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Determinants of Child Mortality in Lao PDR

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ABSTRACT

In Millennium Development Goals (MDGs), health issue especially child health is stressed as an important sector needed to be improved in many developing countries. This issue is also being concerned by Lao government. In Lao PDR, with a human development index rank of 133th, child health issue is critical (World Bank, 2008). Therefore, in National Growth and Poverty Eradication Strategy (NGPES), improving child's health is addressed as one of the main priorities because Lao PDR has relatively young structure of population. With a rank of 50th, Child mortality rate is still considered high, although it has dropped from 163 to 79 per 100 live births during 1990-2005 (UN, 2008). In order to have an appropriate policy to achieve the target, studying on what determinants of child mortality is needed. However, the analysis on this issue in Lao PDR is still rare.

Using Lao Reproductive Health Survey 2005 (LRHS2005), this paper examines the determinants of child mortality in Lao PDR by comparing the differences among regions and among ethnic groups. This study finds that maternal education plays significant role on reducing child mortality in Lao PDR. Mothers with at least finished primary school level education shows negative impact on child mortality. Primary education attainment shows no much child mortality differential between northern and central regions while that has no impact in southern region in reducing child mortality. The study also finds that government's family planning program and availability of health worker in child's living area are also proved to be the important factors for reducing child mortality in Lao PDR.

Key words: Lao PDR, Child Mortality, Education.

JEL Classification: I00, I10, I12

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1. INTRODUCTION

Good health is a crucial component of overall well-being since it raises the productive level of human capital, and this has a positive effect on individual productivity and on economic growth (Savedoff and Schultz, 2000). In response to the important role of health issues on development, child health is addressed as one of the most important goals needed to be achieved in the MDGs between 1990-2015, Specifically, the United Nations has targeted reducing infant and child mortality by two-thirds (UN, 2000).

In Lao PDR, child health problems are crucial issues that need to be addressed in order to achieve sustainable development, because Lao PDR has a young population structure. To mitigate this problem, the government adopted the NGPES in October 2003, where health continues to be one of the top priority sectors. However, with a limited budget for health (merely around 4% of GDP), the progress on improving the health care system is quite slow. The Lao PDR human development index ranking is 133 out of 179 countries, with under-five child mortality ranking 50 out of 210 countries in the world (World Bank, 2010a). Even though child mortality rates in Lao PDR declined from 163 to 75 per 1000 live births during 1990-2005 (UN, 2010), the rates still rank second highest in Southeast Asian countries. The majority of deaths come from the preventable causes such as diarrhea, malaria, measles, and acute respiratory infections.

Because of the limited government budget, in order to allocate this small amount of funds effectively to combat child mortality, its determinants need to be identified. Case studies of empirical analysis on the determinants of child mortality in Lao PDR are still rare. To contribute to this knowledge gap, our study intends to provide an empirical estimation of the determinants of child mortality in Lao PDR by addressing the following questions: (1) what are the differences of the factors that cause child mortality among regions?; (2) what determinants of child mortality does the government urgently need to intervene?, and (3) what policies would improve child health conditions in different regions?

2. REVIEW OF LITERATURE ON CHILD MORTALITY

From the large and growing literature, determinants of child mortality are roughly divided into three groups: biological, socio-economic, and demographic and environmental aspects. In biological determinants, breastfeeding is recognized as one of the most important factors affecting child survival. Breastfeeding not only provides protection against gastrointestinal and respiratory disease, but also meets infants' nutrition requirements. Therefore, from the previous studies, breastfeeding has a strong impact on reducing child mortality (Forste, 1994; Mustafa and Odimegwu, 2008). Moreover, maternal age at birth and birth order also tend to have impact on child survival. Women who gave birth to children at a very young age have a higher risk of maternal mortality and child mortality (Wolpin, 1997). In addition, gender of children also affects the child mortality rate. In general, the mortality rate of female infants is lower because of biological and genetic advantage (UNICEF, 2010a).

Regarding socio-economic factors, maternal education plays an important role in reducing child mortality. Education delays marriage, which prevents married women from having children at a very young age. Moreover, educated mothers tend to be able to utilize health information such as having better a perception of how to deal with ill children, providing better nutrition, and using contraceptive methods to space births. Most empirical literature supports that maternal education has an impact on improving child survival

regardless the level of its effects varying among countries and regions. For instance, mothers who complete secondary school in Cote d'Ivoire and those who finish middle school in Ghana have an impact on reducing child mortality (Benefo and Schultz, 1996). While in Kenya, to have a similar level of effect, mothers need to finish at least secondary school (Mustafa and Odimegwu, 2008). In Indonesia, improvement in child survival is only associated with mothers who have completed primary and secondary school levels (Mellington and Cameron, 1999).

There is evidence that household income affects child mortality negatively. It is believed that wealthier families can provide better nutrition, shelter and health services to children. On macro level, low income countries have higher rates of child mortality. For instance, in Indonesia, mother with lower expenditure per capita have a higher probability of experiencing child mortality (Mellington and Cameron, 1999). However, some cases such as the study of determinants of child mortality in Kenya of Mustafa and Odimegwu (2008) suggest that family wealth does not have an impact on infant and child mortality. There is no concrete support for effects of urban/rural residences, occupation status of mothers on child mortality since the results vary among countries and regions.

Environmental determinants, such as accessing to health facilities, drinking water sources, having access to latrines are also important factors for child survival. In Indonesia, accesses to pipe water and latrines have impact on reducing child mortality (Mellington and Cameron, 1999). This finding was also confirmed by Hala (2002) in the case study of Egypt. However, in the case study of Malawi, owning a pit latrine does not have any effect on reducing child mortality (Baker, 1999).

According to literature, there are endogeneity problems concerning unobserved variables that correlate with parental education such as parents' ability and family background (educational level of children's grandparents and family's wealth). There is a concern that girls might have less opportunity to study than boys because of family background (Breierova and Duflo, 2004, Schultz, 2009). Wolfe and Behrman (1987) argue that there is no effect of mother's education on fertility and child health after controlling mother's from family background. In addition, a possible endogeneity problem concerning child mortality and fertility is addressed in the study of fertility and child mortality in Cote d'Ivoire and Ghana. Instrumental Variables (IV) is used to overcome this problem (Benefo and Schultz, 1996). High rate of child mortality can increase fertility because of died-child replacement mechanism of parents. On the other hand, high fertility might induce high child mortality because having more children means having higher risk of child mortality.

In summary, during the last two decades economic analysis of health, both theoretical and empirical, has addressed different types of child mortality's determinants and has covered many developed and developing countries. In the case of Lao PDR, however, in spite of the importance of health issues, studies were carried out only in forms of surveys mainly focusing on collecting statistical data and they just stopped providing summary reports based on collected data. Also health projects are largely formulated and designed based on ad hoc surveys and practical reports. To our best knowledge, the (academic) empirical analyses of child mortality determinants for this country are still rare. Recognizing this gap, this study is set to empirically examine and identify determinants of child mortality. The results of this study are expected to clarify the relation and the importance of those potential determinants of child mortality and consequently provide more information for better policy making to improve child health in Lao PDR.

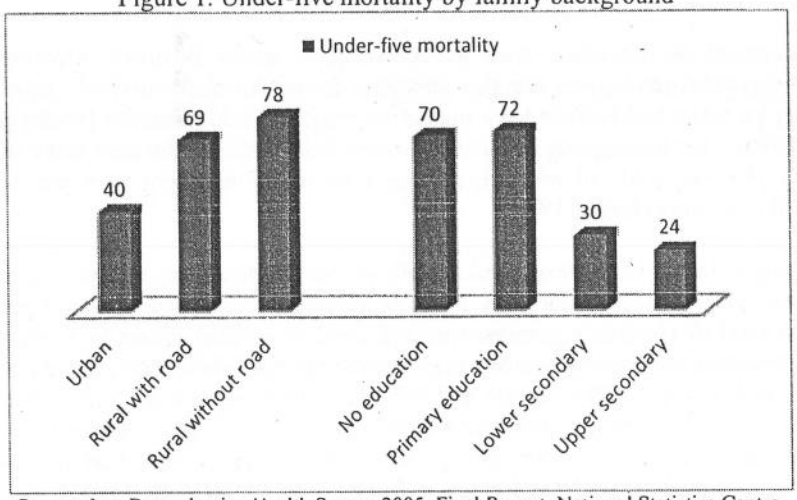
3. CHILD MORTALITY AND ACCESSING TO HEALTH CARE IN LAO PDR

3.1 Child Mortality Situation

Ranking 50th in the world and 2nd in Southeast Asia, the under-five child mortality rate in the Lao PDR has substantially declined from 235 to 79 per 1000 live births from 1960 to 2005 (World Bank, 2010a).

Looking at child mortality by family background in Figure 1, there is still a big gap of child mortality among the regions and among mother's education background. The highest under-five child mortality rates are found in rural areas without road access (78 per 1000 live births) where the lowest rates are in urban areas (40 per 1000 live births). Regarding child mortality by mother's education background, there are slight differences between the child mortality of uneducated mother and mother's with primary education level. However, there is a huge gap between mothers with primary education and secondary education (NSC, 2005).

Figure 1: Under-five mortality by family background



Source: Lao Reproductive Health Survey 2005, Final Report. National Statistics Centre.

The comparison between year 2000 and 2005 from Table 1 shows the declining trend in the infant mortality rate (IMR) and child mortality rate (CMR). IMR declined by 32.2% from 82.2 to 55.7 per 1000 live births. Considerable variations among provinces are apparent with the largest percentage of decline found in Bokeo, in which IMR declined from 73.3 in 2000 to 38.6 in 2005 or by 47.2 %, and in Saravane in which IMR declined from 75.8 to 42.3 per 1000 live births. Some provinces have experienced an increase in IMR; and these provinces are Vientiane Capital, Luangnamtha, Borikhamxay, Khammuane, and Xaysomboon.

As shown in Table 2, the national level infant mortality rate in year 2005 was 55.7 infant deaths per 1000 live births, and the neonatal mortality rate was 25.9 and post-neonatal mortality rate was 29.8 per 1000 live births. This means that about half of infant deaths occur within the first month of life.

Table 1: Change in infant mortality rate and child mortality rate between 2000 and 2005

Province	IMR			CMR		
	2000	2005	% change	2000	2005	% change
North						
Phongsaly	61.9	60.4	-2.4	15.5	17.2	11.0
Luangnamtha	88.3	93.0	5.3	30.8	17.1	-44.5
Oudomxay	79.1	62.6	-20.9	32.0	22.5	-29.7
Bokeo	73.3	38.7	-47.2	18.3	27.6	50.8
Luangprabang	124.8	93.8	-24.8	25.0	15.2	-39.2
Huaphanh	58.3	52.4	-10.1	36.4	21.0	-42.3
Xayabury	46.8	38.6	-17.5	19.3	18.8	-2.6
Central						
Vientiane capita	17.9	34.0	89.9	3.6	-	
Xiengkhuang	69.6	30.0	-56.9	20.9	15.7	-24.9
Vientiane	34.9	10.6	-69.6	24.0	2.2	-90.8
Borikhamxay	26.0	26.4	1.5	21.7	-	
Khammuane	91.5	99.7	9.0	24.6	3.4	-86.2
Savannakhet	98.7	82.6	-16.3	25.1	18.3	-27.1
Xaysomboon SR	58.7	68.0	15.8	9.6	8.3	-13.5
South						
Saravane	75.8	42.3	-44.2	20.8	16.7	-19.7
Sekong	55.4	50.8	-8.3	15.3	9.6	-37.3
Champasack	77.8	66.8	-14.1	16.0	26.3	64.4
Attapeu	93.1	70.1	-24.7	18.6	26.9	44.6
Total	**82.2**	**55.7**	**-32.2**	**24.8**	**15**	**-39.5**

Source: Lao Reproductive Health Survey 2005. Final Report. National Statistical Centre.

Factors influencing neonatal mortality could be due to genetic factors while post neonatal mortality could be due to external factors such as improper feeding patterns, infectious diseases, etc (NSC, 2005b). The level of neonatal, post neonatal and infant mortality rates varies among provinces. The highest IMR is found in Khammuane, which was 99.7, meaning that 99 to 100 babies out of 1000 live births did not reach their first birthday. 58.7 deaths out this figure are contributed to neonatal mortality, and the remaining of 41.1 are contributed to post-neonatal mortality. Slightly lower rates are found among provinces in Luangnamtha (93.0), Luangprabang (93.8), Savannakhet (82.6) and Attapeu (70.1). IMR over sixty is found in Phongsaly (60.4), Oudomxay (62.6), Xaysomboon (68.0), and Champasack (66.8). The lowest IMR is in Vientiane (10.6). The highest neonatal mortality rates are found in Luangnamtha (50.7), Khammuane (58.7) and Huaphanh (40.5). In these provinces, the neonatal mortality rate contributes to half of the IMR. In addition, post-neonatal mortality in some provinces was also high, which was around 40 per 1000 live births. These provinces are Phongsaly (41.1), Luangnamtha (42.3), Luangprabang (57.7), Khammuane (41.1), Savannakhet (44.2), Xaysomboon (40.8), and Champasack (51.7).

Table 2: Neonatal, post neonatal, infant and child mortality rate per 1000 live births for 5 years preceding the survey by province

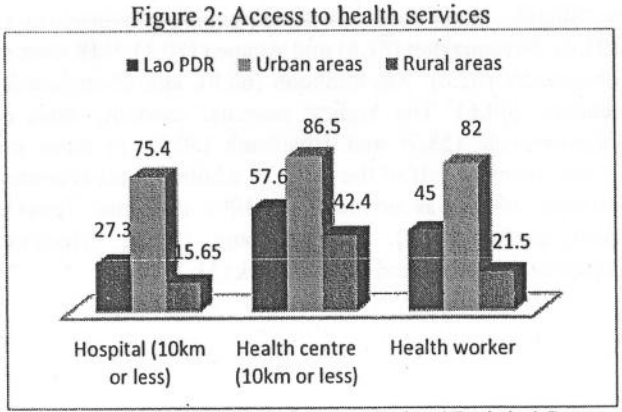
Province	Number of live births	Number of deaths <1 year	Neonatal mortality rate (NNMR)	Post neonatal mortality rate (PNMR)	Infant mortality rate (IMR)	Child mortality rate (CMR)
North						
Phongsaly	414	25	19.3	41.1	60.4	17.2
Luangnamtha	355	33	50.7	42.3	93	17.1
Oudomxay	431	27	30.2	32.5	62.6	22.5
Bokeo	310	12	6.5	32.3	38.7	27.6
Luangprabang	416	39	36.1	57.7	93.8	15.2
Huaphanh	420	22	40.5	11.9	52.4	21
Xayabury	337	13	26.7	11.9	38.6	18.8
Central						
Vientiane capital	235	8	29.8	4.3	34	-
Xiengkhuang	466	14	12.9	17.2	30	15.7
Vientiane	566	6	7.1	3.5	10.6	2.2
Borikhamxay	303	8	9.9	16.5	26.4	-
Khammuane	341	34	58.7	41.1	99.7	3.4
Savannakhet	339	28	38.3	44.2	82.6	18.3
Xaysomboon SR	294	20	27.2	40.8	68	8.3
South						
Saravane	449	19	29	13.4	42.3	16.7
Sekong	650	33	16.9	33.8	50.8	9.6
Champasack	464	31	15.1	51.7	66.8	26.3
Attapeu	428	30	30.4	39.7	70.1	26.9
Total	**7218**	**402**	**25.9**	**29.8**	**55.7**	**15**

Source: Lao Reproductive Health Survey 2005, Final Report. National Statistics Centre.

3.2 Accessing to Health Care

Although access to health services has generally improved in the last two decades in the Lao PDR, increases in the public health have been insufficient and unevenly distributed. In Figure 2, 75.4% and 86.5% of the population live 10 km or less from a hospital and health centre respectively in urban areas, while only 11.3% and 27.1% of the population in rural areas without roads do. Moreover, only 12% of the population in rural areas without roads have access to Medical Worker compared to 82% of people in urban areas (NSC, 2008).

Figure 2: Access to health services



Source: LECS 4, 2007/08. Final Report. National Statistical Centre.

Water and sanitation is still a severe problem in Lao PDR. According to the national household survey in 2007/08 (Table 3), 34% of people were living without safe drinking water or latrines; only 23% of people in rural area (with no road access) have access to safe drinking water (piped water, protected well and purified water); and over 60% of rural people had no access to latrines. As a result, they had a larger potential to have diarrhea, cholera, or typhoid fever. Among those diseases, diarrhea is known as one of the three main causes of child mortality (the other two are malnutrition and respiratory infections).

Table 3: Health environment and prevention by provinces and Regions in 2007/08

	% of population		% of population covered by	
	having safe water in the village	without toilet	Immunization program	Anti-malaria program
Lao PDR	66	34	98	76
Urban area	88	11	97	80
Rural area with road access	61	41	99	75
Rural area without road access	23	66	95	68
North	66	32	97	74
Phongsaly	60	69	94	57
Luangnamtha	82	38	87	60
Oudomxay	68	30	98	81
Bokeo	65	33	92	35
Luangprabang	70	34	100	89
Huaphanh	63	38	100	81
Xayyaboury	58	6	100	80
Center	69	25	98	77
Vientiane C.	95	2	100	79
Xienkhuang	58	28	95	37
Vientiane P.	71	12	94	78
Borikhamxay	76	8	88	85
Khammuane	37	44	100	78
Savannakhet	60	51	100	82
South	57	59	100	78
Saravane	71	80	98	74
Sekong	65	53	100	56
Champasack	41	51	100	82
Attapeu	95	39	100	82

Source: LECS 4, 2007/08. Final Report. National Statistical Centre.

4. THEORETICAL FRAMEWORK, EMPIRICAL MODEL, AND DATA

4.1 Theoretical Framework

The theoretical framework in this Chapter follows framework of human capital investment (Becker, 1965) and household production function model. Child health demand function is derived from the health demand function developed Rosenzweig and Schultz (1983).

Parents obtain utility from their surviving children (CS), goods affecting child survival (Y) and consuming other goods (X), subject to budget constraint (where I is household total resource, p_x is price of others goods, p_y is price of consumption goods affecting child survival and p_m is price of medical care) and child survival production function (CS). CS function consists of consumption goods affecting child survival (Y), medical care (M) augment utility only through CS function, biological endowment (B),household and parents' characteristics (Z), and health environment (G).

The utility maximization is expressed as follow:

$$Max U(X,Y,CS)$$

$$S.t$$

$$CS = cs(Y,M,B,Z,G)$$

$$I = p_x X + p_y Y + p_M M$$

By solving this maximize utility function of the parents, we would obtain the optimum level of the choice variables as a function of all of the exogenous variables. The reduced form demands are:

$$X = x(p,I,B,Z,G)$$

$$Y = y(p,I,B,Z,G)$$

$$M = m(p,I,B,Z,G)$$

Substitute these into the child survival production function. The reduced form of optimum child's survival demand function can be written as:

$$CS^* = cs(y(p,I,B,Z,G),m(p,I,B,Z,G),B,Z,G)$$

$$CS^* = cs(p,I,B,Z,G)$$

With respect to the data used in this Chapter base on cross-sectional data, prices of all goods can be considered as a constant except for the price of health care such as ability of mother to provide health care or number of Medical Worker in each region. In this chapter, number of the Medical Worker in the district is used as a proxy of price for health care. The cost of medical care in Lao PDR is almost free, thus the more number of the Medical Worker available in their region, the lesser of opportunity cost of the patients.

Therefore, the optimum child survival production function is influenced by the price of medical care (p_m*), total household resource (I), biological endowment (B), household's and parents' characteristic (Z), and health environment (G). The reduced form of health equation can be denoted as follow:

$$CS^* = cs(p_m^*, I, B, Z, G)$$

4.2. Empirical Model

Based on the above theoretical framework, the reduced form of determinants of child mortality used as empirical model in this chapter is shown as follow:

$$CS=\beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_5+\beta_6x_6+\beta_7x_7+\beta_8x_8+\beta_9x_9+\beta_{10}x_{10}+\beta_{11}x_{11}+\beta_{12}x_{12}+\beta_{13}x_{13} \quad (1)$$

where CS is child mortality which is influenced by Price of medical care [number of Medical Worker in a district (x_1) is used as proxy], Family's wealth (I) [due to limitations of data, a household asset index (x_2) is constructed and used as a proxy of household wealth or income], Child biological endowments (B) [include child's gender (x_3), birth status (x_4), birth order (x_5), experiencing miscarriage of mother and mother age at birth (x_6)], Parents' characteristic and socio-economic status (Z) [parents' education (x_7), parents' occupation (x_8), living region (x_9), are chosen as explanatory variables], Variables for health environment (G) [include access to safe drinking water sources (x_{10}), and kind of latrines (x_{11}). Moreover, born after 1997 (x_{12}) and knowledge of contraceptive (x_{13}) are used to control the effect of family planning program.

Equation (1) applies the Probit model to estimate the impact of explanatory variables on the probability of child mortality.

4.3 Data

4.3.1 Statistical Data

Statistical data used for our analysis in this Chapter were obtained from the Lao Reproductive Health Survey 2005 (LRHS-2005), which was conducted from March 2004 to February 2005 by the National Statistic Centre (NSC) of Laos. The LRHS2005 sample is made up of 13107 married women aged between 15-49 years regardless of their married status which provide information of 33,040 children. The dataset includes information on household condition, reproduction, mortality, socio-economic background, etc.

Since this study focuses on the child mortality, the sample is limited to the children who were born five years before the survey. Upon removing incomplete data, the econometric analysis is based on 30,665 observations covering roughly 93% of the original samples, which is considered a very high ratio by any standard. Therefore, this sample size is deemed sufficient for analyzing the determinants of child mortality.

4.3.2 Variable and Defintion

The following are definitions of variables used in the empirical analysis:

- Under-five mortality: children who were born alive and the later die before reaching their fifth birthday at least five years before survey.
- Female dummy: this is a dummy variable and is defined as 1 if the gender of children is female and 0 otherwise. It is used as proxy of child health endowment.

- Twin dummy is defined as 1 if a child were twin born and 0 otherwise. This variable is expected to have positive sign with child mortality because a child who born twin tends to have weaker health status.
- Born after year 1996 is a dummy variable if a child were worn after the year 1996 and 0 otherwise. This dummy variable is used as proxy of family planning affect on child survival rate because in 1995 the government of Lao PDR launched nation-wide family planning program.
- Child birth order: this is categorized into four groups: Birth order 1 (first child), Birth order 2-3, Birth order 4-5, and Birth order 6+. This variable is also used as a proxy of a child biological endowment and it is expected to have a positive correlation with child mortality.
- Mother age at birth is the age of mother at the time a child was born.
- Parents' education: this variable describes the years parents spent in school. It was divided into five groups/ranges: No education=1; with some primary school level (1-4 years of school) =2; finish primary school level (5-7 years of school) =3; finish lower secondary school (8-10 years of school) =4, and finish high school and higher education (11+ years of school) =5.
- Experiencing miscarriage is dummy variable and defined as 1 if a woman has experienced miscarriage and 0 otherwise. This dummy is used as proxy of mother health and expected to have a positive sign with child mortality.
- Contraceptive knowledge is a dummy variable and defined as 1 if a woman has ever heard about any modern contraceptive method and 0 otherwise. This variable is used to capture the impact of contraception on child mortality.
- The number of Medical Worker is the number of Medical Worker in the district where a child lives. It is used as proxy of price for health care.
- Wage earner worker dummy: this is a dummy variable and is defined as 1 if the father and mother of a child are wage earner workers and 0 otherwise.
- Similar to the analysis in Chapter 3 (assessment of determinants of fertility), asset index (capital index) is used as a proxy of family's wealth to control family's background regarding family's wealth in the estimation of child mortality. The index calculated in Chapter 3 is used in this analysis without modification.
- Access to safe drinking water: This dummy variable is a proxy for health environment and is defined 1 if a household has access to piped water, protected borehole, protected well, and 0 otherwise.
- Toilet: meaning the latrine type used in the household. There are three categories: normal toilet=1; dry toilet=2; and no toilet=3.
- Rural dummy: this is a dummy variable and is defined as 1 if a person lives in a rural area and 0 otherwise.
- Regional: there are three regions: northern region =1; central region =2; and southern region =3.

4.3.3 Major Characteristics of Samples

The variables for empirical analysis are calculated and compiled from LRHS2005 data applying the definitions in the previous section. Table 4 presents the means and standard deviations of certain variables.

Comparing to the average rate of Under-five child mortality, the rate in this Chapter (approximately 100 per 1000 live birth) is different from the report from National Statistic

Centre. It is because the average mortality rate of children under-five is calculated by direct estimation method based on reports of children that are dead and alive at least five years before survey, while the average mortality rate of children under-five from the National Statistic Centre is calculated by indirect estimation method based on the total number of children born and still living (NSC, 2005b).

With regard to health input factor, averagely there are 48% of girls, with birth order of 3 children, and 8% of women age before 18 years old had experience of giving birth. This has shown that the percentage of early child bearing age among married women in Lao PDR is relatively high.

Table 4: Basic characteristics of variables in child mortality analysis

Variables	Obs	Mean	Min	Max
Under-five child mortality	32962	0.1001	0	1
Female dummy	32962	0.4841	0	1
Twin dummy	32962	0.0099	0	1
Born after 1997 dummy	32962	0.5419	0	1
Birth order order1st	32962	0.2849	0	1
2rd and 3rd	32962	0.4123	0	1
4th and 5th	32962	0.1973	0	1
6th and more	32962	0.1055	0	1
Mother age at birth	32737	25.0052	13	48
Wife's Education (year)	32962	2.9776	0	11
Wife's no education	32962	0.3628	0	1
Some priamry	32962	0.2967	0	1
Primry school	32962	0.2335	0	1
Lower secondary school	32962	0.0784	0	1
Upper secondary school and high	32962	0.0286	0	1
Husband's education (years)	31576	4.5543	0	11
Husband no education	31556	0.1753	0	1
Some priamry	31556	0.2842	0	1
Primry school	31556	0.3184	0	1
Lower secondary school	31556	0.1376	0	1
Upper secondary school and high	31556	0.0845	0	1
Used to misscarriage	32962	0.1697	0	1
Heard of contraceptive	32962	0.9016	0	1
No.health worker	32962	43.3269	6	113
Wage earner men	31510	0.1145	0	1
Wage earner women	32962	0.0325	0	1
No toilet	32962	0.5074	0	1
Normal toilet	32962	0.3888	0	1
Dry toilet	32962	0.1038	0	1
Access to safe water	32962	0.4980	0	1
Rural dummy	32962	0.8262	0	1
Northern	32962	0.3955	0	1
Central region	32962	0.3704	0	1
Sounthern region	32962	0.2341	0	1

Source: Author's calculation

Regarding socio-economic determinants, the samples have the following characteristics: 17% of men and almost 30% of women have not received education; there are 3% of women wage earner; and around 82% of samples are living in rural areas. Based on these characteristics, the estimation in this Chapter would be partly upward biased. With respect to health environment, almost 50% of the samples have no access to latrines and only 38% of those having access have normal toilet, while main drinking water sources come from well without cover, river, rain, stream and dam.

This means that most of the households in the samples live in poor health environment. Moreover, the distance to the nearest health care facility is relatively far and it normally takes roughly 2.5 hours, which indicates a relatively harsh condition, particularly in rural and remote areas.

5. EMPIRICAL RESULT

Equation (1) is estimated by using the Probit model. The marginal effects and z-statistics are summarized in Table 5 and 6:

The empirical analysis consists of six cases. The first three cases analyze under-five child mortality at national level (general case) and separately between urban and rural areas as presented in Table 5. Table 6 displays the comparison among northern, central, and southern regions.

Child gender has significant impact on child mortality in the Lao PDR. A child who was born a girl has a lower mortal probability. In general, being girl decreases mortal probability by 0.95% at the 1% significance level compared to a boy. A similar result is also revealed for the case of girl in urban and rural area. This finding is consistent with many previous studies in various countries, such as Bobak (2000) in Czech Republic and Mustafa and Odimegwu (2008) in Kenya. The cause for such outcome can be explained by the fact that boys have biological disadvantage which result in a smaller number of boys surviving their fifth birth day than girls (UNICEF, 2010a). Comparing the differences among regions, the gender difference on child survival rates is not significant in the southern region.

Generally, children who were born in higher birth order have higher risk of child mortality. Comparing children who were born as the first child, the probability of surviving reduces by 0.08%, 4%, and 10% for children who were born as 2-3, 4-5, and higher birth order, respectively, with statistical significance at the 10% or 1% level. The reason behind this may come from the fact that mothers who have given birth to too many children have weaker health which would affect the next child born. Moreover, higher birth orders imply bigger household size which would further lead to higher competition on food consumption among the household members.

Children who were born as twin have higher probability of dying before reaching their fifth birth day in the Lao case. The coefficient shows that the probability of child mortality of twin children is about 8% higher as compared to single case at the 1% statistical significance. Similar results are also found in urban and rural areas and all regions except for the South. The assumption behind this is that children who were born as twin have weaker health which need more care and medical attention comparing to children who were born alone.

With regard to mother's age at birth, mothers who have children at very young age tend to expose to higher probability of child mortality. Specifically, a difference in mother's age of one year is associated with 0.3% higher probability of child mortality at the 1% statistical significance level. Similar results are found in urban and rural areas, and in all regions. It is claimed that the main reason is the reproductive immaturity (Wolpin, 1997). Interestingly, the impact of mother's age at birth in urban areas is relatively weak as compared to other cases. This can be understood as mothers in urban areas have better access to health care services.

Maternal education is found to have strong impact on improving child survival. In general, comparing with children of mothers with no formal education, a child who belongs to mothers with complete primary, lower secondary and higher education has lower probability of child mortality by 2.3%, 3.7% and 2.0% points, respectively. This finding supports previous literature such as Mellington and Cameron (1999) in Indonesia's case. Comparing between urban and rural areas, it is found that mothers with primary and lower secondary educational level would be exposed to lower child mortality in both urban and rural area, while higher education has effect only in urban areas. This may be because in rural areas the number of women with higher education is negligibly small and access to health care is very limited. In terms of regional disparity, primary education attainment shows difference in child mortality in all three regions. In Lao PDR, mothers' education starts to show some effect on reducing probability of child mortality at the primary school level.

Children who were born to mothers with miscarriage experience have higher risk of dying before reaching their fifth birthday. In general, being a child of mother who experienced miscarriage is associated with higher probability of under-five mortality by a difference of 4% points at the 1% significance level. This similar result is also found urban/rural areas, and among the three regions. This finding stresses the importance of mother health on child survival.

There is no difference on survival rate between children who belong to mothers having knowledge of contraceptives and those who do not.

The number of Medical Workers in a district shows a significant impact on reducing child mortality, especially in rural areas and the central region. Overall, an increase in number of Medical Workers in the district by 1 person would reduce probability of child mortality 0.02% points at the 5% level. Such a similar impact also occurs in rural areas and the central region with a somewhat different magnitude.

In regard to family's wealth, poverty tends to raise the child mortality rate in the Lao PDR. Comparing with the 20% lowest asset group (the lowest quintile), on average children born in the highest 20% group (the highest quintile) are exposed to lower probability of death by 2.5% point at 1% statistical significance level. Poverty exerts a strong negative impact on child survival in rural areas, the northern region and central region. For regional differences, the highest coefficient of wealth index (4.2%) is found in highest quintile in the North.

In terms of health environment, the presence of a normal toilet would reduce probability of infant death, whereas using a dry toilet is associated with increasing child mortality in rural areas and at country level. The reason behind this is that having toilets might not provide sufficient sanitation and would instead create health problem if the latrines were not kept clean (Lahiri and Chanthaphone, 2003). However, the impact of this variable varies among regions. Having access to latrines induces lower probability of child mortality in the northern

and southern region, while having access to normal toilet in the central region has contradicting effect. This may be attributable to the fact that having access to latrines does not totally reflect the impact of health environment on child mortality because the latrines may not be available at the time the children were born, especially in remote areas. Recently, there are many projects aim to provide latrines for people in poor villages and remote areas in order to improve population health status. Comparing between 2003 and 2008, the number of households having access to latrines sharply increased from 17% to 44% in rural areas without road access (NSC, 2008).

On the subject of drinking water sources, access to safe drinking water would decrease probability of child mortality in Lao PDR context, especially in the North. This result lends support to the findings in Mellington and Cameron (1999) for Indonesia and Hala (2002) for Egypt. Accessing safe drinking water sources also associates with preventing many diseases, such as diarrhea which is one of main cause of child mortality in many countries including the Lao PDR.

Table 5: Child mortality at national level, the difference between urban and rural areas

Under-five child mortality	Total dy/dx (z)	Urban dy/dx (z)	Rural dy/dx (z)
Female dummy	-0.0096***	-0.01*	-0.0095**
	(-2.98)	(-1.77)	(-2.53)
Twin dummy	0.0803***	0.1251***	0.0676***
	(3.67)	(2.57)	(2.81)
Born after 1997 dummy	-0.0442***	-0.02***	-0.0499***
	(-12.65)	(-3.54)	(-12.16)
Birth order order1st (Base category)			
2rd and 3rd	0.0082*	0.0066	0.0084*
	(1.91)	(0.9)	(1.66)
4th and 5th	0.0443***	0.029**	0.0473***
	(6.55)	(2.15)	(6.15)
6th and more	0.1029***	0.0557**	0.1117***
	(9.01)	(2.25)	(8.75)
Mother age at birth	-0.0036***	-0.0018**	-0.0039***
	(-9.16)	(-2.35)	(-8.78)
Wife's Education (0 year is Base category)			
Some priamry (1 - 4 years)	-0.0018	-0.0132	0.0009
	(-0.44)	(-1.64)	(0.2)
Complete primry school (5 - 7 years)	-0.0231***	-0.0195**	-0.0243***
	(-5.01)	(-2.29)	(-4.51)
Complete lower secondary school (8 - 10 years)	-0.0377***	-0.0291***	-0.0398***
	(-6.06)	(-3.6)	(-4.85)
Complete upper secondary school and higher (11 + years)	-0.021*	-0.0271***	-0.0019
	(-1.7)	(-2.76)	(-0.09)
Husband's Education (0 year is Base category)			
Some priamry (1 - 4 years)	0.0067	0.0343	0.0052
	(1.3)	(1.39)	(0.92)
Complete primry school (5 - 7 years)	0.0051	0.0403**	0.0021
	(0.94)	(1.84)	(0.34)
Complete lower secondary school (8 - 10 years)	-0.004	0.0384	-0.0107
	(-0.58)	(1.64)	(-1.34)
Complete upper secondary school and higher (11 + years)	-0.0076	0.0329	-0.01
	(-0.84)	(1.48)	(-0.84)
Used to misscarriage	0.0408***	0.014*	0.0485***
	(8.29)	(1.86)	(8.29)
Heard of contraceptive	-0.0027	0.0223	-0.0046
	(-0.49)	(1.32)	(-0.74)
No.health worker	-0.0002**	-0.0002	-0.0002**
	(-2.03)	(-1.25)	(-2.01)
Wage earner men	-0.0044	-0.0092	0.0013
	(-0.65)	(-1.4)	(0.14)
Wage earner women	-0.0093	0.0018	-0.0232
	(-0.74)	(0.15)	(-1.34)
Lowest quintile (Base category)			
Quintile 2	0.0055	0.0283	0.0042
	(1.07)	(0.88)	(0.75)
Quintile 3	-0.0027	0.0011	-0.0032
	(-0.5)	(0.05)	(-0.54)
Quintile 4	-0.0046	-0.0052	-0.0052
	(-0.79)	(-0.26)	(-0.79)
Quintile 5	-0.0255***	-0.024	-0.0251***
	(-3.79)	(-0.95)	(-3.25)
No toilet (Base category)			
Normal toilet	0.007	0.012	0.007
	(1.5)	(1.47)	(1.31)
Dry toilet	0.0241***	0.0082	0.0262***
	(3.85)	(0.58)	(3.75)
Access to safe water	-0.0063*	-0.0049	-0.0044
	(-1.75)	(-0.68)	(-1.06)
Rural dummy	0.0211***		
	(4.02)		
Northern (Base category)			
Central region	-0.0201***	-0.0255***	-0.0183***
	(-5.07)	(-3.48)	(-3.97)
Sounthern region	-0.0007	0.0129	-0.0055
	(-0.15)	(1.42)	(-1.08)
Observation	30665	5274	25391
Pseudo R-square	0.0442	0.0691	0.0358

Notes: 1) Heterosketdasticity has been tested and corrected. 2) Corrected z-statistics in parentheses. 3) * significant at 10% level. 3) ** significant at 5% level. 4) *** significant at 1% level.

Table 6: The difference of child mortality among regions

Under-five child mortality	Northern region dy/dx (z)	Central region dy/dx (z)	Southern region dy/dx (z)
Female dummy	-0.0115**	-0.0081*	-0.0091
	(-2.08)	(-1.81)	(-1.32)
Twin dummy	0.0735**	0.1614***	0.0376
	(2.06)	(3.17)	(1.17)
Born after 1997 dummy	-0.0432***	-0.0433***	-0.0495***
	(-7.31)	(-8.72)	(-6.3)
Birth order order1st (Base category)			
2rd and 3rd	0.0077	0.0062	0.0122
	(1.04)	(1.04)	(1.28)
4th and 5th	0.045***	0.033***	0.058***
	(3.96)	(3.41)	(3.94)
6th and more	0.1136***	0.085***	0.1091***
	(5.91)	(4.98)	(4.63)
Mother age at birth	-0.0043***	-0.0026***	-0.0037***
	(-6.39)	(-4.6)	(-4.46)
Wife's Education (0 year is Base category)			
Some priamry (1 - 4 years)	-0.0024	-0.0037	0.0017
	(-0.32)	(-0.64)	(0.2)
Complete primry school (5 - 7 years)	-0.0266***	-0.0162**	-0.0199*
	(-3.3)	(-2.55)	(-1.84)
Complete lower secondary school (8 - 10 years)	-0.0377***	-0.0205**	-0.0589***
	(-3.06)	(-2.38)	(-4.9)
Complete upper secondary school and higher (11 + years)	-0.0162	-0.0046	-0.0605***
	(-0.51)	(-0.31)	(-3.01)
Husband's Education (0 year is Base category)			
Some priamry (1 - 4 years)	0.0336***	0.0041	-0.0281***
	(3.65)	(0.53)	(-2.88)
Complete primry school (5 - 7 years)	0.0122	0.0022	-0.0041
	(1.31)	(0.29)	(-0.37)
Complete lower secondary school (8 - 10 years)	0.0243*	-0.019**	-0.0076
	(1.68)	(-2.28)	(-0.55)
Complete upper secondary school and higher (11 + years)	0.0174	-0.0137	-0.016
	(0.8)	(-1.28)	(-0.93)
Used to misscarriage	0.0237***	0.0482***	0.0468***
	(2.74)	(6.54)	(4.85)
Heard of contraceptive	-0.0072	-0.0167	0.0017
	(-0.76)	(-1.51)	(0.16)
No.health worker	-0.0002	-0.0002***	0.0003
	(-0.86)	(-2.75)	(1.27)
Wage earner men	-0.0015	0.0014	-0.0188
	(-0.11)	(0.15)	(-1.54)
Wage earner women	-0.052***	-0.0103	0.0606
	(-2.91)	(-0.71)	(1.55)
Lowest quintile (Base category)			
Quintile 2	-0.0004	0.0056	0.0035
	(-0.05)	(0.68)	(0.32)
Quintile 3	-0.0112	-0.002	-0.0012
	(-1.4)	(-0.24)	(-0.1)
Quintile 4	-0.0178**	0.0018	-0.0138
	(-1.89)	(0.21)	(-1.06)
Quintile 5	-0.0429***	-0.0204**	-0.0186
	(-4.22)	(-2.01)	(-1.12)
No toilet (Base category)			
Normal toilet	0.032***	-0.0196***	0.0216**
	(3.61)	(-3.14)	(2.12)
Dry toilet	0.0344***	0.0019	0.0533***
	(3.33)	(0.23)	(2.96)
Access to safe water	-0.0104*	-0.0001	-0.0002
	(-1.72)	(-0.02)	(-0.02)
Rural dummy	0.022**	0.0247***	0.0063
	(2.3)	(3.8)	(0.49)
Observation	12160	11313	7192
Pseudo R-square	0.0325	0.0718	0.0424

Notes: 1) Heterosketdasticity has been tested and corrected. 2) Corrected z-statistics in parentheses. 3) * significant at 10% level. 3) ** significant at 5% level. 4) *** significant at 1% level.

6. CONCLUSION

The issue of improving maternal and child health needs to be addressed in order to enhance population well being. Usually, healthy mothers deliver healthy children and healthy children would have high potential to become productive labor force in the future. Thus, both maternal and child health problems need to be solved and improved together to reduce child mortality rate.

It is shown here that birth order and mother age at birth are crucial to child survival. These two elements can be easily improved through family planning programs. In terms of socio-economic factors, education is highly associated with reduced child mortality, especially maternal education at the basic level such as primary and lower secondary level. Family wealth also plays a significant role in child survival. Regarding health environmental factor, the study provides evidence that Medical Workers contribute significantly to improving child survival rate, especially in rural areas. In addition, access to safe drinking water sources is seen as a crucial factor for reducing child mortality rate, since it directly associates with child health. In this aspect, it is essential that the government of Lao PDR implement appropriate policies and intervention on family planning programs. Meanwhile, it is recommended that there should be urgent improvement in the areas of women's basic education, as well as the number and quality of Medical Workers in all regions. Furthermore, it is also crucial to accelerate poverty reduction programs and projects and enhance sanitation situations in rural areas.

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