

MEDICAL COST AND OUT-OF-POCKET EXPENDITURE FOR PRETERM INFANTS: EVIDENCE FROM VIETNAM

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Abstract

Background The large health costs associated with preterm births have been well documented in high income countries. Relatively little data on this issue is currently available from developing countries. The aim of this study was to assess private and public costs associated with preterm births in Vietnam. **Methods** This cross-sectional study used medical and financial data from one provincial and one national hospital in Vietnam. Cost data for all infants discharged from the two hospitals in 2017 was collected and analyzed. **Results** Average total medical cost per child was USD 1643.52 in the national hospital and USD 668.94 in the provincial hospital. Mean medical out-of-pocket expenditure was USD 60 at the national hospital. No medical out-of-pocket expenditure was reported at the provincial hospital when parents complied with national health insurance policies. Substantial out-of-pocket expenditure was incurred by those who bypassed lower-level facilities. Parents seeking care at specialized hospitals without medical authorization paid on average an additional USD 240, which equates to 111% of the average monthly wage in Vietnam. **Conclusions** This study suggests that the average medical costs of preterm infants in Vietnam are substantial. The average co-payment for families who complied with national health insurance policy was USD 39. The average out-of-pocket costs of preterm infants who bypassed lower-level facilities without referral authorization were about six times higher than those of infants who had a proper transfer.

Background

According to World Health Organization, 15 million infants are born prematurely worldwide every year (1). Preterm birth, which is defined as childbirth occurring at less than 37 completed weeks of gestation, is a leading cause of death in children under 5 years in low and middle income countries, and a major determinant of neonatal mortality and morbidity globally (1). Children born prematurely have higher rates of cerebral palsy, sensory deficits, learning disabilities and respiratory illnesses compared with children born at term (1). The morbidities associated with preterm birth often extend to later life, resulting in considerable physical, psychological, economic and social costs (1).

There is a large literature dedicated to understanding the health costs associated with preterm births in high income settings. A systematic review of US data suggested an average cost of USD 203k for preterm infants born at 25 weeks of gestation, and costs between USD 70k and 100k for gestational ages <27 weeks (2). Evidence from the UK suggests that compared to the full-term group, extreme preterm infants generated an additional societal cost of GBP 5658 over a 12-month follow-up period (3). Health service costs for preterm infants generally decrease with gestational age and birth weight, but this also depend on length of stay at health facilities as well as on the number of surgical procedures and respiratory treatments received by the infant (4-7).

Only few studies relating to preterm births have been published on Vietnam. A prospective cohort study of 1709 women identified physically demanding work during pregnancy as well as intrauterine device removal less than 12 months before the current pregnancy as primary risk factors for a preterm birth (8). A cross-sectional study from Dong Anh District in 2014-2015 also found that with antenatal depression, employment in the agricultural sector and domestic violence were associated with an increased risk of preterm birth (9).

From a health system perspective, Vietnam is an interesting setting to study the cost of preterm births. Even though all clinical expenditure incurred by preterm infants should be covered by the national health insurance in principle, this is not always the case in practice for two reasons: Firstly, health insurance will only cover 100% of the clinical cost at higher-level facilities – where most premature babies are treated – if the child is referred to these tertiary hospitals by lower-level facility staff. Given that the perceived quality of care is higher at tertiary hospitals, bypassing lower level facilities is relatively common, and may result in substantial out-of-pocket expenditure if tertiary care is not approved by the physicians in charge. Secondly, out-of-pocket payments may also arise when hospitals (specifically specialized hospitals) administer drugs or provide services which are not covered by the national health insurance. To assess the total cost of preterm infant treatment, as well as the financial contribution made by families, we worked together with both a provincial and a national Hospital in Vietnam in 2017, and extracted all medical and financial records for preterm infants treated in this period.

Methods

Study design

This is a retrospective study that used secondary medical and financial data extracted from Vietnam National Children's Hospital and Thanh Hoa Provincial Pediatric Hospital.

Health system settings

Vietnam's public healthcare system is divided into four administrative levels: The first level is the central or national level (Level I); the second level is the provincial level (Level II), the third level is district level (Level III), and the fourth level is the communal level (Level IV).

Level I facilities include national general and specialized hospitals, national research institutes, training institutions, pharmaceutical companies. These facilities are mostly located in large cities and subordinate to the Ministry of Health (MOH). At the central level, the MOH is also responsible for formulating and executing health policies and programs for the entire country.

Level II facilities includes municipal and provincial hospitals, including general hospitals and specialized hospitals such as pediatric hospitals, obstetrics and gynecology hospitals, hospitals of ophthalmology, and other specialized health centers such as preventive medicine centers and mother and child's health protection centers.

Level III facilities include district general hospitals responsible for curative services and preventive medicine defined in the national preventive program guidelines. Some rural areas have one or more polyclinics that operate under the guidance of the district hospital. These clinics mainly provide basic curative care for people living in communes of the districts.

Level IV facilities mostly include Community Health Centers (CHCs) that are responsible for primary curative and preventive care as well as implementation of national health programs, including maternal and child healthcare programs. Within CHCs, village health workers provide health information, education, and communication. They also provide first aid and care for common diseases, implement family planning, and other national health programs.

Under Vietnamese health insurance law (2009), all children under six years of age are automatically covered by national health insurance. In principle, this insurance covers all costs associated with premature births as long as parents seek treatment at their assigned facilities, and do not seek specialized (hospital) treatment without obtaining prior approval and referral from a basic health facility.

If a child is born prematurely, it is usually transferred from the delivery room to the pediatric ward for intensive care right after birth. Depending on the child health status, children may – upon consultation with the parents – be transferred to specialized hospitals. In such circumstances, preterm infants born in a community health center or district hospital are typically transferred to the provincial pediatric hospital. From a provincial pediatric hospital, children with several severe health conditions may be referred to the National Children's Hospital.

Study setting

All data analyzed in this study were collected from two large hospitals in Vietnam. Despite major efforts to reduce neonatal mortality, in 2015, 12 per 1000 live births died during the neonatal period in Vietnam (10). Preterm birth complication have remained a leading cause of neonatal deaths (41%, 2015); with 9% of all infants born before 37 weeks of gestation (11).

Two hospitals were purposively sampled for this study: Vietnam National Children's Hospital (VNCH) and Thanh Hoa Pediatric Hospital. Thanh Hoa Pediatric Hospital is a provincial hospital (second level) and the only public pediatric hospital in Thanh

Hoa Province. As such, it is responsible for the treatment of all children with severe health problems in the province. The province comprises 24 districts, 1 town, 2 cities, and a total population of 3.5 million inhabitants (12). The area is environmentally heterogeneous including lowlands, mountains, and seaside areas. It also has a whole range of economic sectors such as agriculture, forestry, fishery, tourism, and an industrial center (12).

Vietnam National Children's Hospital is a national hospital (the first level) located in Hanoi City. It is a primary referral hospital for all 38 provinces of northern Vietnam, as well as a center for research, teaching, and postgraduate training in newborn diseases. As the largest pediatric hospital in northern Vietnam, the Neonatal Care Unit of the hospital is responsible for the treatment and care of all premature infants and newborns referred from lower-level facilities for specialized care. This covers a total population of 43.2 million people.

Participants

A preterm child in this study was defined as an infant born alive before 37 weeks of gestation. We defined our target population as all infants discharged from the two hospitals between 1 January and 31 December 2017.

Sample size and sampling method

The records for all preterm infants (n=261) discharged from the Neonatal Care Unit of Thanh Hoa Pediatric Hospital in 2017 were selected. Due to the large number of cases, a random sample of infants (n=500) was selected from all those discharged from the Neonatal Care Unit at the National Children's Hospital (n=800) during 2017. This n=500 target was chosen in order to be able to detect a mean difference in total cost between the two hospitals of at least 25% of the standard deviation of individual total costs with 90% power.

Variables

Outcome variables: The primary outcome variable was the total numerical medical cost. All cost data were extracted from the hospital records and converted to USD using an exchange rate of 1 USD=23.245 Vietnamese Dong (VND) (2018).

Total direct medical costs were defined as the total amount invoiced by a hospital after the child was discharged from the hospital. The total direct medical cost was then divided into cost paid by national health insurance and the out-of-pocket cost paid by parents.

Covariates: Social-demographic and clinical characteristics of premature infants were extracted from the hospital records. These included: gender (male, female), ethnicity (Kinh, others), place of residence (urban, rural), length of stay (<14 days, 15-29 days, >30 days), weight at birth (>2500g, 2499-1500g, 1499-1000g, <1000g), gestational age (32-37 weeks, 28-31 weeks, <28 weeks), place of referral (health facility, home), transfer type (proper transfer, improper transfer), and referral type (from home to Thanh Hoa Pediatric Hospital, from health facility to Thanh Hoa Pediatric Hospital, from home to Vietnam National Children's Hospital, and from health facility to Vietnam National Children's Hospital).

Statistical analysis

Firstly, detailed statistics on total direct medical cost as well as costs per service category were generated. Secondly, we estimated the relative cost of being referred to a national rather than a provincial hospital for treatment using a series of linear regression models. We first quantified the average cost differences between the provincial and the national hospital including and excluding child characteristics. The main independent variable of interest was a dichotomous variable for the child being treated at the national hospital, using the provincial hospital as a reference. In the adjusted model, we included the following covariates to account for potential differences in medical need: gender, ethnicity, place of residence, weight, and length of stay.

Thirdly, we further divided the sample into four types of basic health system trajectories: 1. Infants' families seeking care directly (without prior referral from level III or IV) at Thanh Hoa Pediatric Hospital; 2. Infants referred from a local health facility to Thanh Hoa Pediatric Hospital; 3. Infants' families seeking care directly at Vietnam National Children's Hospital; and 4. Infants referred from lower-level health facilities to Vietnam National Children's Hospital. Following this, we first estimate unadjusted associations with cost (mean cost differences), and then estimated how large the cost differences were adjusting on observable child characteristics. We used robust variance estimates to adjust for heteroskedasticity of residuals in the linear regression models.

Given that appropriate referrals are critical for reimbursement of out-of-pocket payments by the insurance, we also looked directly at the relationship between transfer type and out-of-pocket expenditure in different referral groups. A transfer was considered as a proper transfer to a higher-level hospital if the child had referral documents from a local registered facility or was admitted to the hospital as an emergency case.

All analyses were performed using the STATA statistical software package (Release 14; College Station, TX: StataCorp LP).

Results

After the data were cleaned, the final sample included 482 infants from the national hospital and 261 records from the provincial hospital. 18 records from the national hospital were excluded from this study due to a lack of necessary information in their medical records. Figures 1 and 2 illustrate the spatial distribution of the 743 preterm infants in our sample.

Figure 1 [see Additional file 1] shows the number of premature infants admitted to Vietnam National Children's Hospital by province. Infants were received from all provinces in the area and 23 infants were from Thanh Hoa province. The largest number was from Hanoi City (120 infants), followed by Nam Dinh Province (35 infants) and Bac Giang Province (27 infants).

Figure 1: Distribution of preterm infants admitted to Neonatal Care Unit of Vietnam National Children's Hospital by province (n=482).

Source: OpenStreetMap. URL: <https://download.geofabrik.de/asia/vietnam.html>

Figure 2 [see Additional file 1] shows the number of premature births by district/town in Thanh Hoa Province. The largest number of premature infants came from Thanh Hoa City (37 infants), followed by Tinh Gia District (18 infants) and Tho Xuan District (18 infants)

Figure 2: Distribution of preterm infants admitted to Thanh Hoa Pediatric Hospital by district/town (n=261).

Source: OpenStreetMap. URL: <https://download.geofabrik.de/asia/vietnam.html>

Table 1 summarizes the main characteristics of study participants. 53.3% of preterm infants were male in the Thanh Hoa Pediatric Hospital and 67% in Vietnam National Children's hospital. Most children belonged to the Kinh ethnic group and resided in urban areas. Gestational age at birth were relatively similar in the two hospitals with about 55% of preterm infants born between week 32 and week 37, and less than 10% of infants were born prior to 28 weeks of gestation. No infant deaths were reported in the Thanh Hoa Pediatric Hospital; 9.8% of infants died in Vietnam National Children's Hospital. With regard to the length of stay in both hospitals, the majority of preterm infants were admitted for less than 14 days of treatment (75.5% in Thanh Hoa Pediatric Hospital and 46.7% in Vietnam National Children's Hospital). Most mothers were in the 20-34 year-old age group (81.6% in Thanh Hoa Pediatric Hospital and 82.8% in Vietnam National Children's Hospital).

Table 2 shows mean values and the proportions for the main cost categories of the two hospitals. Average medical cost was about two and half times higher in the national than in the regional hospital. In the national hospital, bed-days accounted for the largest share of the total cost while in provincial hospital the largest expense was the cost of drugs. The largest relative difference in cost was observed for medical supplies, which were almost 9 times more costly in the national than in the regional hospital.

Table 2: Type of medical direct costs in two hospitals (USD, 2018)

Table 3 shows a first set of regression results for total and out-of-pocket costs. As already seen in Table 2, average total cost per child was substantially higher at the national hospital. Compared to the provincial hospital, the average additional cost per child at the national hospital was USD 974.6 (95% CI: USD 810.8, USD 1139; $P < 0.001$). After controlling for the child covariates displayed in Table 1, the estimated difference declined to USD 471.1 (95% CI: USD 322.1, USD 620.1; $P < 0.001$). The primary cost-factor differing between the two hospitals was the average duration of stay (as already visible in Table 1), which accounted for about 50% of the drop between unadjusted and adjusted differences.

Columns 3 and 4 show differences for out-of-pocket expenditures. Rather remarkably, no (zero) out-of-pocket expenditure was reported for the provincial hospital. Therefore, the estimated unadjusted difference of USD 64.6 (95% CI: USD 57.9, 71.4, $P < 0.001$) directly corresponds to the average out-of-pocket expenditure for the national hospital. When we adjusted for child differences, this difference lowered to USD 48.8 (95% CI: USD 41.8, USD 55.7; $P < 0.001$). Ethnicity, remoteness and length of stay had a significant impact on out-of-pocket costs. The Kinh ethnic group was also associated with an average out-of-pocket expenditure increase of USD 12.9 (95% CI: 21, 4.9; $P < 0.05$). Residing in a rural area was associated with an increase of USD 13.3 (95% CI: 3.8, 22.8; $P < 0.05$) compared to urban areas. Stays of more than 30 days were on average associated with an out-of-pocket expenditure increase of USD 82.7 (95% CI: 66, 99.3; $P < 0.05$) compared to stays of less than 14 days.

Regarding point of referral, 47 infants came from home and 214 babies were transferred from a health facility to Thanh Hoa Pediatric Hospital. Of the referred to the national hospital, 43 infants came directly from home, and 439 infants were transferred from other facilities. Table 4 shows regression results for total costs and out-of-pocket costs by referral group.

Column 2 of Table 4 shows that the average total cost per infant transferred from a health facility to Thanh Hoa Pediatric Hospital was USD 262.5 (95% CI: 0.8, 524.1; $P < 0.05$) higher than those infants coming from home to Thanh Hoa Pediatric Hospital. The average total cost per infant seeking care directly from home to Vietnam National Children's Hospital, and those transferred from health facilities increased by USD 561 (95% CI: 61, 1061; $p < 0.005$) and USD 1252 (95% CI: 971.7, 1532.4; $P < 0.001$) respectively, compared to those coming from home to Thanh Hoa Pediatric Hospital.

After controlling for child characteristics, the total costs of infants transferred from a health facility to Vietnam National Children's Hospital were still the highest and generated an adjusted difference of USD 662 (95% CI: 455.1, 868.8; $P < 0.001$) in comparison with infants seeking care from home at Thanh Hoa Pediatric Hospital. The adjusted differences for the group of infants coming from home to Vietnam National Children's Hospital and infants transferred from health facilities to Thanh Hoa Pediatric Hospital were USD 376 (95% CI: 36.1, 716; $p < 0.005$), and USD 198.4 (95% CI: 6.6, 390.3; $P < 0.05$) respectively.

Results from the regression models for out-of-pocket costs are presented in Column 3 and 4 of Table 4. Adjusting for other covariates, families of preterm infants coming from home to Vietnam National Children's Hospital paid an average of USD 75.1 as out-of-pocket costs (95% CI: 41.5, 108.7; $p < 0.005$) and families with babies referred from a health facility to Vietnam National Children's Hospital paid an average of USD 47.2 in out-of-pocket expenditure (95% CI: 37.8, 56.6; $P < 0.001$) more than families of infants seeking care directly from home to Thanh Hoa Pediatric Hospital.

Ethnicity, place of residence, and length of stay displayed statistically significant associations with out-of-pocket costs. The Kinh ethnic group was also associated with an average out-of-pocket expenditure increase of USD 11.9 (95% CI: 19.8, 4; $P < 0.05$). Residing in rural areas was associated with greater out-of-pocket costs (USD 15.9; 95% CI: 5.7, 26.1; $P < 0.05$) compared to urban areas. In comparison with stays of less than 14 days, stays between 15-29 days and lasting longer than 30 days increased out-of-pocket costs by an average of USD 10.4 (95% CI: 2.3, 18.4; $P < 0.05$), and USD 84.6 (95% CI: 68, 101.2; $P < 0.05$) respectively.

Out of a total of 482 preterm infants admitted to the national hospital, 440 cases were referred from a lower-level health facility to national hospital and 42 infants were seeking care directly from home to the hospital.

Figures 3a [see Additional file 1] shows the out-of-pocket costs of preterm babies transferred from home to Vietnam National Children's Hospital by transfer type. Of the 42 infants who came from home to the national hospital, 8 cases were classified as

improper and 34 cases as proper. The average out-of-pocket expenditure for the improper group was USD 214.3 which was significantly higher than proper group whose average expenditure was USD 42.9 for cases classified as proper (p-value <0.001).

Figure 3a: Out-of-pocket costs for preterm infants transferred from home to Vietnam National Children's Hospital by transfer classification (number of proper cases: 42; number of improper cases: 8)

As seen in Figure 3b [see Additional file 1], of the 440 cases transferred from a health facility to Vietnam National Children's Hospital, only 3 cases were classified as improper. The average of out-of-pocket costs in the improper group was USD 307, compared to an average expenditure of USD 61.9 for the 437 cases who were transferred appropriately (p-value <0.001).

Figure 3b: Out-of-pocket costs for preterm infants transferred from a health facility to Vietnam National Children's Hospital by transfer classification (number of proper cases: 437; number of improper cases: 3)

Discussion

Preterm birth does not only constitute a major medical challenge (13, 14), but it is also a potential threat for the immediate, short- and long-term physical, emotional and financial wellbeing of infants and their families. As we have shown in this study, preterm births also constitute a considerable financial burden to the health system. Our study has yielded several key findings.

Firstly, it is apparent from the literature and from our own findings that the primary driver of cost is gestational age. Infants born very prematurely require intensive care and tend to stay considerably longer in hospital (5, 7, 15-18). Secondly, and more importantly, from a health system perspective, the location of treatment appears to have major implications for both total and out-of-pocket expenditure. Mean total cost per child at the national hospital level was two and a half times higher than the mean cost observed at the provincial hospital. About 50% of the difference was directly attributable to observable child characteristics, with higher average hospital stays for children treated in the national hospital. The remaining additional cost is likely to reflect both a larger number of tests, treatments and services delivered at a higher cost per unit charged by the national hospital. This is even more apparent if you examine the average cost per bed-day by each hospital. In the provincial hospital, an average of USD 14.3 was charged per bed-day, while USD 23.6 was the average price per bed-day at the national hospital. This should not be taken as evidence that the national hospital is overcharging patients, but likely reflects differences in staffing, equipment, and general infrastructure costs at the higher-level facilities that need to be covered in order to be able to provide appropriate, high quality treatment for severe conditions.

This difference in cost is directly related to our third point. Our results suggest that the Vietnamese system is set up to provide relatively strong incentives for individuals to seek treatment at lower-level facilities prior to seeking care at provincial and national hospitals. According to Vietnam Health Insurance Law, children under 6 years old in Vietnam are fully covered by the national public health insurance as long as they are admitted in accordance with the correct procedure to public hospitals (19). Proper admission into the health system requires that patients either arrive at higher-level hospitals with the appropriate referral order from a lower-level provider or as emergency case. While the classification of an emergency case may not always be obvious, health providers do clearly assess some transfers as inappropriate and higher co-payment. In our sample, the average additional co-payment borne out of an improper referral was about USD 240, which equates to 111% of the average monthly wage (2018) (20).

This study had several limitations. Firstly, the study was conducted in only two hospitals. While these hospitals were purposely chosen to represent level I and level II facilities, they may not necessarily be representative of all hospitals of a similar level in the country. Secondly, we were not able to capture the additional medical costs families may have incurred prior to being admitted to our study hospitals. Such costs could for example include direct medical costs in local hospitals such as physician charges and other professional fees. Our study also showed that preterm infants spent an average of 11 days and 9 days in lower-level health facilities or at home before they were admitted to Thanh Hoa Pediatric Hospital and the national hospital respectively. Applying the daily rate of 14.3 dollars seen at the provincial hospital, this would equal an additional cost of bed-days of USD 157.3 and USD 128.7 respectively. Future studies utilizing additional data sets linking hospital discharge with other databases which include vital statistics such as outpatient care, could provide a more detailed picture of these costs. Lastly, our

study did not attempt to measure the indirect costs of premature birth including the cost of transport, accommodation, food, and days of work. It also did not attempt to quantify the social, psychological, or emotional costs to mothers and families.

Conclusion

The results presented in this study suggest that the average medical costs of preterm infants in Vietnam are substantial for the health system overall. Families complying with national health insurance policies seem to be relatively well protected from these (often very high) costs, with an average co-payment was USD 39 for families who complied with national health insurance guidelines. Out-of-pocket costs were about six times higher for parents who bypassed lower-level facilities without acquiring the appropriate authorization.

Abbreviations

MOH: Ministry of Health; CHCs: Community Health Centers

Declarations

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Availability of data and materials

The datasets analyzed for this study are not publicly available due to given approval limited to use for this study only but are available from the corresponding author on reasonable request.

Authors' contributions

TBAN contributed to developing the research question, conducting the data collection, data analysis, and drafting and revising the manuscript. PMH carried out data collection, provided inputs for manuscript, and commented for the manuscript. PHP participated in field supervision, data collection, and provided comments for the manuscript. PVE participated in editing and providing comments for the manuscript. GF contributed to advising on the statistical analysis, editing and providing comments for manuscript. All authors contributed in the development, review and approval of the final manuscript.

Ethics approval and consent to participate

The study was approved by the Ethical Committee of the Vietnam National Children's Hospital Institute

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests

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Tables

Table 1: Social-demographic and clinical characteristics of study participants

Characteristics	Total	Thanh Hoa Pediatric Hospital		National Children's Hospital	
		n=261	N	%	N
Gender					
Male	462	139	53.3	323	67
Female	281	122	46.7	159	33
Ethnicity					
Kinh	674	230	88.1	444	92.1
Others	69	31	11.9	38	7.9
Place of residence					
Urban	163	40	15.3	123	25.5
Rural	580	221	84.7	359	74.5
Gestational age					
32-37 weeks	410	147	56.3	263	54.6
28-31 weeks	272	90	34.5	182	37.8
<28 weeks	61	24	9.2	37	7.6
Weight at birth					
>=2500g	61	12	4.6	49	10.2
2499-1500g	422	166	63.6	256	53.1
1000-1499g	202	63	24.1	139	28.8
<1000g	58	20	7.7	38	7.9
Death					
No	696	261	100	435	90.2
Yes	47	0	0	47	9.8
Length of stay					
<14 days	422	197	75.5	225	46.7
15-29 days	193	52	19.9	141	29.2
>30 days	128	12	4.6	116	24.1
Referral type					

From home to Thanh Hoa Pediatric Hospital	45	45	17.2	0	0
From health facility to Thanh Hoa Pediatric Hospital	216	216	82.8	0	0
From home to National Children's Hospital	42	0	0	42	8.7
From health facility to National Children's Hospital	440	0	0	440	91.3
Place of referral					
Health facility	656	216	82.8	440	91.3
Home	87	45	17.2	42	8.7
Transfer type					
Proper	732	261	100	471	97.7
Improper	11	0	0	11	2.3
Mother's age					
<20 years old	53	25	9.6	28	5.8
20-34 years old	612	213	81.6	399	82.8
>35 years old	78	23	8.8	55	11.4

Table 2: Type of medical direct costs in two hospitals (USD, 2018)

Type of costs	Thanh Hoa Pediatric Hospital. n=261, mean (%)	Vietnam National Children's Hospital. n=482, mean (%)
Total cost	668.9	1643.5
Cost of bed-days	159.1 (23.8%)	515.1 (31.4%)
Cost of laboratory tests	94.1 (14.1%)	201.1 (12.2%)
Cost of surgery	119.4 (17.9%)	403.9 (24.6%)
Cost of medical supplies	18.9 (2.8%)	158.4 (9.6%)
Cost of drugs	249.9 (37.3%)	328.4 (20%)
Other costs	27.59 (4.1%)	36.64 (2.2%)

Table 3: Social-demographic and clinical characteristics predicting medical direct cost (USD, 2018)

Characteristics	Total cost				Out-of-pocket cost			
	Unadjusted	P	Adjusted	P	Unadjusted	P	Adjusted	P
	Regression		Regression		Regression		Regression	
	Coefficient		Coefficient		Coefficient		Coefficient	
	(95% CI)		(95% CI)		(95% CI)		(95% CI)	
	(1)		(2)		(3)		(4)	
Hospital								
Thanh Hoa	(ref)		(ref)		(ref)		ref)	
Pediatric								
Hospital								
Vietnam	974.6	<0.001	471.1	<0.001	64.6	<0.001	48.8	<0.001
National	(810.8-		(322.1;		(57.9; 71.4)		(41.8;	
Children's	1139)		620.1)				55.7)	
Hospital								
Gender								
Male			(ref)				(ref)	
Female			-66.7	0.428			-1.8	0.634
			(-231.8; 98.4)				(-9.1; 5.5)	
Ethnicity								
Kinh			(ref)				(ref)	
Others			53.4	0.683			-12.9	0.002*
			(-202.9;				(-21; -4.9)	
			309.8)					
Place of residence								
Urban			(ref)				(ref)	
Rural			165	0.081			13.3	0.006*
			(-20.2; 350.1)				(3.8; 22.8)	
Length of stay								
<14 days			(ref)				(ref)	
15-29			737.9	<0.001			9.4	0.025*

days	(566.7; 909.1)			(1.2; 17.6)	
>30 days	2323	<0.001		82.7	<0.001
	(1982.8; 2663.2)			(66; 99.3)	
Weight					
>2500g	(ref)			(ref)	
1500- 2499g	102.1	0.391		5.28	0.607
	(-131.6; 335.9)			(-14.8; 25.4)	
1000- 1499g	32.7	0.815		0.5	0.960
	(-241.1; 306.6)			(-20.8; 21.9)	
<1000g	599.89	0.002		22	0.089
	(224; 975.7)			(-3.3; 47.3)	

Ref: Reference group

***:** P<0.05

Table 4: Transfer groups predicting medical direct cost (USD, 2018)

Characteristics	Total cost				Out-of-pocket cost			
	Unadjusted Regression Coefficient (95% CI) (1)	P	Adjusted Regression Coefficient (95% CI) (2)	P	Unadjusted Regression Coefficient (95% CI) (3)	P	Adjusted Regression Coefficient (95% CI) (4)	P
Transfer groups								
From home to Thanh Hoa	(Ref)		(Ref)		(Ref)		(Ref)	
Pediatric Hospital								
From health facility to Thanh Hoa	262.5 (0.8; 524.1)	0.045	198.4 (6.6; 390.3)	0.043	0		1.3 (-6.1; 8.7)	0.737
Pediatric Hospital								
From home to National Children's Hospital	561 (61; 1061)	0.033	376 (36.1; 716)	0.03	75.6 (42.1; 109.1)	<0.001	75.1 (41.5; 108.7)	<0.001
From health facility to National Children's Hospital	1252 (971.6; 1532.4)	<0.001	662 (455.1; 868.8)	<0.001	63.6 (56.8; 70.4)	<0.001	47.2 (37.8; 56.6)	<0.001
Gender								
Male			(Ref)				(Ref)	
Female			-75.4 (-239.7; 88.9)	0.368			-1.2 (-8.5; 6)	0.736

Ethnicity					
	Kinh	(Ref)		(Ref)	
	Others	35.2	0.788	-11.9	0.003*
		(-221.3;		(-19.8; -4)	
		291.8)			
Place of residence					
	Urban	(Ref)		(Ref)	
	Rural	140	0.144	15.9	0.002*
		(-47.9;		(5.7; 26.1)	
		328)			
Length of stay					
	<14 days	(Ref)		(Ref)	
	15-29 days	719.8	<0.001	10.4	0.012*
		(547.8;		(2.3; 18.4)	
		891.7)			
	>30 days	2305	<0.001	84.6	0.012*
		(1959.9;		(68; 101.2)	
		2650)			
Weight					
	>2500g	(Ref)		(Ref)	
	1500-2499g	110.4	0.352	4.20	0.682
		(-122.5;		(-15.9;	
		343.3)		24.3)	
	1000-1499g	30.8	0.826	-0.6	0.958
		(-243.7;		(-22.1; 21)	
		305.3)			
	<1000g	594.8	0.002	21.2	0.099
		(219.6;		(-4; 46.5)	
		969.9)			

Ref: Reference group

*: $P < 0.05$

Figures

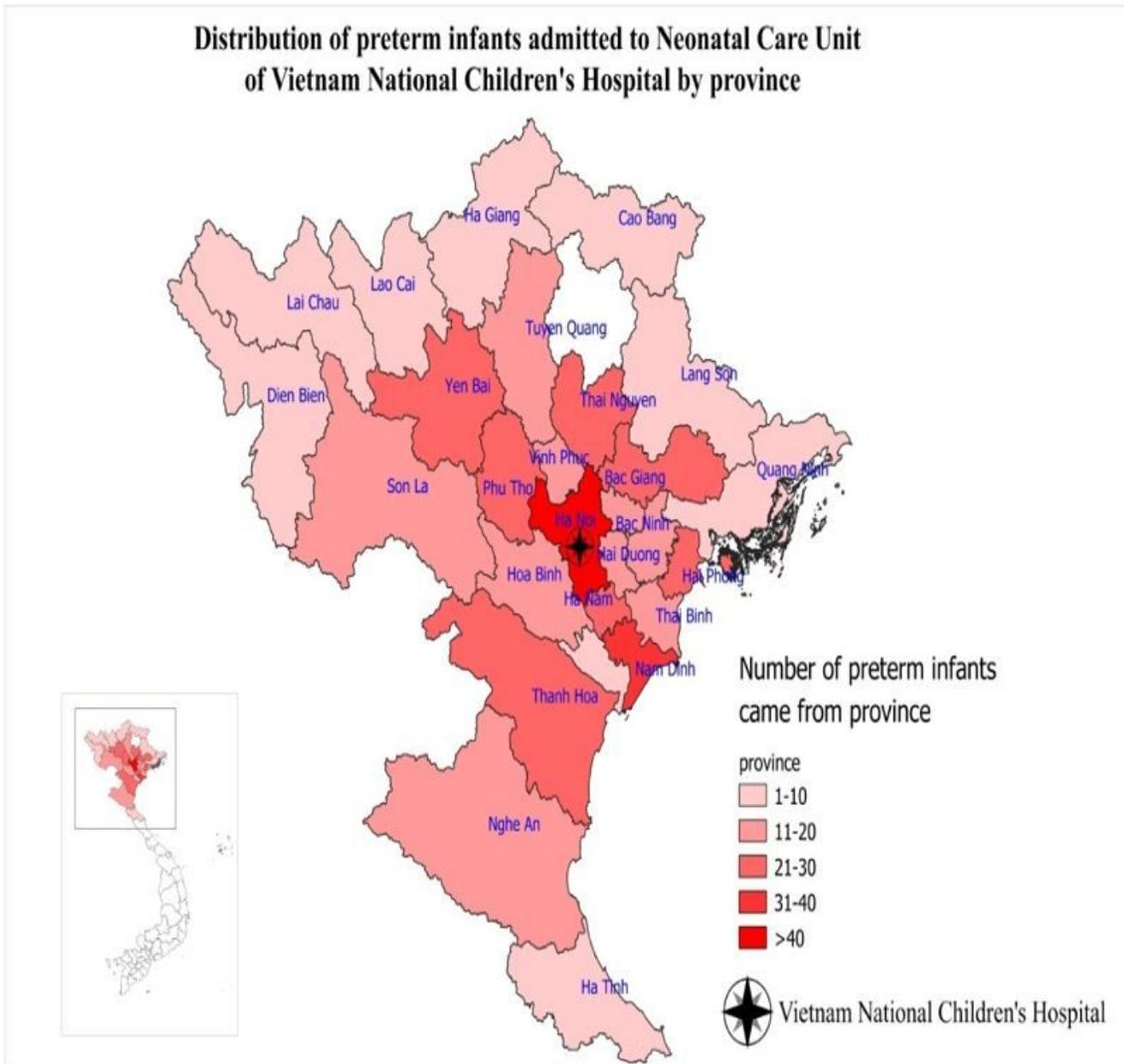


Figure 1

Distribution of preterm infants admitted to Neonatal Care Unit of Vietnam National Children's Hospital by province (n=482).

Source: OpenStreetMap. URL: <https://download.geofabrik.de/asia/vietnam.html>

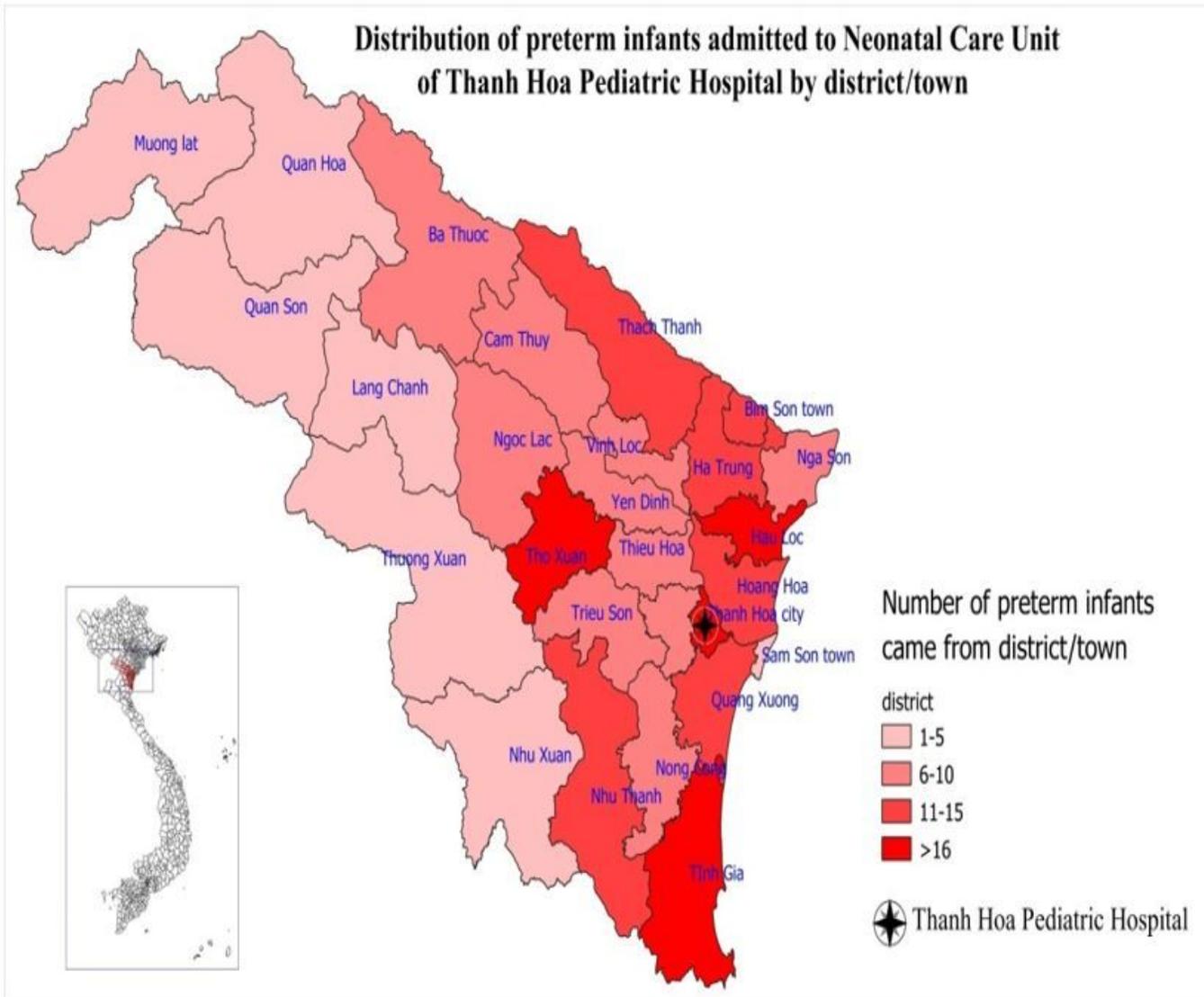


Figure 2

Distribution of preterm infants admitted to Thanh Hoa Pediatric Hospital by district/town (n=261). Source: OpenStreetMap. URL: <https://download.geofabrik.de/asia/vietnam.html>

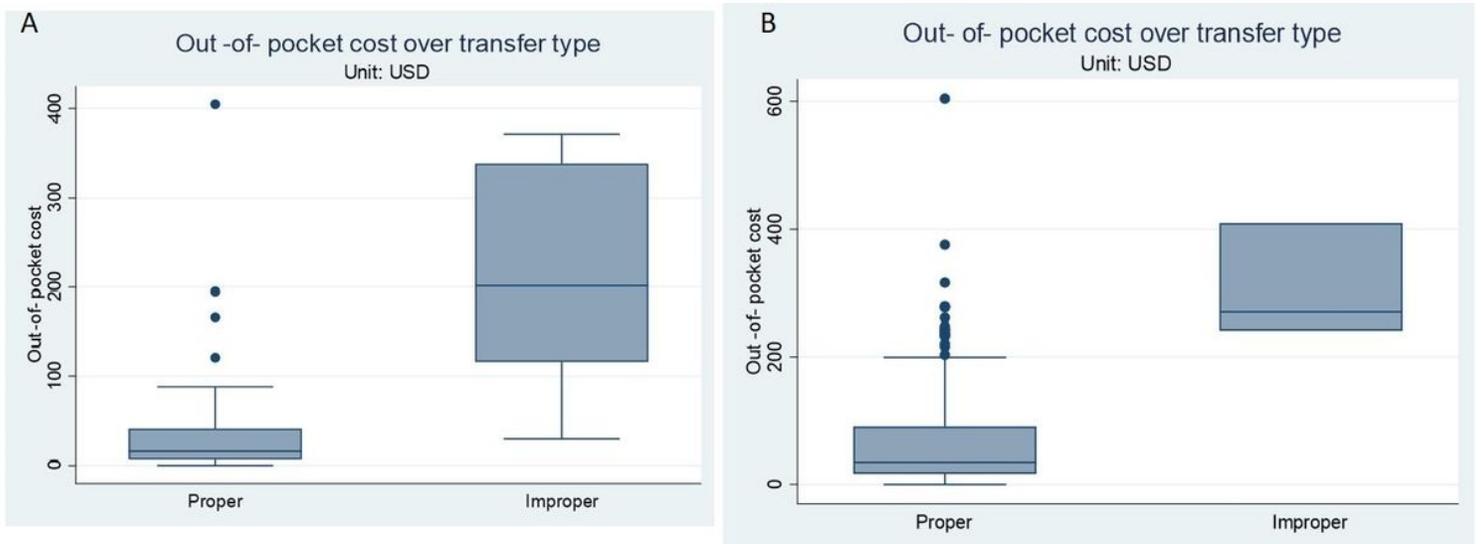


Figure 3

A. Out-of-pocket costs for preterm infants transferred from home to Vietnam National Children's Hospital by transfer classification (number of proper cases: 42; number of improper cases: 8). B. Out-of-pocket costs for preterm infants transferred from a health facility to Vietnam National Children's Hospital by transfer classification (number of proper cases: 437; number of improper cases: 3)