencing infants' mortality are gestational age, birth weight, Apgar score, gestational hypertension, duration of hospitalisation and type of delivery.

Based on the path analysis, it is possible to categorise the effective variables on low-birth-weight infants' mortality showing that the birth weight was the most important factor which has negative and direct relationship on infants' mortality rate. The higher the birth weight, the less is the mortality.

In a study from Beilinson Medical Center, based on the path analysis, birth weight was negatively associated with low-birth-weight infants' mortality.[16] Sulkes *et al.,* reported direct relationship between low birth weight and infants mortality which corresponds to the results of some Iranian and other studies.[17-21]

The results of this study indicate that the duration of low-birth-weight infant's hospitalisation is also associated with infant's mortality (coefficient = 0.7; $P < 0.001$) which corresponds to the results of a study from Colombia, where early hospital discharge was considered to be a safety factor for very low-birth-weight infants.[22] The reason may be as follows: High prevalence of sepsis in wards without standard design; high ratio of infant to nurse; Overcrowding in post-NICU due to high ratio of birth; improper number of beds to patient in countries with low economy. So we may need to revise discharge criteria in such countries.

The age of pregnancy termination is also associated with IMR either directly or indirectly by influencing birth weight and hospitalisation. A cohort study from Pakistan showed that infants' immaturity is one of the main factors of their mortality.[23] Another study from India proved a direct link between age of pregnancy termination and infants' mortality.[24] A study from Malaysia revealed a significant association between the pregnancy termination age and mortality of infants with very low birth weight.[25] Finally, several Iranian studies on newborns distinguished the pregnancy termination age and infant immaturity as the main factors of infants' mortality.[14,15,19] All these studies suggest that instructing pregnant mothers properly, promoting their health care and avoiding early termination of pregnancy may decrease birth rates of immature infants and IMR.

Our study revealed that only gestational blood pressure, among the maternal factors, was in relationship with

infants' mortality the result that had been reported previously.[8,23] We, therefore, suggest a regular monitoring blood pressure and education of pregnant mothers individually to control their blood pressure.

Cardiac, renal and neurological congenital malformations are increasingly important problem worldwide and in Iran, requiring screening and prompt treatment.

By the result of our study we found that low Apgar score relates to LBW mortality. A study from Bosnia and Herzegovina showed that low Apgar score at the first and fifth minutes will increase the infants' mortality.[8] Similar results were reported from America.[19] Therefore, the infants' Apgar score may be another variable which should be carefully assessed by clinicians, researchers, managers and policy makers.

The prevalence of VLBW infants in this study is much higher than that reported earlier.[6,7,26-29] A possible explanation is that Alzahra hospital is the only well-equipped specialised hospital in Northwestern of Iran, and most deliveries in this centre are of high risk, all of whom are referred from other towns and villages. Moreover, by advancing caretaking, upgrading professional skills, instructing pregnant mothers properly in the region could improve the results of care for VLBW newborns.

There are some difficulties in the current study such as incompleteness of notes about the pregnant and infants. More attention should be paid to proper documenting the course of pregnancy and delivery in the future studies. Another limitation is that the study is based on the results from one referral centre and it is impossible to generalise the results.

CONCLUSION

We identified factors of very-low-birth weight mortality using the path analysis statistical method. The results of the study indicated that the duration of low-birth-weight infant's hospitalisation is also associated with infant's mortality (coefficient -0.7; $P < 0.001$). Our study revealed that among the maternal factors only gestational blood pressure was in relationship with infants' mortality. The results can be used for improving decision-making in the field. Considering the role of the path analysis in recognition direct and indirect factors we strongly support implementing this statistical method in medicine.

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