

**Topographical Differences of Infant Mortality in Nepal:
Demographic and Health Survey 2011**

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Abstract

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Epidemiology

Objective: Infant mortality is a major problem in Nepal, particularly for residents in remote rural areas. Lack of roads and absence of hospitals and health facilities in remote areas contribute to the problem. The objectives of this study were to assess infant mortality rate (IMR) in the three ecological zones of Nepal (Mountain, Hill and Terai) and to examine the effect of distance to health facility on the association between ecological zone and infant mortality.

Methods: The Nepal Demographic and Health Survey (NDHS) conducted in 2011 was used to calculate infant mortality rates for the Mountain, Hill and Terai zones of Nepal. Infant mortality was compared across three ecological zones in a sample of 5,306 live births in the five years preceding the survey. Logistic regression was used to assess the association between ecological zones and infant mortality focusing on distance to health facility and adjusting for potential confounders including maternal age at first birth, education level, total children ever born, birth interval and infant size at birth.

Results: The weighted IMR in each ecological zone was calculated to be 59 (95% CI: 36-81), 44 (35-53), and 40 (33-47) infant deaths per 1000 live births for the Mountain, Hill and Terai zones, respectively. Residing in the Mountain zone was associated with a greater risk of infant mortality compared to those in the Terai zone (OR=1.42, 95% CI: 1.01-2.02, p=0.04). The risk of infant mortality in the Hill zone did not differ significantly from risk in the Terai zone (OR=1.17, 95% CI: 0.86-1.57, p=0.30). The elevated risk of infant mortality in the Mountain Zone compared to the Terai zone was observed only among mothers who perceived distance to health facility as a major problem (OR=1.55, 95% CI: 1.01-2.40, p=0.04). There was no significant difference in IMRs in the three ecologic zones among births to women who did not perceive distance as a big problem. In addition, a greater percent of women in the Mountain zone reported that distance to health facilities was a big problem (70.8%) compared to 60.0% in the Hill zone and 45.6% in the Terai zone.

Conclusions: The excess risk of infant mortality in the Mountain zone of Nepal is due to both 1) the higher risk of infant mortality in the Mountain zone vs. the Hill and Terai zones among births to women who perceived distance to health facilities as a big problem; and 2) the higher proportion of births in the Mountain zone where distance to health facilities is perceived to be a big problem. These findings highlight the importance of accessibility of health services, particularly in the Mountain zone of Nepal. Going forward it will be important to develop intervention strategies and programs that will target remote populations.

Keywords: Infant mortality, ecological, region, developing country

TABLE OF CONTENT

ACKNOWLEDGMENTS.....	1
LIST OF ABBREVIATIONS.....	2
LIST OF FIGURES.....	3
LIST OF TABLES.....	4
INTRODUCTION.....	5
OBJECTIVES.....	10
METHODS.....	11
RESULTS.....	16
DISCUSSION.....	24
REFERENCES.....	31

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LIST OF ABBREVIATIONS

NDHS	Nepal Demographic and Health Survey
IMR	Infant Mortality Rate
PSU	Primary Sampling Unit
EA	Enumeration Area
VDC	Village Development Committee
OR	Odds Ratio
CI	Confidence Interval
USAID	United States Agency for International Development
WHO	World Health Organization
ICF	Inner City Fund

LIST OF FIGURES

Figure 1. Infant mortality rate in different ecological zones (Mountain, Hill, Terai) of Nepal by perceived distance to health facility (big problem vs. not a big problem).....	22
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LIST OF TABLES

Table 1. Distribution of all births in the five years preceding the survey by background characteristics, Nepal DHS 2006-2011 (Unweighted).....	17
Table 2. Distribution of births, infant deaths and infant mortality rate during the five years preceding the survey by ecological zone, Nepal DHS 2006-2011.....	18
Table 3. Infant mortality rate (IMR) among all births in the five years preceding the survey by background characteristics, Nepal DHS 2006-2011 (Unweighted).....	20
Table 4. Infant mortality rate in ecological zones based on distance to health facility, Nepal DHS 2006-2011 (Unweighted).....	21
Table 5. Unadjusted association between infant mortality and selected covariates using logistic regression; odds ratios (ORs), 95% confidence intervals (CIs) and p-values are shown.....	22
Table 6. Unadjusted associations ecological zones and infant mortality by distance to health facility. Odds ratios (ORs), 95% confidence intervals (CIs) and p-values are shown.....	23
Table 7. Associations between ecological zones and infant mortality by distance to health facility adjusted for selected maternal and child covariates.....	23

INTRODUCTION

Geography of Nepal

Nepal is a landlocked country in Southeast Asia with approximately 30 million people and a highly varied topography. The country is divided into three ecological zones based on altitude: Mountain (north, highest altitude), Hill (central) and Terai (southern, low-lying flatlands) (Briney, 2011).

The Mountain zone situated in the Great Himalayan Range covers 15% (22,077 sq km) of the total land of the country and is home for 7.3% of the total population. It is covered with snow-capped mountains. The altitude ranges from 4,877 to 8,848 meters, including the highest elevation in the world. The Hill zone covers 68% (1,00,083 sq km) of the total land of the country and is the home for 44.3 % of the population. The altitude in this zone varies from 610 to 4,877 meters. The Terai zone, at the lowest altitude, covers 17% (25,020 sq km) of the total land of the country and has the highest population density with 48.4% of the population (Joshi et al. 2012).

Geographical variation is an issue in health care delivery in Nepal. Accessibility to health care facilities and services is a particular concern in the Mountain zone due to its high altitude and lack of roads compared to the Hill and Terai zones. In Nepal, the majority of people live in rural areas, especially in the Mountain zone. While, the Mountain zone has the greatest ecological disadvantage in terms of health care access, the Mountain zone has received limited attention from the government of Nepal. People living in this zone are in settlements far away from health

facilities. Furthermore the lack of roads and poor transportation in the Mountain zone severely limits access to health care (Bhandari et al. 2007).

Infant Mortality Rate

Infant mortality rate (IMR), the number of deaths among infants under one year of age per 1,000 live births, is often used as an indicator of the level of health in a country. Prematurity, lower respiratory tract infection (pneumonia), sepsis, and diarrhea are the major causes of infant mortality in Nepal (Christian et al. 2001). Deaths during infancy may be associated with many other factors including poor public health facilities and lack of access to health care resources (Atla et al. 2013).

According to the United Nations, the overall worldwide infant mortality rate is 49.4 deaths per 1,000 live births. In 2012, almost 5 million deaths occurred within the first year of life, which represented 73% of all deaths among children under five years of age (WHO 2013). Most of these deaths occur in developing countries, where infant mortality rates are 10 times higher than in developed countries (Katz et al. 2003). In the 2011 Nepal Demographic and Health Survey (NDHS), the infant mortality rate in the five years preceding the survey was 46 per 1,000 live births. At this mortality rate one in every 22 Nepalese children dies before reaching the age of one year (MOHP 2012).

The NDHS has found that infant mortality rates vary substantially across the three ecological zones with the highest infant mortality rates in the Mountain zone (MOHP 2012). An earlier study in Nepal also showed risk of infant and child death to be higher in the Mountain zone compared to the Terai and the Hill zone (Gubhaju 1984). Even after decades, infant mortality in

the Mountain zone of Nepal continues to be high.

Infant mortality rate is directly and indirectly influenced by a number of factors including socio-economic, cultural, demographic and lifestyle factors in addition to health care. An earlier study (Suwal 2001) reported that place of residence, parity, ethnicity, and immunization were the main predictors of infant mortality in Nepal. Results suggested that mothers who were living in urban areas, who were of Newar ethnicity, who had fewer children and whose infants were immunized had a lower probability of infant deaths (Suwal 2001). Other studies have found that maternal characteristics (maternal age, birth spacing, birth order, maternal night blindness and maternal mortality) and social factors were associated with higher infant mortality in Nepal (Katz et al. 2003, Christian et al. 2001, Gubhaju 1984).

An analysis of determinants of neonatal mortality in Nepal from 2006-2011 survey found that maternal education was a significant predictor (Paudel et al. 2013). The neonatal mortality rate among mothers with no education was 38 deaths per 1,000 live births compared to 28 deaths per 1,000 among mothers with education. In an earlier study conducted in urban Nepal (Pant 1991), parental education was associated with infant mortality. For mothers who had no education the IMR was 78 per 1000 compared to 44 per 1000 for mothers with some education, and the IMR was 82 per 1000 when the father had no education compared to 61 per 1000 when the father had some education (Pant 1991).

Chin et al. (2011) analyzed geographic inequalities in infant and child mortality across Nepal and demonstrated an association between distance to the nearest health facility and infant mortality.

For each 10-kilometer increase in distance to the nearest health facility there was 6% higher

hazard of infant death. In another study in Nepal, Paudel (2012) found that less than one third of the households in a rural district of Nepal had access to health care services. In that study access to health facility was categorized as those who went to a health facility but did not receive health care services (poor access) and those who did not seek health care services (lack of access).

Twenty-two percent of the total population who had been sick within three months prior to the study reported that long distance to health care facilities was one of the reasons for not accessing health care. People living closer to the health facility accessed health care facilities 3 times more frequently than those living further away from the health facility (OR=3.35).

Yadav (2010) assessed health care services utilization by people in two different Village Development Committees (VDC's) in the Dhanusha district of Nepal and found that distance was a significant indicator for utilization of health services. A majority of people who were within 2 kilometers of a health care facility had higher utilization than those living beyond 2 kilometers. Although transportation and communication services have been expanding in Nepal, health care access and distance to facilities remain as problems due to geographical conditions (Acharya et al. 2000, Sharma et al. 1990).

Rationale of this study

There are wide disparities in infant mortality rates in different ecological zones of Nepal. It is important to understand the risk factors that may be associated with this disparity to formulate appropriate policies. People living in the Mountain zone have less access to transportation and health care facilities compared to those living in the Hill and Terai zones.

Several studies have evaluated the risk factors and disparities for neonatal mortality in Nepal (Paudel et al. 2013, Nguyen et al. 2013). Information about the disparities in infant mortality in Nepal is limited. Major causes of death for infants are different from those of neonates. In addition to lack of basic newborn care, a range of other factors such as poor knowledge related to disease and health care, increasing cost of services, and inability to reach health care facilities on time due to lack of transportation affect infant survival in developing countries. This study is one of the few that looks primarily at disparities in infant mortality, which may or may not be the same as for neonatal mortality. However, because infant deaths in this study also include neonatal deaths (69%), this study will address some of the common disparities.

Other studies have been conducted to determine the associations between infant mortality in Nepal based on types of residence (rural vs. urban) (Suwal et al. 2001, Thapa et al. 2011) but few studies have investigated variation and risk factors relative to ecological zones of Nepal. Because of the scarcity of research, relatively little is known about the various factors that influence infant mortality rates across the ecological zones. This study aims to fill the gaps in knowledge by evaluating infant mortality in three ecological zones of Nepal. This study also evaluates multiple

potential confounders in the association between ecological zone and infant mortality, including age of mother at first birth, education of mother, total children ever born, birth interval, size of birth, gender of baby, types of residence, maternal occupation, gender of head of household and perceived distance to health care facility.

This study seeks to build a better understanding of infant mortality across different ecological zones of Nepal. Based on the findings, policy makers will be able to focus efforts to reduce infant mortality in the ecological zones of Nepal, particularly the Mountain zone.

OBJECTIVES

Overall Aims

The overall aim of the study is to explain the differences in IMR among the ecologic zones in Nepal.

Specific Objectives

The specific objectives of the study were:

1. To examine the association between ecological zones and infant mortality in Nepal.
2. To assess the effect of perceived distance to health facility on the association between ecological zones and infant mortality in Nepal.

METHODS

Nepal Demographic and Health Survey (NDHS) Data

The data employed in this study are from the Nepal Demographic and Health Survey (NDHS) 2011, a 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. The 2011 NDHS was a five-year project to assist institutions in Nepal in collecting and analyzing data. This was carried out under the aegis of the Population Division of the Ministry of Health and Population of Nepal, technically supported by the international inner city fund (ICF) and financially supported by the United States Agency for International Development (USAID) through its mission in Nepal. The primary purpose of the 2011 NDHS was to provide policymakers with current and reliable information on maternal and child health, infant and child mortality, family planning, fertility preferences, women empowerment, utilization of health services, immunization, nutrition, and knowledge of HIV/AIDS and other sexually transmitted infections in order to plan health services. The 2011 survey for the first time also collected information on various types of domestic violence. In addition to national estimates, the survey provides information by ecological zones, development regions and urban and rural areas.

The study sample was drawn from 75 districts of Nepal, all of which are divided into Village Development Committees (VDCs) in rural areas and municipalities in urban areas. VDCs and municipalities are further sub-divided into wards. A ward in Nepal is a political division. Nine wards make up a VDC. In urban areas, larger wards are divided into sub-wards. The primary sampling unit (PSU) for the 2011 NDHS was an enumeration area (EA). An EA was defined as a

ward in rural areas and sub-ward in urban areas. The 2011 NDHS used the updated sampling frame developed by the Central Bureau of Statistics for the 2001 Population Census, which used a list of EA's with population and household information. The updated sampling frame took into account population growth and mass internal and external migration in 10-year period.

The sample selection for the survey was based on a stratified two-stage cluster sample design. Stratification was done by cross-classification of three horizontal ecological zones and five vertical development regions (eastern, central, western, mid-western and far-western), resulting in 15 eco-development regions also known as domains. Further, due to small sample size in the Mountain zones, the Western, Mid-western and Far-western Mountain zones were combined into one stratum, resulting in 13 domains.

In the first stage of sampling, the number of EA's in each domain was selected with probabilities proportional to the size of the EA. To achieve the target sample size in each domain, selection of EAs in the urban and rural areas was in the ratio of 1 urban to 2 rural EAs yielding 289 PSUs (95 in urban areas and 194 in rural areas).

In the second stage, 35 households in each selected urban EA and 40 households in each selected rural EA were randomly selected. Interviews were completed for 10,826 households, which included 12,674 women age 15-49 in all selected households and 4,121 men age 15-49 in every second household. Response rate was 99 % and 95% respectively. The unit of analysis in present study was infants who were born to women in the sample within the five-year period preceding the survey (n=5,306).

Data Availability

The NDHS 2011 is a publicly available data source. 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 reviewed this study and considered it exempt from human subjects review because it used only publically available data.

Study Variables

The variables used in this study were constructed from responses to specific items in the NDHS files.

Dependent Variable

Infant Mortality Rate: Number of infant deaths within the first year of life occurring in the five years preceding the NDHS survey divided by the number of births reported during the same five-years.

Independent Variables

Ecological zone: Mountain, Hill and Terai

Other variables:

Types of residence: Urban and Rural- Urban areas classified as large cities (capital cities and cities with over 1 million population), small cities (population over 50,000) and towns (other urban areas), and all Rural areas assumed to be countryside

Development region: Eastern, Central and Western- Mid-western and Far-western combined to form Western

Wealth Index: Poor, Middle and Rich- A composite measure of a household's cumulative living standard based on household's ownership of selected assets, such as televisions and bicycles; the materials used for housing construction and types of water access and sanitation facilities.

Religion: Hindu, Buddhist, Muslim and Kirat/Christian

Ethnicity: Brahmin/Chhetri, Newar, Janajati, Dalit and Other

Sex of household head: Male and Female

Distance to health facility: Respondents were asked to indicate whether distance to a health facility was a "big problem" or "not a big problem"

Mother's age at first birth: < 20 years and \geq 20 years

Mother's education: No education, Primary, Secondary and Higher education

Total children ever born: \leq 4 children and > 4 children

Employed: All year, Seasonal and Occasional

Sex of the child: Male and Female

Birth interval (time interval between the index child and next oldest): < 2 years, 2 years, 3 years and \geq 4 years

Birth size: Mother's impression of size of the child at birth as Average or Large and Small or

Very Small

Husband's education level: No education, Primary, Secondary, Higher and Don't know

Data Analysis

The variables used were drawn entirely from the children's file (NPKR60dt) of the survey. For analysis, infant mortality (infant death versus non-death) was the dependent variable.

Bivariate analyses (using weighted and unweighted data) were done to describe the distribution of the potential co-variables by ecological zone, using Pearson's chi-square test. Where expected cell counts were less than 5, the Fisher exact test was used. Variables that were significant in bivariate analysis were further analyzed in logistic regression. In addition, IMR's were computed by ecologic zone for each value of the covariate. Test of trend was used to assess trends in IMR in each ecological zone for the full sample and stratified by whether perceived distance to health facility was reported to be a big problem. IMRs and 95% confidence intervals (CIs) were calculated.

Logistic regression was used to assess the association between ecological zones and infant mortality with and without controlling for other variables. These analyses were performed on 1) the whole sample and 2) subsamples where distance to health facilities was considered either to be a "big problem" or "not a big problem". Odds ratios (ORs), 95% confidence intervals (CIs), and p-values for each model were produced.

Data management and analysis was conducted using Stata version 11 (Stata Corporation, College Station, TX, USA). Some of the proportions and rates were weighted for the sampling probabilities, while the rest of the analyses were done without using weighting. Sampling

weights were used to address the complex sampling design of the NDHS survey and to produce representative estimates for Nepal.

RESULTS

In the study sample, the total number of live births in the five years preceding the Nepal Demographic and Health Survey in 2011 was 5,306, of which 237 infants died within the first year of life. The infant mortality rate (IMR) in the sample was 45 deaths per 1000 live births, which is higher than the reported IMR in Nepal (40 deaths per 1000) (CIA 2014).

Table 1 presents the distribution of selected household, maternal, child and paternal descriptive characteristics of the live-born infants in each ecological zone. While 79% of the women in the total sample gave birth in rural areas, 94% of births in the Mountain zone were in rural settings. In the Mountain zone only 7% of the births were among rich women, while 77% of the women giving birth were poor. In the full sample, the greatest proportions of births were among mothers of Hindu religion (85%) followed by Buddhist (8%). The proportion of mothers who perceived distance to health facility as a big problem was greatest among women in the Mountain zone (71%) and least among Terai zone (46%). Birth interval was less than 2 years for 47% of the women in the full sample and did not vary substantially by ecologic zone. Greater proportions of women in the Mountain zone were with no education (57%) compared to the Hill zone (43%) and the Terai zone (45%). A slightly larger proportion of births in the Mountain zone were considered to be small or very small (21%) compared to Terai zone (15%).

Table 1: Distribution of births in the five years preceding the survey 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)
Development region				
• Eastern	323 (31.6)	443 (20.7)	441 (20.5)	1207 (22.7)
• Central	244 (23.9)	346 (16.2)	533 (24.7)	1123 (21.1)
• Western	453 (44.4)	1346 (63)	1177 (54.7)	2976 (56)
Wealth index				
• Poor	789 (77.3)	1355 (63.4)	619 (28.7)	2763 (52)
• Middle	162 (15.8)	254 (11.8)	516 (23.9)	932 (17.5)
• Rich	69 (6.7)	526 (24.6)	1016 (47.2)	1611 (30.3)
Religion				
• Hindu	852 (83.5)	1840 (86.1)	1839 (85.4)	4531 (85.3)
• Buddhist	130 (12.7)	220 (10.3)	60 (2.7)	410 (7.7)
• Muslim	-	9 (0.4)	208 (9.6)	217 (4.0)
• Kirat/Christian	38 (3.7)	66 (3.0)	44 (2.0)	148 (2.7)
Ethnicity				
• Brahmin/Chhetri	514 (50.3)	960 (44.9)	529 (24.5)	2003 (37.7)
• Newar	17 (1.6)	81 (3.7)	33 (1.5)	131 (2.4)
• Janajati	262 (25.6)	678 (31.7)	630 (29.2)	1570 (29.5)
• Dalit	227 (22.2)	388 (18.1)	363 (16.8)	978 (18.4)
• Other	-	28 (1.3)	596 (27.7)	624 (11.7)
Sex of household head				
• Male	784 (76.8)	1537 (71.9)	1645 (76.4)	3966 (74.7)
• Female	236 (23.1)	598 (28.0)	506 (23.5)	1340 (25.2)
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)
Household size (Mean/SD)	5.8 (2.0)	5.8 (2.3)	6.5 (3.3)	6.1 (2.7)
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)
Employed				
• All year	661 (68.0)	1283 (70.4)	469 (37.5)	2413 (59.7)
• Seasonal	291 (29.9)	462 (25.3)	678 (54.2)	1431 (35.4)
• Occasional	19 (1.9)	76 (4.1)	102 (8.1)	97 (4.8)
Child characteristics				
Sex of the child				
• Male	524 (51.3)	1118 (52.3)	1113 (51.7)	2755 (51.9)
• Female	496 (48.6)	1017 (47.6)	1038 (48.2)	2551 (48.0)
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)
Paternal characteristics				
Husband's education level				
• No education	224 (21.9)	377 (17.6)	473 (21.9)	1074 (20.2)
• Primary	294 (28.8)	553 (25.9)	483 (22.4)	1330 (25.0)
• Secondary	407 (39.9)	951 (44.5)	909 (42.2)	2267 (42.7)
• Higher	94 (9.2)	249 (11.6)	268 (12.4)	611 (11.5)
• Don't know	1 (0.09)	5 (0.2)	18 (0.8)	24 (0.4)

IMR, calculated with both weighted and unweighted data, was highest in the Mountain zone followed by the Hill and Terai zones (Table 2). Overall, the Mountain zone had a 42% increased risk of IMR compared to the Terai zone; the Hill zone had a 17% increased risk of IMR compared to Terai zone.

Table 2: Births, number of infant deaths and infant mortality rate in each ecological zone in the five years preceding the survey, Nepal DHS 2006-2011

		No. of live births (%)	No. of Infant death	IMR/1000 (95% CI)	Risk Ratio (Unweighted)
Mountain	Un-weighted	1020 (19.2)	56	54 (40-68)	1.42*
	Weighted	428 (7.9)	25	59 (36-81)	
Hill	Un-weighted	2135 (40.2)	97	45 (36-54)	1.17
	Weighted	2130 (39.5)	95	44 (35-53)	
Terai	Un-weighted	2151 (40.5)	84	39 (30-47)	Ref
	Weighted	2833 (52.5)	115	40 (33-47)	

* P-value of chi-square test statistically significant at 0.05

Comparisons between infant mortality rates in Mountain, Hill and Terai zones for selected background characteristics are presented in Table 3. 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). Sex of the household head was not a significant risk factor for any of the ecological zones. In all ecological zones, women who perceived distance to health facility as a big problem had higher experience of infant mortality compared to women who did not perceive distance as a big problem. Overall, IMR was highest among the women in the Mountain zone who perceived distance as a big problem (63 per 1000). Infant mortality was higher among mothers who were young (<20 years) (48 per 1000) compared to those who were older (39 per 1000). However, in the Mountain zone, IMR was higher among mothers who were ≥ 20 years (62 per 1000) compared to younger mothers (48 per 1000). In the full sample, IMR was higher among infants born to mothers who had no education compared to those with secondary or higher education; in

the Mountain zone, IMR among mothers who had no education was (61 per 1000). For the full sample, IMR did not vary between male and female infants, but in the Mountain zone male infants had a higher IMR (64 per 1000) compared to female infants (44 per 1000). Infants of small or very small birth size were at higher risk of IMR, and the risk for small infants was more pronounced in Terai zone (66 per 1000). Similar to mother's education level, across all ecological zones, infants born to fathers with no education had higher IMR compared to those born to fathers with secondary or higher education.

Table 3: 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	Hill IMR	Terai IMR	Total IMR
Household characteristics				
Residence				
• Urban	-	38	39	36
• Rural	58	47	39	46
Development region				
• Eastern	43	49	34	42
• Central	36	37	45	40
• Western	72	46	38	47
Wealth Index				
• Poor	65	50	35	51
• Middle	24	35	56	45
• Rich	-	38	32	32
Religion				
• Hindu	56	44	41	45
• Buddhist	61	63	-	53
• Muslim	-	-	38	36
• Kirat/Christian	-	15	-	6
Ethnicity				
• Brahmin/Chhetri	64	44	20	43
• Newar	-	49	30	38
• Janajati	41	47	39	43
• Dalit	52	36	49	44
• Other	-	142	48	52
Sex of household head				
• Male	54	45	36	43
• Female	55	45	47	47
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
Employed				
• All year	51	48	25	44
• Seasonal	65	45	44	48
• Occasional	52	39	58	50
Child characteristics				
Sex of the child				
• Male	64	45	37	46
• Female	44	45	40	43
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
Paternal characteristics				
Husband's education level				
• No education	62	58	61	60
• Primary	57	41	49	48
• Secondary	54	46	27	40
• Higher	31	32	22	27
• Don't know	-	-	-	-

Overall, women who perceived the distance to a health facility as a big problem experienced greater risk of infant mortality (51 per 1000) compared to those women who did not perceive distance as a big problem (35 per 1000) (Table 4). The increased risk of infant mortality associated with distance to a health facility was significant (chi-square test) in the Mountain and Hill zones (RR=1.9, $p<0.05$ and RR=1.6, $p<0.05$) but not in the Terai zone (RR=1.1, $p=ns$).

Table 4: Infant mortality rate in ecological zone based on distance to health facility, Nepal DHS 2006-2011 (Unweighted).

			Mountain	Hill	Terai	Total
Distance to health facility	Big problem	N (%)	723 (70.8)	1283 (60)	981 (45.6)	2987 (56.2)
		No of Infant Death	46	68	41	155
		IMR (95% CI)	63 (45-81)	53 (40-65)	41 (29-54)	51 (43-59)
	Not a big problem	N (%)	297 (29.1)	852 (39.9)	1170 (54.3)	2319 (43.7)
		No of Infant Death	10	29	43	82
		IMR (95% CI)	33 (13-54)	34 (21-46)	36 (25-47)	35 (27-42)
Risk Ratio for Infant Mortality (Big problem/Not a big problem)			1.9*	1.6*	1.1	1.5

* P-value of chi-square test statistically significant at 0.05

The underlying pattern of IMR in each ecological zone based on perceived distance to health facility is displayed in Figure 1. In the total sample and in each ecological zone, the IMR was consistently higher for women who perceived distance to health facility as a big problem, especially in the Mountain zone (Chi-square for trend=0.04). The IMR's among women who did not perceive distance as a big problem were similar in the three ecological zones (Chi-square for trend=0.73).

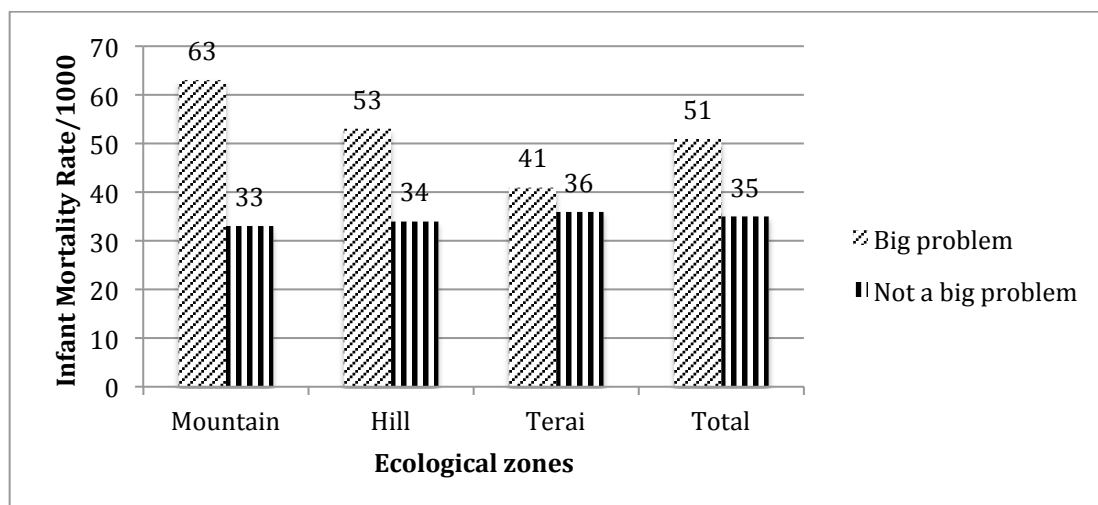


Figure 1. Infant mortality rate in different ecological zones based on perceived distance to health facility

The logistic regression model results are presented in Table 5. 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). Similarly, infants born to women who perceived distance to a health facility as 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).

Table 5: Unadjusted association between infant mortality and selected covariates using logistic regression; odds ratios (ORs), 95% confidence intervals (CIs) and p-values are shown.

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

* P-value statistically significant at 0.05

The association between ecological zone and infant mortality was analyzed by logistic regression for women who did and did not perceive distance to health facility as a big problem, without (Table 6) and with (Table 7) adjustment for covariates. 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 where distance to health care facilities was not considered to be a big problem. These results persisted after adjustment for potential confounders.

Table 6: Unadjusted associations ecological zones and infant mortality by distance to health facility. Odds ratios (ORs), 95% confidence intervals (CIs) and p-values are shown.

Ecological zone	Distance to health facility			
	Big problem		Not a big problem	
	OR (95% CI)	p value	OR (95% CI)	p value
Terai	Ref		Ref	
Hill	1.28 (0.86-1.90)	0.21	0.92 (0.57-1.49)	0.74
Mountain	1.55 (1.01-2.40)	0.04*	0.91 (0.45-1.83)	0.79

* P value statistically significant at 5%.

Table 7: Associations between ecological zones and infant mortality by distance to health facility adjusted for selected maternal and child covariates.

Ecological zone	Distance to health facility			
	Big problem		Not a big problem	
	aOR (95% CI)	p value	aOR (95% CI)	p value
Terai	Ref		Ref	
Hill	1.29 (0.80-1.93)	0.20	0.92 (0.56-1.50)	0.74
Mountain	1.57 (1.01-2.40)	0.04*	0.75 (0.37-1.55)	0.44

* Adjusted for mother's age at first birth, mother's education, total children ever born, birth interval, birth size.

DISCUSSION

This study aimed to examine the influence of ecological zone (Mountain, Hill and Terai) on infant mortality in Nepal. Study results demonstrated that infant mortality was substantially higher among women living in the Mountain zone compared to those in the Hill and Terai zones. In all 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. The risk of infant mortality in the Mountain zone relative to the other zones was statistically significant among women who perceived distance to a health facility as a problem, even after adjusting for possible confounders (including mother's age at first birth, mother's education, total children ever born, birth interval and birth size). However, residence in the Mountain zone was not associated with increased risk of infant mortality among women who did not perceive distance to a health facility as a big problem. Furthermore, because a significantly higher proportion of births in the Mountain zone occur where distance to health care facilities is considered to be a big problem, the differential of IMR is compounded. This emphasizes the importance of accessibility of health facility for infant survival in Nepal, specifically in the Mountain zone.

Few studies have examined the topographical or regional variation of infant mortality in Nepal. Previous studies have been conducted either in specific districts of Nepal or investigating specific disease conditions as major risk factors for infant mortality (Katz et al. 2003, Shah et al. 2010, Christian et al. 2004). A randomized community trial in the Sarlahi district of Nepal, reported maternal mortality as a strong predictor for infant death at all ages with highest risk in the post-neonatal period (OR=6.43 at 0-7 days, OR=11.73 at 8-28 days and OR=51.68 at 4-24

weeks) (Katz et al. 2003). An observational study in the Mahottari district of Nepal investigated causes of infant deaths and found sepsis to be the major cause (23%), followed by pneumonia (17%) (Shah et al. 2010). Relative to ethnicity, infant deaths were highest among Dalits (65 per 1000 live births) followed by Janajatis (60 per 1000 live births) (Shah et al. 2010).

Results from the NDHS 2011 show wide differentials in infant mortality across the country (MOHP 2012). The IMR for the 10-year period preceding the survey was 73 deaths per 1,000 live births in the Mountain zone and 53 deaths per 1,000 live births in Terai zone (MOHP 2012). A study that investigated spatial patterns of infant and child mortality across Nepal in the different development regions observed increased mortality in the Far-western and Mid-western development regions after accounting for mother and household characteristics (Chin et al. 2011). An earlier study (Gubhaju 1984) showed geographical differences of infant mortality by ecological zones, but no recent studies have looked for variation of infant mortality in Nepal by ecological zone. A study by Atla et al., which is not yet published, evaluated childhood mortality differentials relative to ecological zones.

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 (Chin et al. 2011, Shah et al. 2010). The results of the present study are consistent with a study in Nepal that observed a six percent increased hazard of infant and child death for each 10 km increase in distance to the nearest primary health center and nearest highway (Chin et al. 2011). 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 access basic health care services (Paudel et al.

2012). 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” (Pokharel et al. 2007). Focus group discussions to examine underutilization of health services leading to poor maternal and perinatal outcomes revealed distance as one of the risk factors. Women who perceived distance to health care services as “near” had higher utilization of services (72.4%) compared to those who perceived it to be “far” (27.6%) and experienced 3 times less perinatal mortality (Pokharel et. al 2007). Another study in Mid- and Far-western Nepal, reported that the primary reasons reported by women who did not seek maternal health services were distance to a health facility (45%) and inadequate transportation (21%).

To the best of our knowledge, no other studies have measured the perceived distance to a health facility as a ‘big problem’ and ‘not a big problem’. Individuals have a broad range of perception and attitude towards distance that impacts health outcomes. In the present study, the measure of distance to health facility is a behavioral measure of the perception of mothers. It is the first to report the associations between the perceived distance to a health facility and IMR within ecological zones in Nepal in a nationally representative sample. Understanding the mother’s perception of distance could lead to new approaches to increase health care access.

This study is supported by a previous study in Nepal that assessed relative and absolute inequalities in neonatal mortality by using NDHS 2011 data (Paudel et al. 2013). The results showed inequalities by ecological zone, even though wealth status was the major predictor (Paudel et al. 2013). Those living in the Mountain zone had a 40% increased risk of neonatal mortality compared to those in the Hill zone. Similar to our results, a study by Nguyen et al. (2013) in Nepal, showed inequalities in child mortality by ecological zones disaggregated by urban/rural residence with highest child mortality rates in the Mountain zone.

Residents of the Mountain and Hill zones of Nepal struggle with its geography and lack of infrastructure. A National Health Policy (NHP) was developed in 1991 to address the health of the nation in terms of improved infrastructure for delivery of health care services at the district level and below (Deslich BJ). The policy required addressing the problem of health care access relative to the geography of the zones. There are very few roads in the Mountain and Hill zones and even the roads that exist are in very poor condition. In addition, people usually do not have any means of transportation, which aggravates the problem of reaching a health facility.

In addition to distance, patient sex and ethnicity have previously been found to be significantly associated with access to health care services (Paudel et al. 2012). In our study, sex of household head was not associated with infant mortality in the total sample or when stratified by ecological zones. In the present study, ethnicity was not a predictor of infant mortality. This is likely due to variations in the ethnic distribution of the sample. Some ethnic groups who reside in the Terai zone are not found in the Mountain zone. Further, there can be marked difference in groups who are of the same ethnicity but in different ecological zones (for example, Hill Brahmin and Terai Brahmin), and this may have contributed to inconsistent patterns.

The present study also did not show a consistent effect of socio-economic status on infant mortality. A possible explanation may be the variables used for measuring wealth status of the household. This study used 'wealth quintile' of the household, which was based on available data on household ownership of 33 selected assets and housing characteristics. These assets may not be appropriate to capture the wealth status in the context of Nepal, as there is no clear demarcation to separate very rich from rich and very poor from poor, especially in remote Mountain and Hill zones.

Previous studies in Nepal have reported that mother's age, mother's education, sex of child, number of children ever born, religion, previous birth interval and types of birth were significant predictors of infant mortality (Adhikari et al. 2011). 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 preventives measures and have more personal autonomy. Mothers who had more than four children were more likely to experience infant mortality as compared to those who had four or less children. This could be because families have to share limited resources between an increasing numbers of people, leading to insufficient nutrition for the new member.

Sex of the infant did not show a significant difference in infant mortality in our study; however, male infants appeared to be disadvantaged relative to female infants in the Mountain zone where the excess risk of male mortality was 45 percent. Male disadvantage in mortality is evident in most countries and for all ages, but the magnitude varies depending on social, environmental and economic conditions (Drevenstedt et al. 2008). An Ethiopian study reported 38% higher risk of dying during the neonatal period among male children than females (Mekonnen et al. 2013). These differences may be explained by biological factors, as male infants tend to be more vulnerable to infectious diseases as well as harsh climate as compared to females (Drevenstedt et al. 2008). The Mountain zone in Nepal has a poor climate with subzero temperatures which could be a possible explanation of the higher infant mortality among males.

Similar to other studies, this study also found an increase in infant mortality with decreasing birth interval. A study in Nepal reported significantly higher infant mortality among those who had birth intervals of less than a two year (62 per 1000 live births) compared to those who had 4 or more years of interval between births (27 per 1000 live births) (Adhikari et al. 2011).

Pregnancies occurring in short intervals may result in poor outcome of infants such as low-birth weight, preterm delivery, and small for gestational age, which eventually increases the likelihood of death.

STRENGTHS AND LIMITATIONS

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 (Corsi et al. 2012). Several components of the survey were tailored to the characteristics of Nepal, which made the comparison between ecological zones possible. This study had a number of important social and demographic variables for households, women, children and men to assess their individual effect on infant mortality.

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. For example, women who have lost an infant may be more likely to report that distance to a health facility is a big problem. 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. Further, the effect of distance on infant mortality cannot be generalized to other settings because individuals may have very different interpretation of “perceived distance” depending on the access and geography. For analyzing data, we were restricted to limited variables in the survey; hence this study could not evaluate some important variables of interest (health practices, causes of death). Many other

variables of interest (immunization, breast-feeding status) were not used due to missing values in the survey.

CONCLUSION

Infant death is determined by many complex factors, which include individual risks, cultural characteristics, geographical barriers, socioeconomic factors and environmental factors. This study identified variation of infant mortality by ecological zone and the importance of geographical access to a health facility, particularly in the Mountain zone of Nepal. In remote zones of Nepal where people have to walk for hours and sometimes days to reach the nearest health facility to receive basic health care, distance to health care facilities is an issue of utmost importance. In order to reduce infant mortality further, there is need for interventions that would address the problem of lack of local facilities, lack of roads, unavailability of transportation, and long distances from the settlements to the nearest clinic. Policy makers need to prioritize the needs of communities and form a policy to implement programs that will provide equitable delivery of health services at the national level. Further, this study suggests that more research is needed to understand the role of distance in the risk of infant mortality.

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