Topographical Differences of Infant Mortality in Nepal

Dev R,[1] Williams MF,[2] Fitzpatrick AL,[3] Connell FA[1]

[1]Department of Health Services

[2]Departments of Epidemiology

[3]Department of Family Medicine and Epidemiology

University of Washington

1959 NE Pacific St, Seattle, WA 98195, USA.

Corresponding Author

Rubee Dev

Department of Health Services

University of Washington

1959 NE Pacific St, Seattle, WA 98195, USA.

E-mail: rubeed@uw.edu

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ABSTRACT

Background

Infant mortality is a major problem in Nepal, particularly in the mountainous region of the country.

Objective

To identify factors that contributes to the high rate of infant mortality in the mountain zone in Nepal.

Method

Data were derived from the 2011 Nepal Demographic and Health Survey (NDHS). Infant mortality was analyzed across three ecological zones in a sample of 5,306 live births in the five years preceding the survey. The contribution of risk factors to the excess infant mortality was assessed using multiple logistic regression.

Result

Infant mortality rate (deaths per 1000 live births) in the ecological zones were 59 (95% CI: 36, 81), 44 (35, 53), and 40 (33, 47) for the mountain, hill and terai zones, respectively. Women living in the mountain zone were more likely to report that distance to care was a "big problem" and had a greater risk of infant mortality compared to the terai zone (OR=1.42, 95% CI: 1.01, 2.02, p=0.04). This increased risk was observed only among births to mothers who perceived distance to the nearest health facility as a "big problem" (aOR=1.57, 95% CI: 1.01, 2.40, p=0.04) controlling for other risk factors.

Conclusion

These findings suggest that the higher Infant mortality rate (IMR) in the mountain zone was among the women who perceived distance to health facilities as a big problem. Improved accessibility to health services, particularly in this zone, is an essential strategy for reducing infant mortality in Nepal.

KEY WORDS

Access to care, developing country, ecological, geography, infant mortality

INTRODUCTION

Nepal is a country with a highly varied topography. Government geographers divide the country into three ecological zones based on altitude: Mountain Zone (highest altitude), Hill Zone (central) and the Terai Zone (low-lying flatlands).[1,2] Geographical variation is an important issue in health care delivery in Nepal, especially with regard to the mountain zone, which is most disadvantaged relative to health care access but receives limited attention.[3]

Infant mortality rate (IMR), the number of deaths of infants under one year of age per 1,000 live births, is an indicator of the quality of health in a country. In 2012, almost 5 million deaths worldwide occurred within the first year of life.[4] Most of these deaths occur in developing countries.[5] In the 2011 Nepal Demographic and Health Survey (NDHS), the IMR was 46 per 1,000 live births. At this mortality rate, one in every 22 Nepalese children dies before reaching one year of age.[6] One of the study has shown premature birth, lower respiratory tract infection, and diarrhea as the major causes of infant mortality in Nepal.[3] However, infant mortality may also be associated with poor public health services and lack of access to health care facilities.[7]

The IMR in Nepal is directly and indirectly influenced by a number of factors including socio-economic, cultural, demographic and maternal characteristics.[1,3,7-9] Chin et al. demonstrated that for each 10 kilometer increase in distance to the nearest health care facility in Nepal there was 6% higher hazard of infant death.[10]

Paudel et al. found that less than one third of the households in a rural district of Nepal had adequate access to health care services due to geographical location.[11] Health care access and distance to health care facilities is a particular problem for the residents in the Mountain zone.[12,13]

Though several studies have evaluated the differences for neonatal mortality (deaths within the first twenty eight days of life) in Nepal, studies of disparities in infant mortality is limited.[14] Few studies have investigated factors for infant mortality relative to ecological zones of Nepal.[8,15] This study aims to fill the gaps in knowledge by evaluating infant mortality in the three ecological zones of Nepal and examining factors that contributed to differentials in infant mortality among the three zones.

METHODS

The data utilized in this study are from the NDHS 2011, a publicly available, nationally representative sample survey. This survey was the eighth in a series of national population and health surveys and the fourth comprehensive survey conducted as part of the global Demographic and Health Surveys (DHS) program in Nepal. Data were obtained through the on-line database (Measure DHS Data Archive) and the full data set was downloaded after obtaining authorization from the Measure DHS team. The Institutional Review Board at the University of Washington approved this study.

The survey was based on a stratified two-stage cluster sample design. Stratification was done by cross- classification of the three ecological zones of Nepal (mountain, hill, terai) and the five administrative development regions (Eastern, Central, Western, Mid-western and Far-western). Due to small sample size in the Mountain zones, the Western, Mid-western and Far-western mountain zones were combined into one stratum. The data set contains sampling fractions for each stratum, which permits the calculation of weighted estimates using the Stata 11 commands for the analysis of stratified, cluster-sampled data.

The units of analysis in the present study were infants born to women in the sample within the five-year period preceding the survey (n=5,306). All variables were drawn from the Children's file (NPKR60dt) of the NDHS survey. The primary outcome measure was infant mortality rate (IMR), defined as the number of infant deaths divided by the total number of live births in the sample during the five-year period. The primary independent variable was the ecological zones of Nepal, mountain, hill and terai. The potential co-variates examined were types of residence (urban vs. rural), developmental regions, socio-economic status (SES), religion, ethnicity, mother's age at first birth, birth interval, total children ever born to mother, sex of the child, mother's estimate of birth weight, sex of head of household, mother's education level, husband's education level, maternal employment status, and maternal perception of distance to health facility.

Bivariate analyses (using weighted and unweighted data) were conducted to describe the distribution of the potential co-variates by ecological zone, using Pearson's chi-square test. Where expected cell counts were less than five, the Fisher exact test was used. Variables that were significant in bivariate analysis were included in logistic regression models. In addition, IMR's were computed by ecologic zone for each value of the covariate. The Cochran-Armitage test of trend of odds was used to assess increasing or decreasing trends in IMR across ecological zone stratified by whether or not perceived distance to health facility was reported to be a "big problem." Logistic regression was used to assess the association between ecological zones and infant mortality with and without control for other variables. These analyses were performed 1) on the sample as a whole and 2) on the sample stratified by perception of distance to nearest health care facilities among mothers as a "big problem" and "not a big problem".

Data management and analysis were conducted using Stata version 11 (Stata Corporation, College Station, TX, USA). Both weighted and unweighted analyses were performed. Substantial differences between weighted and unweighted results were not seen. For the sake of clarity, only unweighted estimates are presented in Tables 1-4.

RESULTS

In the study sample, the total number of live births in the five years preceding the survey was 5,306, of which 237 infants died within the first year of life. The unweighted overall IMR in the sample was 45 deaths per 1000 live births while the weighted IMR was 44. The weighted IMR in each ecological zone was 59 (95% CI: 36, 81), 44 (35, 53), and 40 (33, 47) for the mountain, hill and terai zones, respectively.

The distribution of selected household, maternal and child characteristics in each ecological zone are shown in Table 1. Almost all mothers in the mountain zone (94.3%) resided in rural settings compared to 81.5% and 70.2% of the women in the hill and terai zones. There were marked differences in SES among women in the three zones. The proportion of mothers who perceived distance to the nearest health facility as a "big problem" was greatest among women in the mountain zone (70.8%) and least among terai zone (45.6%). Greater proportions of women in the mountain zone reported no education (57.1%), compared to women in the hill zone (43.3%) and the terai zone (44.9%). Birth interval between infants was less than 2 years for 46.6% of the women in the full sample and did not vary substantially by ecologic zone. A greater proportion of births in the mountain zone were considered to be of small or very small birth weight (20.5%) compared to the terai zone (15.2%).

Comparisons between infant mortality rates in mountain, hill and terai zones for selected background characteristics are shown in Table 2. The results indicate that infant mortality was higher among those who lived in rural areas (46 per 1000), especially in the mountain zone (58 per 1000). The higher IMR in the mountain zone was observed for births perceived to be "average or large", but not for "small or very small" infants. In all ecological zones, women who perceived distance to the nearest health care facility as a "big problem" had increased risk of infant mortality compared to women who did not perceive it as a "big problem." Among births where distance to a health care facility was perceived to be a "big problem", IMR was highest among the women in the mountain zone (63 per 1000). However, among women who did not perceive distance as a big problem, the IMRs were not significantly different in the three ecological zones (p value=0.73).

Table 1. Characteristics of births by background characteristics, Nepal DHS 2006-2011 (Unweighted)

Background Characteristics		Ecological zone (NDHS 2011)			
		Mountain N (%)	Hill N (%)	Terai N (%)	Total N (%)
Household characteristics	Residence				
	• Urban	58(5.6)	393 (18.4)	640 (29.7)	1091 (20.5)
	• Rural	962(94.3)	1742 (81.5)	1511 (70.2)	4215 (79.4)
	Wealth index				
	• Lower SES	789(77.3)	1355 (63.4)	619 (28.7)	2763 (52)
	• Average	162(15.8)	254 (11.8)	516 (23.9)	932 (17.5)
	• Higher SES	69(6.7)	526 (24.6)	1016 (47.2)	1611 (30.3)
	Distance to health facility				
	• Big problem	723(70.8)	1283 (60.0)	981 (45.6)	2987 (56.2)
	• Not a big problem	297(29.1)	852 (39.9)	1170 (54.3)	2319 (43.7)
Maternal characteristics	Mother's age at first birth				
	• Less than 20 years	557(54.6)	1084 (50.7)	1231 (57.2)	2872 (54.1
	• 20 or more years	463(45.3)	1051 (49.2)	920 (42.7)	2434 (45.8)
	Mother's education				
	• No education	583(57.1)	925 (43.3)	966 (44.9)	2474 (46.6)
	• Primary	199(19.5)	454 (21.2)	407 (18.9)	1060 (19.9)
	• Secondary	217(21.2)	620 (29.0)	635 (29.5)	1472 (27.7)
	• Higher	21(2.0)	136 (6.3)	143 (6.6)	300 (5.6)
	Total children ever born				
	• Four or less	797(78.1)	1789 (83.7)	1927 (89.5)	4513 (85)
	• More than four	223(21.8)	346 (16.2)	224 (10.4)	793 (45.9)
Child characteristics	Birth Interval				
	• < 2 years	447(43.8)	974 (45.6)	1052 (48.9)	2473 (46.6)
	• 2 years	238(23.3)	451 (21.1)	363 (16.8)	1052 (19.8)
	• 3 years	151(14.8)	269 (12.5)	300 (13.9)	720 (13.5)
	• 4 + years	184(18.0)	441 (20.6)	436 (20.2)	1061 (20.0)
	Birth size				
	• Average or larger	810(79.4)	1714 (80.2)	1822 (84.7)	4346(81.9)
	• Small/very small	210(20.5)	421(19.7)	329(15.2)	960(18.09)

Table 2. Infant mortality rate (IMR) among all births in the five years preceding the survey by background characteristics, Nepal DHS 2006-2011 (Unweighted)

Background characteristics			NDHS 2011			
			Mountain IMR (n/1000)	Hill IMR (n/1000)	Terai IMR (n/1000)	Total IMR (n/1000)
All births			59	44	40	45
Household characteristics	Residence	Urban	-	38	39	36
		Rural	58	47	39	46
	Wealth Index	Lower SES	65	50	35	51
		Average	24	35	56	45
		Higher SES	-	38	32	32
	Distance to health facility	Big problem	63	53	41	51
		Not a big problem	33	34	36	35
Maternal characteristics	Mother's age at first birth	Less than 20 years	48	48	48	48
		20 or more years	62	41	26	39
	Mother's education	No education	61	44	50	50
		Primary	55	52	34	46
		Secondary	41	45	29	38
		Higher	-	29	13	20
	Total children ever born	Four or less	52	45	36	43
		More than four	62	43	58	52
Child characteristics	Birth Interval	< 2 years	71	60	46	56
		2 years	46	44	55	48
		3 years	26	22	30	26
		4 + years	48	27	13	25
	Birth size	Average or larger	54	42	34	40
		Small/very small	57	59	66	61

After adjustment for potential confounders, infants born to women living in the mountain zone had 42% higher odds of infant death compared to those living in the terai zone (OR=1.42, 95% CI: 1.01-2.02) (Table 3). Infants born to women who perceived distance to a health facility to be a big problem had significantly higher odds of infant death (OR=1.40, 95% CI: 1.10-1.90). Infants born in rural areas were at higher risk for infant mortality but this was not statistically significant (OR=1.28, 95% CI: 0.91-1.82).

The association between ecological zone and infant mortality was analyzed separately for births to mothers who perceived distance to health facility as a big problem and to those who did not. Both unadjusted and adjusted (for mother's age at first birth, mother's education, total children ever born, birth interval, birth size) odds ratios were computed (Table 4). Among women who perceived distance to a health facility as a problem, residence in the mountain zone was a significant risk factor in both unadjusted and adjusted logistic regression models. On the other hand, residence in the mountain zone was not a statistically significant risk factor for infant mortality among births to women who did not perceive distance as a big problem.

Table 3. Unadjusted association between infant mortality and selected covariates using logistic regression.

Background characteristics		OR (95% CI)	p-value
Ecological zone	Terai	Reference	
	Hill	1.17 (0.86-1.57)	0.29
	Mountain	1.42 (1.01-2.02)	0.04[a]
Types of residence	Urban	Reference	
	Rural	1.28 (0.91-1.82)	0.15
Distance to health facility	Not a big problem	Reference	
	Big problem	1.40 (1.10-1.90)	0.004[a]

[a]P value statistically significant at 0.05.

DISCUSSION

Infant mortality was substantially higher among women living in the mountain zone of Nepal compared to those in the hill and terai zones. In all three ecological zones, infant mortality was higher among those who perceived the distance to a health facility as a big problem compared to those who did not perceive distance as a big problem.

Table 4. Unadjusted and adjusted association between ecological zones and infant mortality by distance to health facility.

Ecological Zone	Distance to Health Facility							
	Unadjusted Odds Ratios				Adjusted Odds Ratios			
	Big Problem		Not a Big Problem		Big Problem		Not a Big Problem	
	OR (95% CI)	p value	OR (95% CI)	p value	aOR (95% CI)[b]	p value	[a]OR (95% CI)[b]	p value
Terai	Reference	--	Reference	--	Reference	--	Reference	--
Hill	1.28 (0.86-1.90)	0.21	0.92 (0.57-1.49)	0.74	1.29 (0.80-1.93)	0.20	0.92 (0.56-1.50)	0.74
Mountain	1.55 (1.01-2.40)	0.04[a]	0.91 (0.45-1.83)	0.79	1.57 (1.01-2.40)	0.04[a]	0.75 (0.37-1.55)	0.44

[a]P value statistically significant at 0.05.
[b]Adjusted for mother's age at first birth, mother's education, total children ever born, birth interval, birth weight size.

A higher proportion of mothers in the mountain zone, compared to the other two zones, reported that distance to a health facility was a big problem. Furthermore, among women who perceived distance to a health facility as a problem, the risk of infant mortality in the mountain zone relative to the other zones was significantly higher, even after adjusting for possible confounders. On the other hand, among women who did not perceive distance to a health facility as a big problem, residence in the mountain zone was not associated with increased risk of infant mortality compared to living in the hill or terai zones. These findings suggest that the higher IMR in the mountain zone can be attributed to a combination of 1) the higher prevalence of access problems and 2) the greater risk IMR associated with access problems in the mountain zone compared to the two other ecologic zones. However, this result may have some limitation, as studies have not been conducted to assess whether or not the perceived difficulty of access to health facility is a real difficulty.

Consistent with a previous study that assessed relative and absolute inequalities in neonatal mortality using NDHS 2011 data, the results of this study showed inequalities by ecological zone.[16] Residents of the mountain and hill zones face geographical and infrastructure challenges in access to health care.[17] Earlier studies of infant mortality in Nepal have been either confined to only some districts or have investigated specific disease conditions as major risk factors.[6,18,19] This study highlights the importance of access to health care facilities as an important factor.

The effect of distance to health facility on childhood mortality and maternal mortality in Nepal has been previously examined; however, measurements of distance have varied.[10,18] The results of the present study are consistent with an earlier study in Nepal that observed a six percent increased hazard of infant death for each 10 km increase in distance to the nearest health center and nearest highway.[10] However, the associations were not statistically significant. Another study in Salma VDC, Jajarkot, Nepal reported that 22% of households in the study area perceived distance to health facility as a barrier to accessing basic health care services.[20] The findings of the current study are supported by a study conducted in BP Koirala Institute of Health Sciences, Nepal, which categorized distance to health facility as "near" and "far".[21] Women who reported distance to health care services as "near" had higher utilization of services (72.4%) compared to those who reported distance to health care services as "far" (27.6%), and experienced two-thirds less perinatal mortality.[21]

This study presents the results of the associations between the perceived distance of women to a health care facility and IMR across three ecological zones in Nepal. Perception of distance to a health care facility is important in Nepal as it is highly influenced not only by actual distance but also terrain, seasonal variation, time required, lack of transport, and costs incurred. In mountain and hill areas, where people often have to walk five or more hours over difficult terrain to reach a health care facility, accessibility to health care is limited beyond the actual distance in kilometers.[22,23]

The present study did not show a consistent effect of socio-economic status on infant mortality. A possible explanation may be the index used for measuring wealth status of the household (based on 33 selected assets), which may not be appropriate to capture the SES in the context of Nepal. Previous studies in Nepal have reported that mother's education, number of children ever born, religion, previous birth interval and types of birth were significant predictors of infant mortality.[24,25] Our study also showed higher infant mortality among mothers who had no education or only primary education compared to mothers with secondary or higher education. This may be because educated mothers are more aware of disease conditions and preventive measures have more personal autonomy, and are less likely to live in remote areas.

This study had several strengths. The data for this study was drawn from the Nepal Demographic and Health Survey 2011, which was a nationally representative survey and had a large sample size providing good generalizability of the outcome. Other advantages of this dataset include its high response rates, standardized data collection procedures across countries and consistent content over time.[26]

The study also had several limitations. The DHS data are derived from cross-sectional surveys which collect information from respondents about past events, behaviors, and outcomes. Such self-reporting is subject to recall bias.

Also, because of the design of the study, the analysis could only provide evidence of associations between the ecological zones and infant mortality but cannot show temporal relationships. The perception of distance to health facility was based on the perceived self-report of mothers and individuals have a broad range of attitudes about the impact of distance on access to health care. Also, although the NDHS survey asked whether distance to a health care facility was a big problem generally, not just in relation to the index pregnancies, it is possible that women who had lost a child were more likely to report problems with access to care. Finally, this study was, by necessity, restricted to the variables in the survey; hence this study could not evaluate some important variables of interest such as health practices, and other causes of infant death.

CONCLUSION

This study identified the importance of geographical access to a health care facility as a primary risk factor for infant mortality, particularly in the mountain zone of Nepal. In order to reduce infant mortality in Nepal, there is a critical need for interventions to address the problem of insufficient local health care facilities, lack of roads, unavailability of transportation, and long distances from villages and residences to the nearest clinic. Further, this study recommends more research to understand the role of distance in the risk of infant mortality.

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