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Effects of Pregnant Mothers' Work on First-Year Infant Deaths in a Thai Prospective Cohort

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Abstract

This study examines the relationship between mothers' work and infant death in Thailand. It estimates the survival probability at a given time using data from a prospective cohort study of Thai children during 2000-2002. A cohort of 4,245 infants was followed from 28-32 weeks gestation until one year of age. The study found that mother's occupation had an independent relationship with infant death ($p< 0.10$). Infants of mothers with mid-level occupations during pregnancy showed a lower risk of death than those with lower level occupations (odds ratio = 0.42, $p= 0.082$). In addition, the Kaplan-Meier cumulative probabilities of survival support the finding that this difference occurred in the late-neonatal and post-neonatal periods. However other factors occurring during pregnancy and the neonatal period – namely a lack of attended antenatal care, low birthweight, preterm birth, perinatal hospitalization morbidity of the mother, income of the household head, and geographic area – also increased the risk of infant death. The findings indicate that the Thai government should be concerned about working conditions for female agricultural workers and construction laborers, and that pregnant women and their families should be encouraged to access both pre- and post-natal maternal and child health services, especially in the late and post-neonatal periods. Such measures would save infant lives and lower the infant mortality rate for Thailand.

Keywords

Infant death; maternal employment; mother's occupation; work during pregnancy; child health

Introduction

Investigations of differentials in the infant mortality rate (IMR) have been approached from multidisciplinary perspectives, including public health, sociology, economics, ethics and population policy. These perspectives are becoming more relevant for many countries with the advent of the Millennium Development Goals (MDG) in 2015. Thailand's IMR has been at a low level (24 and 11 in 2001 and 2010, respectively) compared to the world average (56 and 41 in 2001 and 2010, respectively) (World Bank, 2003; 2012). Thailand also has been in a better situation compared to other Association of Southeast Asian Nations (ASEAN), except for Singapore and Malaysia. Nevertheless, Thailand's IMR can still be considered high compared to developed countries such as Sweden, Switzerland, Canada, Ireland and Japan (Wibulpolprasert, 2001; 2011).

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In the past three decades, globalization has changed the role of Thai women from mainly reproduction to increased economic contribution to the family (Kusamawalee, 2004). While Thai women have always participated in agricultural labor in rural areas, since the 1980s their rate of employment outside the home has grown. The proportion of women working in the service sector has almost tripled while the proportion of women working in manufacturing has doubled (Jones & Chandoevwit, 2011). In 1989 the Thai female employment ratio was relatively high compared with other Southeast Asian countries (Sethaput & Yoddumnern-Attig, 1992) and results from the National Statistical Office (NSO) show the percentage of married women who are employed increased from 60% in 1995 to 70% in 2013 (NSO, 1995; 2014). Moreover, pregnancy and infant care usually do not cause Thai women to leave their employment (Wacharaporn, 2008).

Yet sometimes the roles of women as mothers and workers outside the home are incompatible. Today's mother often plays the dual role of participating in the workforce as well as being the main caregiver for her offspring. This can have an effect on her child's health and mortality, especially for those working in the informal sector where jobs are typically insecure, pay lower wages, and involve irregular and disadvantaged working conditions (United Nations Population Division, 2002; Kelly et al., 2010). These disadvantages may have an effect on infant health in the first year of life.

Research has shown that the occupation of the mother is an important factor related to infant deaths. Two major theoretical frameworks have been used to explain the causal effect of mother's occupation on infant survival. First, the analytical framework of Mosley and Chen (1984) has been frequently recognized and used in related studies in the developing world. The socioeconomic determinants in that framework include mother's education, income and occupation. These variables affect the proximate determinants, and are closely linked to, child survival. They vary by productivity (time, skill and health) and directly affect the mother and infant during pregnancy (Mosley and Chen, 1984). Secondly, the social determinants of infant mortality and birth outcomes are shown in Kim and Saada's (2013) theoretical framework to have an impact on lowered fertility in western countries. Work and living conditions operate on the intermediary determinants of IMR, and this model also considers time as an important factor (Kim & Saada, 2013). The time constraints of pregnant women and mothers are determined by the working responsibilities in their lives.

Moreover, the critical post-neonatal period is mostly affected by social factors. These frameworks set out the critical relationships in modeling IMR, and form the basis for using evidence on employment and social factors to determine if the mother's work is related to the death of her child in the first year of life. Evidence on mothers' occupations can thus also be analyzed to identify the associated risk.

The Prospective Cohort Study of Thai Children (PCTC) may be the first on-going prospective cohort study in Southeast Asia to collect information on these critical variables over time. The prospective and comprehensive nature of the data were recognized in a recent systematic review as providing critical evidence to uncover the burden of neonatal deaths in limited-data settings in the ASEAN region (Tran, Doyle, Lee & Graham, 2012). Generally, in ASEAN countries there is little data available to establish whether mother's employment during pregnancy affects the probability of infant death. The principal strength of the PCTC data is that it began collecting data on mothers and their employment and family characteristics during pregnancy, permitting an analysis of the association between mother's work in this time period and subsequent infant death.

This paper examines the relationship between employment of the mother and infant death in Thailand by estimating the survival probability over time using data from the PCTC for 2000-2002. The expected benefits of this study are: (1) to highlight the risk factors of the mother's working conditions during pregnancy; (2) to increase understanding of the dual role of the mother; and (3) to collect evidence for policymakers who are concerned about the risks of pregnant women's job conditions. Moreover, this evidence-based approach allows a greater understanding of how to improve the health and well-being of children and contribute to improved understanding of the role that various factors may have on health and disease for children in Thailand over the coming generation.

Materials and Methods

The analysis uses pregnant women/infant cohort data from the PCTC. The data includes eligible, pregnant women interviewed at 28-36 weeks gestation during the years 2000-2002, who were then followed throughout the first year of the child's life. The data were obtained from four district communities and one urban setting: Muang District, Nan Province in the north region; Kranuan District, Khon Kaen Province, in the northeast region; Panomthuan District, Kanchanaburi Province, in the central region; Thepa District, Songkhla Province, in the south region; and a hospital-based sample from Bangkok (the capital city).

Ethical issues of the study were thoroughly reviewed in both the data collection and the analysis phases. The Research Ethics Committee of the National Ethical Committee, Ministry of Public Health, Thailand, approved the PCTC study protocol. In addition ethical approval for this study was given by the Institutional Review Board of the Institute for Population and Social Research, Mahidol University in August 2012.

The data set is comprised of five cohorts consisting of 4,215 mothers and 4,245 live births, including 30 sets of twins. Among these are 31 infants who died during the first year of life. For the Kaplan-Meier analysis to determine survival probability, the timing of the infant death was coded by day-age. Significant risk factors were identified by using the chi-square test, Fisher's exact test and binary logistic regression analysis.

Work status and occupation were classified according to Wacharaporn (2008) and Sawangdee and Piewluang (2001) into four categories and six sub-categories based on the International Standard Classifications of Occupation (ISCO) of the International Labor Office (ILO) and further adopted by the NSO, Thailand. Mothers were first categorized as to whether they were working or not during pregnancy. Next, occupations were grouped into informal or formal, with formal occupations grouped into low, middle and high levels. The three formal occupation categories each had two sub-categories by work type.
With reference to the conceptual frameworks of Mosley and Chen (1984) and Kim and Saada (2013) other independent variables considered in this study include:

- Socioeconomic factors such as region of residence, mother's marital status, mother's educational attainment, household income per capita, and whether the mother had child care assistance from other persons.
- Proximate determinants or intermediary factors such as perinatal morbidity resulting in hospitalization, non-attended antenatal care and mother's age.
- Infant factors including low birth weight (LBW), and pre-term birth.

The chi-square test and Fisher's exact test were used to examine the association between mothers' occupation and infant death during the third trimester of pregnancy. Fisher's exact test was used for examining the significance of the association between two groups when the chi-square test was not appropriate (e.g., with very unequally distributed cells of a two by two table and small sample size). The Kaplan-Meier cumulative proportion surviving (P_x) at various time points was estimated, both for the whole sample and for certain occupational groups (Goel, Khanna, & Kishore, 2010). The log-rank test was applied to compare the difference in survival distributions of two categories. Finally, occupation type was evaluated as a determinant of infant death using binary logistic regression analysis. All analyses utilized the statistical software package STATA.

Results

The total number of live births in the cohorts under examination was 4,245 cases. As seen in Table 1, one-third of the mothers of these children were working in mid-level occupations, 30% in low-level occupations, and 6% in high-level occupations during pregnancy. A higher percentage of infant deaths (relative to survival probability at one year) was found among low-level occupational groups including skilled agricultural and fishery workers (death: non-death, 32.3%: 23.1%) and construction laborers (9.7%: 7.1%), and among those with unreported occupations (9.7%: 0.7%). The rest of the occupations had a lower proportion of infant deaths relative to the proportion of mothers in that occupation.

Table 1: Percentage of infant deaths by mother's work status and occupation (PCTC)

	Death	**Non-death**	**Total**
(Total Number)	(31)	(4,214)	(4,245)
Not working	16.1	17.9	17.9
Informal work	9.7	12.5	12.4
Low-level occupations	41.9	30.1	30.2
Construction laborers	*9.7*	*7.1*	*7.1*
Skilled agricultural and fishery workers	*32.3*	*23.1*	*23.2*
Mid-level occupations	19.4	32.9	32.8
Plant and machine operators	*6.5*	*8.4*	*8.4*
Service workers including clerks, shop and market sales workers	*12.9*	*24.5*	*24.5*
High-level occupations	3.2	5.9	5.8
Government workers including legislators, senior officials and managers	*0.0*	*0.1*	*0.1*
Professionals and technicians	*3.2*	*5.8*	*5.8*
Unreported	9.7	0.7	0.8
Total	100.0	100.0	100.0

Survival analysis

The Kaplan-Meier method was used to estimate the cumulative probability of survival from birth to one year of age (Goel, Khanna, and Kishore, 2010). As is normally seen in studies of infant mortality, the cumulative survival curve dropped sharply during the early days of the infant's life (Figure 1).

When examining mother's employment sub-groups by the cumulative Kaplan-Meier survival curve, maternal work type was not strongly associated with the survival probability of the infants. However, when examining sub-groups of middle- and low-level occupations, the survival curve for the low-level occupational group declined sharply after 7-28 days of life (late neonatal period) and fell more slowly after 28 days of life (during the post-neonatal period) when compared with the middle-level occupational group. By contrast, there was not much difference in survival probabilities for these two occupational groups for the early neonatal period (Figure 2).

To confirm these findings, statistical significance was calculated using the log-rank test (Rosner, 2006). Analysis focused on all five groups of occupations and between the middle- and low-level occupations. The results do not show a distinct difference among all five occupational categories; however the largest difference was found between the middle- and low-level groups of occupations and this was statistically significant at $p<0.10$ (log-rank test chi-square 3.21, $p = .073$).

Figure 1: Kaplan-Meier's cumulative survival curves in the first year of life day-age

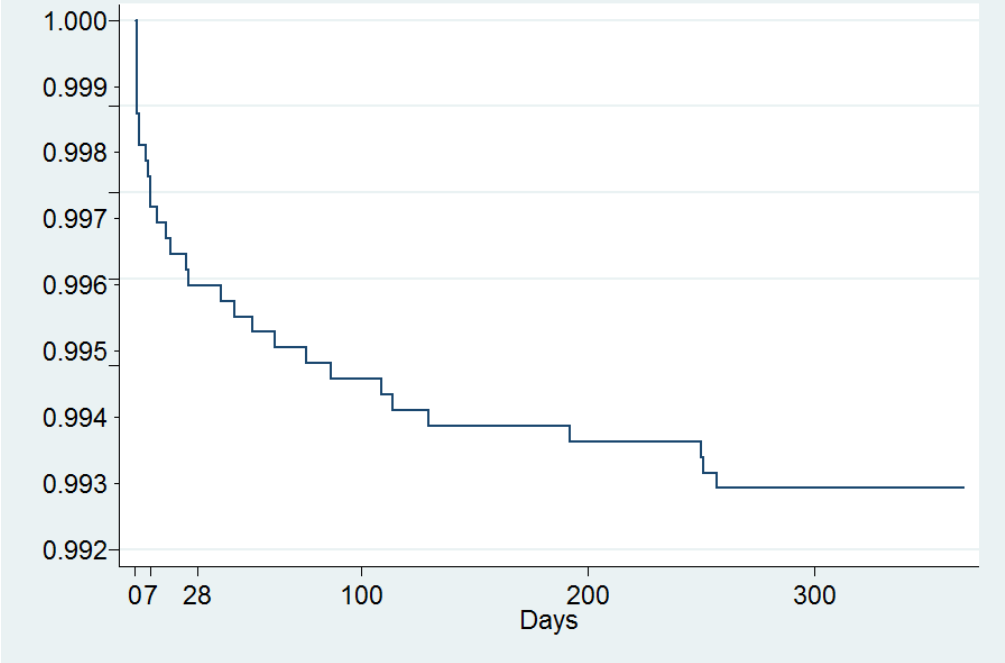
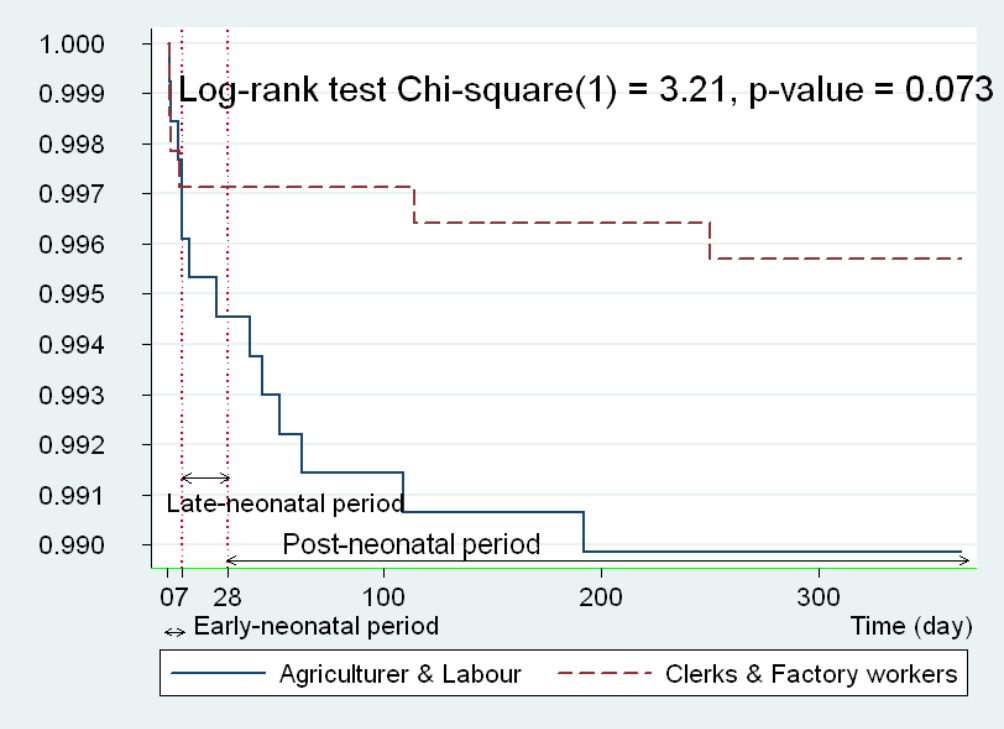


Figure 2: Kaplan-Meier's cumulative survival curves by two occupational groups (low- and middle-level occupations, respectively).



Logistic regression analysis

The association between mother's occupational group and the risk of an infant death was further evaluated by binary logistic regression (Table 2). When analyzing the relative importance of socioeconomic status—particularly occupation—in relation to infant death, pregnant woman's employment and type of occupation were not found to be associated with infant mortality. However, employment in a mid-level job had a protective effect of avoiding early infant death compared with those with low-level occupations. Variables which were significantly associated with infant deaths include not attending ANC, low birth weight, pre-term birth, perinatal hospitalized morbidity, lower income per capita, and rural area residence.

Table 2: Percentage distribution of mother's socioeconomic factors and odds ratio from logistic regression analysis on infant death in the PCTC.

Characteristics	Percent	Odds ratio	p-value	p-value of χ^2 model
Mother's socioeconomic factors				
Mother's work**, α	100.0			
Unemployed	16.1	0.65	0.410	
Informal workers	9.7	0.56	0.364	
Low-level occupations (ref)	41.9	1.00	-	
Middle-level occupations	19.4	0.42	0.082	
High-level occupations	3.2	0.40	0.372	0.016

Characteristics	Percent	Odds ratio	p-value	p-value of χ^2 model
Not reported	9.7	10.11	0.001	
Mother's education*, α	100.0			
No education(ref)	6.5	1.00	-	
< secondary school	67.7	0.73	0.669	
>+ secondary school	16.1	0.71	0.684	0.048
Not reported	9.7	7.02	0.035	
Marital status**, α	100.0			
Live together	87.1	1.00	-	
Single parent	3.2	1.53	0.679	0.008
Not reported	9.7	13.34	0.000	
Income per head quartile**, α	100.0			
< 1st quartile (<500)	25.8	1.00	-	
1st-2nd quartiles (500-899)	29.0	1.09	0.858	
2nd-3rd quartiles (900-1,749)	22.6	0.87	0.784	
>= 4th quartile(1750+)	6.5	0.24	0.073	0.007
Not reported	16.1	6.60	0.008	
Child care assistance from other persons**,	100.0			
No (ref)	58.1	1.00	-	
Yes	9.7	1.07	0.859	0.004
Not reported	32.3	17.69	0.000	
Region and urban status†, α	100.0			
Bangkok	3.2	1.00	-	
Rural South	22.6	5.41	0.112	
Rural Northeast	16.1	4.16	0.193	
Urban North	32.3	9.34	0.033	
Rural Central	25.8	6.45	0.082	0.076

α = Fisher's exact results for small expected values (<5) (Rosner, 2006)
*** p<0.001, ** = p<0.01, *=p<0.05 †=p<0.10

Results from the logistic regression show a significant difference for some socioeconomic factors, some proximate determinants, and all infant factors (Table 3). Mother's work sub-group, unemployment, informal work and three levels of occupations were not significant factors for infant mortality at the p<0.05 level in this study. However, if a p-value less than 0.10 is taken into account, those with a middle-level occupation were 58% less likely to be associated with an infant death compared to a low-level occupation (p = 0.08). Secondly, those in the 4th quartile income group were 76% less likely to be associated with an infant death in comparison to those in the 1st quartile. Thirdly, compared with Bangkok, mothers in the urban North and the rural Central region are 9 times and 6 times more likely to experience an infant death (p = 0.03 and 0.08 respectively). Among the proximate determinants, those mothers who did not attend ANC or had perinatal morbidity requiring hospitalization were more likely to experience an infant death (odds ratio = 4.78 and 4.18, p-value = 0.01 and 0.01 respectively). Both infant factors (LBW and pre-term) conferred a high risk of infant mortality in this study (odds ratio = 8.46 and 6.70, p < 0.001 and < 0.001 respectively). By contrast, mother's age group, education, marital status, and whether she had child care assistance from others were not related to infant mortality (p-value > 0.10).

Therefore, the factors that are associated with infant mortality in this study include mother's occupation, income quartile, region of residence, ANC attendance, hospitalization for perinatal morbidity, LBW and pre-term birth.

Table 3: Percentage distribution of proximate determinants and infant characteristics and odds ratio from logistic regression analysis on infant death in the PCTC.

Characteristics	Percent	Crude odds ratio	p-value	p-value of χ^2model
Proximate determinants				
Attended antenatal care**, α	100.0			
Attended ANC(Ref)	58.1	1.00	-	
Not attended ANC	9.7	4.78	0.013	0.008
Not reported	32.3	2.91	0.007	
Perinatal hospitalized infant morbidity*, α,b	100.0			
No(Ref)	48.4	1.00	-	
Yes	16.1	4.18	0.006	0.016
Mother's factors**, α	100.0			
Age 20-34(Ref)	67.7	1.00	-	
Age<20	3.2	3.22	0.254	
Age >= 35	19.4	5.09	0.133	0.006
Not reported	9.7	40.00	0.002	
Infant characteristics				
Pre-term birth***	100.0			
Normal Term Birth(Ref)	48.4	1.00	-	
Pre-term Birth	32.3	6.70	0.000	0.000
Not reported	19.4	4.17	0.003	
Low Birthweight (LBW)***	100.0			
Normal Birthweight(Ref)	38.7	1.00	-	
LBW	32.3	8.24	0.000	0.000
Not reported	29.0	8.46	0.000	

α = Fisher's exact results for small expected values (<5) (Rosner, 2006)

b = Information on perinatal hospitalized infant mortality was coded from raw data collected by Sornsrivichai et al. (2008). Data from three rural districts only is included (n=2,739) as it was not possible to collect hospitalized infant morbidity data using the same methods in the urban districts (Bangkok and Nan) due to heterogeneity.

***p<0.001, ** = p<0.01, *=p<0.05 †=p<0.10

Discussion

Even though the PCTC data set is over ten years old, some key features make the findings reported here still valuable today. First of all, the PCTC used a prospective cohort methodology, and collected data on the mother's occupation. Thus this study permits the analysis of a genuine, causal relationship between mother's work and infant mortality. Owing to

the large size of the PCTC data set, the study can show the effect of date of death through application of the Kaplan-Meier survival probability curve. It allows an examination of a variety of high-risk factors in the low-fertility and low-mortality context in Thailand. The PCTC collected data from a large area in five regions of Thailand which have diverse cultural, language and ethnic differences. These differences help to clarify which factors are most important in elevating or reducing the risk of infant mortality. Although the PCTC resembles a purposively selected sample in a few communities around the country, the prospective nature of the data set makes the PCTC a valuable resource for current and future analysis.

The main findings on infant mortality risk factors reported here are consistent with the recognized analytical framework of Mosley and Chen (1984) and the recent framework of Kim and Saada (2013), which uses the concept of social determinants of infant mortality and birth outcomes by age of infant and non-health policies.

The early neonatal period (0-7 days) is the most critical age for survival due to bio-medical factors. Perinatal conditions are the major causes of infant morbidity (Sornsrivichai, Chongsuvivatwong, Mo-suwan, & Intusoma, 2008) and mortality (Mo-suwan et al., 2009) during the first seven days of life; medical experts maintain that 38% of infant survival is based on receiving ANC and intra-partum care services. In addition, both the rapid drop in survival during this period, as depicted by the Kaplan-Meier survival curve (Figure 1), and the four-fold higher risk of dying if admitted for perinatal morbidity, confirm this serious biological risk in the very early period of life. During this critical period it is difficult to prevent premature death because only one-third of infant deaths can be prevented, and because congenital anomalies and other threatening perinatal conditions cannot be controlled. In the first week of life, biomedical determinants play a major role to protect infants from illness and death, and almost no social factors have significant effects.

The late- and post-neonatal period (8-28 days and 29-365 days of life) are less risky than the first seven days, but social factors begin to play a more important role in infant survival for two reasons. Firstly, many previous researchers have observed that post-neonatal deaths are related to socioeconomic or social factors (Arntzen, Samuelsen, Bakketeig, & Stoltenberg, 2004; Chowdhury, Islam, & Hossain, 2010; Dummer & Parker, 2005; Son & Lee, 2011; Sovio, Dibden, & Koupil, 2012). Secondly, this study found support that the mother's occupation, as a social factor, was significantly associated with the probability of survival at the late- and post-neonatal periods. Specifically, women employed in agriculture and construction jobs (low-level occupations), had a rapid decline in their infants' post-neonotal survival (Figure 2) when compared with women who worked in the industrial and service sectors (mid-level occupations). By contrast, during the previous period (0-7 days) the survival curves were almost the same for these two occupation groups (Figure 2). For this reason, social factors, especially mother's occupation, should be considered as important risk factors for infant mortality.

Socioeconomic disadvantages associated with these occupation groups may account for these differences in infant survival. However, there may be other explanations for this difference, such as physical working conditions, health insurance related to occupation, and the impact of Thai labor laws. Women in the higher-status occupational groups typically have the background and benefits of better education and greater income. Women employed in agriculture or construction work certainly have higher risks at work and poorer working conditions, including a strenuous physical workload and long and irregular work hours, when compared to the industrial and service sector occupations. The linkage between occupation and health insurance depends on the health care system development. In the last decade, the universal health insurance coverage scheme ("30 baht plan") of Thailand has significantly reduced health care access inequality

(Gruber et al., 2013). With regard to Thai labor laws, during the years 2000-2002 agricultural and construction workers were not included as part of the social security fund of the Ministry of Labour and Social Welfare under the Labour Protection Act of B.E. 2541 (1998). This was due to the fact that the law did not protect pregnant female laborers from working in agriculture or fisheries and allowed employers to hire female workers to work in the construction or mining industries (male occupations, Section 38), whereas the remaining occupational categories were addressed under the Labour Protection Act (Ministry of Labour, 1998). Unfortunately, the data in this study show that this did not prevent many poor women from working in these occupations without the protection of the law. Therefore, the differences in working conditions, health security and job protection between these two occupational classifications, so-called "absolute material condition" in a US study (Finch, 2003), should be a concern in reducing social disparity related to infant deaths.

Regarding other social factors, this study found an influence of geographical area and per capita income on infant deaths. The Ministry of Public Health of Thailand (Wibulpolprasert, 2005) reported that there were inequalities of IMR in different population groups, such as non-municipal and municipal residents. This study found that the women in the capital of Nan Province (Northern region) and Panomthuan District (Central region) had a statistically different infant death rate from Bangkok (Capital City), which was related to the difference between non-municipal/municipal and urban/rural areas. However, this finding is possibly related to the research methodology of these two study areas. The Bangkok sample was collected from hospital-based services in Bangkok. This is reflected in the fact that the Bangkok sample had a higher quality of maternal and child health service from a distinguished government hospital, in which there was a higher number of medical and professional staff and higher quality of care. But the women in this area also had higher socioeconomic status. In contrast, the urban capital district of Nan Province is a poorer, provincial urban community, and Panomthuan District both has a lower quality level of health care and is situated in the manicipal and rural area. This difference might account for the fact that the mothers in the urban North and rural Central area had a higher risk of infant deaths than mothers in Bangkok.

All health factors, both pre-natal care (ANC attended) and post-natal care (hospitalized infant morbidity) were the most significant factors for improving infant survival. Mo-Suwan et al. (2009) and Sornsrivichai et al. (2008) suggested that attending ANC can prevent peri-natal morbidity and hospitalized infant morbidity, and these results are reflected in this study's findings. This implies that in order to have a surviving infant through the first year of life, ANC services in pregnancy and postnatal health care are critically important. Also, the same recommendation is made for reducing adverse birth outcomes such as LBW and pre-term birth. Pregnant women should be well prepared with health information and have ready access to health care services to protect their child in this early stage of life.

A note should be made about the cases of unreported mother's occupation, as the highest percentage of infant deaths (9.4%) and a greater proportion of infant deaths than live births (Table 1) occurred among this small number of women (0.75% of all mothers). Possible reasons to explain this include the probability that these cases are drawn from the urban slum context, affected by circular migration and had a high prevalence of maternal and child illnesses.

Firstly, mothers with missing work information accounted for all neonatal and urban infant deaths among the urban North and hospital-based Bangkok cases. Mothers with missing occupation data might be experiencing burdens from living in a very poor environment, with

vulnerability to disease and poor accessibility to higher quality of care. The underreporting of mother's occupation would be more likely to occur among pregnant migrants in urban areas.

Secondly, the PCTC fieldworkers reported that unreported occupation and other background characteristics of the mother were due to migration for work. The same reason was reported in a study in Malawi, where incomplete data due to loss of follow-up participants resulted from migration in urban areas. Moreover, this group had twice as high a chance of having a deceased infant (Lewycka, 2010). Mothers living in urban slums may prefer to return to their place of rural origin for better care of their infants, which was the finding in the Health and Demographic Surveillance System (HDSS) in an urban slum in Kenya (Beguy, Zulu, Muindi, Konseiga, and Yé, 2011).

Lastly, maternal and child illnesses could be one of the possible causes of incomplete information on the pregnant mother's occupation. Moreover, those pregnant mothers who faced pregnancy and delivery complications had a higher chance of neonatal death caused by prematurity or pre-term birth (Campbell, et al., 2004). Two-thirds of the infant deaths in the PCTC 'non-reported occupation of mother' category occurred among LBW and pre-term births. Mothers with severe illness who could not work or care for their vulnerable child in the early stages of life as a consequence are more likely to experience infant death.

Therefore, it is likely that the vulnerable pregnant mother in the slum, the migrant mother and the very ill mother in late pregnancy contributed to the greatest number of infant deaths and higher proportion of deaths than live infants in this study.

Conclusion

The occupational group of the mother has an independent association with infant deaths: those working in agriculture or construction labor had a higher risk of infant death when compared with the middle-level industrial and service-sector occupations. Improving maternal ANC attendance, reducing LBW and pre-term birth infants, enhancing care of perinatal hospitalized cases and improving rural community health care for women engaged in construction labor and agriculture should have a significant impact in reducing infant deaths in Thailand.

The findings of this study suggest an important role for two main institutions in protecting a child with regard to the mother's social factors. First, the results provide evidence supporting an intensified role for government to support those poorer, pregnant women working in agriculture and construction, to increase uptake of ANC services, and improve access to maternal and child health services at hospitals, in order to prevent the risk of LBW, pre-term birth, and peri-natal hospitalized morbidity. Secondly, providing mobile ANC, home-visit ANC, and maternal care coordination for pregnant women in the agricultural and construction fields can also directly address their special needs. Thus, the Thai government and the Ministry of Labour in particular should support health and security insurance for these women and pressure employers to remove them from strenuous labor in order to protect the pregnancy and the health of the child in the first year of life.

Second, the family should be encouraged to support pregnant mothers' access to both pre-natal and post-natal health care services, especially in the post-neonatal period. This would discourage women from working in the first year post-partum. Especially for women in occupations

involving manual labor, families should assist them and support access to health care services, balancing their pregnancy care and carefully monitoring and restricting the amount of arduous work.

Finally, the populations in the rural North and Central areas in underreported occupations and socioeconomic groups should be further studied, in order to understand the higher number of infant deaths in this group.

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