An Evaluation of the Safe Motherhood Hospital Program*

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I. INTRODUCTION

1. A reduction in the maternal mortality ratio (MMR) is one of the targets of the Millennium Development Goals (MDGs). Eight ambitious goals to be achieved by 2015 form the MDGs, which were set out as a global agenda to promote human development and reduce inequalities. With regard to Goal 5 on improving maternal health, Thailand committed itself to reducing MMR by three-quarters between 1990 and 2015. MMR is an indicator for the achievement of the Goal's target. A broad definition of MMR is the number of deaths among women due to pregnancy and childbirth complications per 100,000 live births in a given year.

2. To achieve that MDG target, Thailand should at least have reliable statistics on maternal deaths and should have a clear policy direction for improving maternal health. The Safe Motherhood Hospital (SMH) Program could help in improving the quality of life of women with regard to maternal health and help Thailand achieve Goal 5 if it actually reduces MMR in the country. However, although the Program has been under implementation for nine years, there has been no impact evaluation of it. Therefore, the main objective of this research study is to provide an impact evaluation of the Program's impact on maternal mortality. The Program might also have impacts on the cost of providing maternal care, such as the labor cost for child delivery, the cost of hospital beds and the cost of referring patients. These expected impacts will also be included in our study. This research is expected to promote more discussion on clear policy guidelines to achieve the Goal for improved maternal health.

3. The research will use the propensity score matching (PSM) technique, which is widely used for non-experimental studies. PSM has been a popular approach to estimate causal treatment effects, particularly when evaluating labor market policies and social programs (see Heckman et al. 1997; Dehejia and Wahba 1999; Heckman et al. 1998; Heckman and Smith 1999). The technique is considered inexpensive and very useful for evaluating public projects in countries such as Thailand where projects have been implemented without prior design for impact evaluation.

II. SAFE MOTHERHOOD HOSPITAL PROGRAM IN THAILAND

4. In 1998, the Department of Health (DOH) and the Office of the Permanent Secretary, both departments under the Ministry of Public Health (MOPH), together with the World Health Organization (WHO), initiated a two-year project called the "Excellent Safe Motherhood Hospital Initiative." At the beginning, only a small number of advanced hospitals joined the project. They were expected to be models for other hospitals. Two years later, MOPH asked every hospital under its supervision to cooperate and implement the SMH Program. DOH, which is in charge of the SMH Program, established an 11-step set of guidelines for implementation, as follows:

(a) The director of the hospital adopts a policy to participate in the SMH Program.

(b) The hospital provides training courses for staff concerning the standard of prenatal and postnatal care.

(c) The hospital provides standard prenatal care.

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(d) The hospital provides prenatal care groups with training at least once for pregnant women and their husbands/relatives.

(e) The hospital must have standard child delivery services.

(f) The hospital must provide standard service for newborns in the delivery room.

(g) The hospital must provide standard postnatal care, i.e., group training on baby care, breastfeeding, and family planning.

(h) The hospital must provide standard care for newborns, i.e., vaccination, and training for baby feeding and health monitoring.

(i) The hospital collects maternal, child delivery and newborn data and analyzes the data with healthcare personnel.

(j) The hospital provides counseling services related to unwanted pregnancy and complications in child delivery.

(k) The hospital should collaborate with other hospitals in providing documentation for monitoring prenatal and postnatal healthcare.

5. Together with the guidelines, DOH also provides the hospitals with standard process and self-evaluation guidelines. DOH and Provincial Public Health Offices work together on process evaluation. As of 2005, almost all of the provincial hospitals (except in two provinces) and almost two-thirds (about 63%) of all hospitals have successfully completed the process evaluation.

6. It should be noted that SMH has been adopted as the policy of MOPH. All hospitals under the supervision of MOPH have to cooperate and help MOPH achieve the target. There is no incentive for cooperating and no monetary penalty for not cooperating. Hospitals do not receive an additional budget for following the SMH guidelines. Budget allocation from MOPH is not based mainly on activities, but rather on the size of the hospital. MOPH still retains authority over health personnel allocations even after the implementation of healthcare reform in 2001.

7. DOH has made maternal death a serious issue in every hospital. If there is a maternal death in a hospital, the Provincial Public Health Office and all public hospitals in the same province and neighboring provinces have to organize a confidential case conference and report to DOH on their assessment. The conference is aimed at determining the cause of death and sharing information about the incident with other provinces. DOH and health personnel learn from such a case and try to avoid similar cases in the future. The case conference process could be considered as a non-monetary penalty for those hospitals where maternal deaths have occurred.

III. METHODOLOGY

8. The SMH Program is aimed at improving maternal and child health and reducing mortality among mothers and children. Since collecting data on infant mortality requires a longer period of time than other types of mortality and infant deaths are normally under-reported and very difficult to trace, we do not include an evaluation of how the Program has impacts on infant mortality. The outcome measure of the impact is the proportion of maternal mortality to total child deliveries at the hospital and the cost per delivery. The SMH Program will be evaluated at the community, general and regional hospital levels. Since the decision on SMH Program participation must be that of the director of the hospital, we first provide a model for the decision.

Decision on Program Participation

9. If the decision of a hospital to participate in the Program depends upon the net present value of the social benefit of providing people in the community with healthcare, which can be expressed as NSB_i^*, the director of such a hospital, who has the authority and responsibility for all aspects of the hospital's performance, will make the decision based on the present value of the social benefit of participating in the SMH Program, SB_i, and the present value of the social cost of participating in the Program, SC_i. The director of the hospital will participate in the Program if $NSB_i^* > 0$, where $NSB_i^* = SB_i - SC_i$. The Program might benefit the healthcare of mothers and children when the hospital participates in the Program; however, with limited resources, it may result in costs for other types of patients. For example, if more nurses are allocated for providing maternal and child healthcare, patients seeking other types of care may have to wait longer before getting treatment and may be allocated a shorter time for their consultation.

10. Social benefits and costs also include private (e.g., that of the director of the hospital) benefits and costs. There might be some pressure from MOPH or colleagues that makes the private costs or benefits of the director of the hospital especially high or low. In a province where only one district hospital has not yet participated in the Program, that hospital may feel considerable peer pressure. Such a hospital may make the head of the Provincial Public Health Office appear to be under-performing. As a result, the director (under pressure from outsiders) may place a very high value on his or her private benefits and thus participate in the SMH Program. SB_i and SC_i may depend on many factors such as the following:

- Director's characteristics, e.g., response to new policy or work experience;
- Geographic factors, e.g., location of hospital, distance to referral hospital;

- Socio-demographic structure of people in the community, e.g., proportion of fertile women or older population, proportion of farmers or blue-collar workers, ethnic minorities, concentration of migrant workers, degree of urbanization, share of population in the agricultural sector, average level of education, family structure, main religion, and average earnings;
- Availability of the hospital's resources and infrastructure, e.g., number of healthcare workers, size of hospital, equipment facility of hospital;
- Capacity of the hospital, e.g., number of inpatients and outpatients, number of child deliveries, number of new antenatal care patients.

11. Let these factors be included in vector X_i, the hospital *i*'s decision to participate in the Program can be written as:

$$(1) \quad NSB_i^* = f(X_i)$$

We assume a linear function for NSB_i^*, that is:

$$(2) \quad NSB_i^* = X_i\alpha + \varepsilon_i,$$

where ε_i is an error term with a standard normal distribution. NSB_i^* is unobserved, but we observed the participation of hospital *i* in the SMH Program. Let D_i be 1 if hospital *i* participates in the Program, and 0 otherwise:

$$(3) \quad D_i = 1 \text{ if } NSB_i^* > 0; \text{ and}$$
$$= 0 \quad \text{otherwise.}$$

The probability that a hospital will participate in the SMH Program is given by the following equation:

$$(4) \quad Pr(D_i = 1|X_i) = Pr(NSB_i^* > 0).$$

With a standard normal distribution assumption of ε_i, we estimate (4) using a Probit model.

Mean Impact on Outcome of the Participants

12. To evaluate the impact of the Program, we want to know the difference between the proportion of maternal mortality of the hospitals participating in the Program (treatment group) and the hospitals not participating in the Program (comparison group). Let Y_i be a random variable representing an outcome indicator for hospital *i* (i.e., a proportion of maternal mortality to total child delivery or labor cost per child delivery), Y_{0i} and Y_{1i} are outcome indicators for non-participating and participating hospitals, respectively. The mean impact of the program on the treated *i* — that is, what the literature calls the "average effect of treatment on the treated" (Heckman et al. 1997; Heckman et al. 1998), or ATET — is:

$$(5) \quad ATET = E(Y_{1i} \mid D_i = 1) - E(Y_{0i} \mid D_i = 1).$$

13. If the Program has a positive impact on maternal mortality (i.e., it reduces the mortality rate), the value of ATET will be negative. However, estimation of ATET in the above equation encounters selection bias. This is because participation in the Program is not random. The director of the hospital decides to be in the treatment group when NSB_i^* is positive. An additional problem with the calculation is that we observe only one of the outcomes, $E(Y_{1i} \mid D_i = 1)$. To correct selection bias, we estimate the counterfactual mean outcome of participating hospitals, that is, we want to estimate the average outcome of participating hospitals if they were not in the program, $E(Y_{0i} \mid D_i = 1)$.

14. We assume that conditional on covariates X_i, which are not affected by participation, Program participation is independent of the outcome of treatment and comparison groups. This implies that we observe all variables (i.e., director's characteristics, geographic factors, socio-demographic structure of the people in the community, availability of hospital's resources and equipment, and performance of the hospital) that influence simultaneously the Program participation decision and potential outcomes. This assumption is referred to as "unconfoundedness" or "conditional independent" (Rosenbaum and Rubin 1983; Lechner 1999). However, Heckman et al. (1998) noted that it is necessary only to assume conditional mean independence for the non-participants (i.e., $E(Y_{0i}|X_i, D_i = 1) = E(Y_{0i}|X_i, D_i = 0)$) in order to estimate the average treatment effect on the treated.

15. Rosenbaum and Rubin (1983) showed that, if outcomes are independent of participation conditional on covariates X_i, then they are also independent of participation conditional on the propensity score $P(X_i)$. In our application, the propensity score is the probability of participating in the SMH Program given observed characteristic X_i, or $P(X_i) = Pr(D_i = 1 \mid X_i)$ estimated from equation (4). If that conditional independent assumption holds and $Pr(D_i = 1 \mid X_i) < 1$, the PSM estimator for ATET is:

$$(6) \quad ATET = E_{P(X)|D=1}\{E(Y_{1i} \mid D_i = 1) - E_Y(Y_{0i} \mid P(X_i), D_i = 0)\}.$$

16. Under the conditional independence assumption, exact matching on $P(X_i)$ eliminates all biases due to selection into the Program based on observable variables (Imbens 2004). After obtaining $P(X_i)$, we will match non-participating hospitals that have similar probabilities of participating in the SMH Program. Matching is based on selection on observed variables. Matching acts like random assignment because it balances the observable of the participants and comparison groups.

17. We use the following general form of the matching estimator (e.g., Heckman and Smith 1999).

$$(7) \quad ATET(S) = \sum_{i \in (D_i=1)} [Y_{1i} - \sum_{j \in (D_j=0)} w_{n0,n1}(i,j) Y_{0j}] \text{ for } P(X_i) \in S,$$

where Y_{1i} and Y_{0j} denote outcome indicators for participant *i* and non-participant *j*, respectively, n0 is the number of non-participating hospitals (comparison hospitals), and n1 is the number of participating hospitals; $w_{n0,n1}$ (i, j) is the weight attached to comparison hospital *j* in constructing the counterfactual outcome for participant *i*. The sum of the weights for each *i* equals 1. The set S is the common support of $P(X_i)$. In this study, we define the common support by dropping those treatment observations whose $P(X_i)$ is higher than the maximum or less than the minimum $P(X_i)$ of the comparison hospitals. Moreover, each participant is also matched by using a weighted average over comparison hospitals for sensitivity analysis. Caliper matching, Kernel matching and local linear matching with various bandwidths are used.

IV. DATA

18. The primary source of data is a hospital survey conducted by the author and her associates between September 2007 and April 2008. We started by sending questionnaires to 837 public hospitals under MOPH supervision. With four months of follow-up, including telephone calls and hospital visits, we obtained an 86 percent response rate. Six of the responses were far from complete and thus deleted from the analysis sample.

19. There were 18 districts with more than one MOPH hospital in 2006. We deleted those hospitals from our sample because there were two or three hospitals that shared similar district-related covariates. However, there was only one maternal death outcome in each district and we could not tell which hospital dominated the outcome. We also deleted Health Promotion Centers from our sample because they used to be special health centers for maternal and child healthcare. They did not take part in the SMH Program as implementors, but as evaluators. The recent reform in DOH led some of them to cease providing child delivery services. Two community hospitals eliminated such services because the capacity of one of them was so low that it did not perform child delivery and the other opened in 2006 (the year that we evaluated the impact of SMH). The final sample size was 677 hospitals, composed of 600 community hospitals, 58 general hospitals, and 19 regional hospitals.

20. Additional secondary data were collected from the Community Development Department, Ministry of Interior. The data represented the socio-demographic structure of each district.

21. Based on our survey, 57 hospitals have not yet passed DOH evaluation. About 28 percent passed evaluation after the Program had been implemented for five years. Another 34 percent just passed the evaluation in the past three years. A large proportion of hospitals in northern and southern Thailand passed evaluation in 2006 and in southern Thailand in the period 2003-2004, respectively. In northeastern Thailand, many of the hospitals passed evaluation in 2001, 2002, and 2005. It seemed that a hospital would pass evaluation in the same year as its neighboring hospitals.

22. A typical problem with recording the number of maternal deaths arose when we conducted the hospital survey. The number of maternal deaths counted using the questionnaire was too low. From the interviews with hospital staff, we found that Thai healthcare staff do not correctly understand the definition of maternal death. In this study, we use a definition that is more precise than the one for MMR in the introduction, that is, the definition of maternal death in the 10th revision of the International Classification of Diseases (ICD-10): a maternal death is the death of a woman while pregnant or within 42 days of the termination of a pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by pregnancy or its management, but not from accidental or incidental causes (WHO 2004).

23. Worawan et al. (2007) used civil statistics and inpatient records to calculate the number of maternal deaths in the period 2004-2006. We will use the number of deaths from that study instead of the number obtained from the hospital surveys. Of all the districts in our sample, the reported number of deaths is less than half of the evidence-supported number. All types of hospitals under-report their maternal deaths. Seven of regional hospital replied to the survey that they had no maternal deaths in 2006; however, the data showed that only one of them had no maternal death in that year.

24. It should be noted here that our outcome indicator differs from that of MMR. We did not include mothers who gave birth without visiting a hospital. We did include those giving birth on the way to visit a hospital. Maternal death in this study omits women who died giving birth without having visited a hospital. This omission is not serious since approximately 93 percent of births in 2005 and 2006 were delivered in hospitals.[1] We used the proportion of maternal death to total child delivery as an outcome indicator. The denominator of our outcome indicator differs from that used in the MMR definition. One might call our outcome indicator the "case fatality rate."

V. RESULTS

Program Participation

25. In our analysis, we used two measures of Program participation: whether the hospital participated before 2004 and whether the hospital participated before 2005. We chose those two years because the Program would have been implemented long enough to have more hospitals involved which would show tentative impacts. About 44 percent of the sample passed process evaluation before 2004 and about 57 percent of them did so before 2005. Recent years of Program participation,

such as participation up to 2006 or 2007, may not be good for estimating because almost all hospitals had participated and outcome indicators were measured for the year 2006. In assessing the interview, we found that evaluation in recent years was not as serious as in the earlier period because policymakers have shifted their attention to newer policies, which might dilute the impact of the Program.

26. SMH Program participation is the decision of the director of the hospital. Factors that are expected to have effects on the director's decision and on the outcomes of the hospital are grouped into four categories: director's response to MOPH policies, geographic and health facilities in the district, the district's socio-demographic structure and hospital resources, capacity and infrastructure. Results for Program participation among the full sample and the community hospital sample are presented in Tables 1 and 2. For each sample set, the results are presented before the balancing test and after dropping variables that did not pass the balancing test.

27. The results show that, from the beginning of the SMH initiative to 2003, the number of changes of hospital director had a negative effect on SMH participation among the community hospitals (Table 1). A director with more years of work experience is more likely to have participated in the Program before 2005 (Table 2). Other variables are not statistically significant determinants of Program participation.

28. Hospitals in southern Thailand are more likely to participate in the SMH Program. When the size of a district is large, i.e., a larger number of villages in the catchment area, or a high proportion of population per nurse, the director of the hospital is less likely to participate in the Program. Hospitals in the northeastern part of the country were more likely to participate in the Program before 2004.

29. Population size and the structure of the district by age and sex may also affect Program participation. If there are more females in the childbearing age group than other population groups in the district, the population in that district will need more mother-child healthcare services than a district with fewer such females. The director may see this public need and improve the hospital services in order to respond to the need. This will increase the likelihood of Program participation.

30. Factors such as education, religion and occupation may also have impacts on the director's decision on participation. A highly educated and high-income society tends to be concerned with better healthcare. People with a high education or who work in the formal (non-agricultural) sector tend to have fewer children, and they may spend more time on perinatal care and be more concerned about mother-child care services than those with less education or those who work in agriculture. The director might perceive these factors and act in favor of this population. Thus, he/she would be more likely to participate in the SMH Program.

31. Tables 1 and 2 show that the director is more likely to participate in the Program if the proportion of females to the total population is high and the average household size is large. Large household size may imply a growing population in the district, which requires the provision of healthcare services for mothers and children. On the contrary, with a higher proportion of elderly in the population, it is less likely that the hospital would participate in the Program. Such a hospital may allocate more resources for geriatric healthcare, not maternal care.

32. If the proportion of private employees is high, it is less likely that the community hospital will participate in the Program. Thailand has three public healthcare schemes: Civil Servant Medical Benefit Scheme (CSMBS), Universal Healthcare Coverage Scheme (UC) and Social Security Scheme (SS). Private employees are under SS into which they pay monthly contributions. They have the option of choosing a registered hospital. In most cases, they choose hospitals with good services and equipment, which tend to be general or regional hospitals in cities, not community hospitals. This behavior may discourage community hospitals from focusing their services on private employees.

33. Hospital resources might encourage the hospital director to participate in the SMH Program or might limit the hospital's ability to participate. If a hospital has many doctors, gynecologists or other specialists and nurses, and all the necessary equipment, it would be easy for it to participate in the SMH Program. On the contrary, if such human and physical resources are limited, the hospital would have a difficult time in allocating the resources required to join the Program. It is not likely that such a hospital would get more specialists or gynecologists after participating in the Program since the Program is not designed for more human resource allocation. The Program is under DOH, which has no authority to make resource allocations to public hospitals. Budget, income, the number of new antenatal patients, and the number of inpatients and outpatients indicate the size of hospitals. The large values of these variables imply a high capacity for the hospitals, which might enable them to participate in many MOPH-promoted activities, such as the SMH Program. We do not expect that Program participation can influence these variables as the budget is allocated based on the population size in the catchment area. Moreover, pregnant women do not choose hospitals based on whether or not they are in the SMH Program. The areas of residence of pregnant women determine which public hospital they would visit since most of them are under UC, which covers about 80 percent of the population. That scheme does not allow the eligible population to choose their hospital.

Table 1 Participation in SMH Program before 2004

Variables	Total hospitals				Community hospitals			
	Before the balancing test		After dropping variables that do not pass the balancing test		Before the balancing test		After dropping variables that do not pass the balancing test	
	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics
1. Director and his/her response to policy								
Pass Hospital Accreditation evaluation (1=yes)	0.0275	0.43	0.0264	0.42	0.0567	0.83	0.0063	0.11
Hospital has SMH policy (1=yes)	0.0397	0.14	0.0419	0.15	-0.1002	-0.35	-0.0305	-0.12
Director announces SMH policy (1=yes)	0.2472	1.09	0.2404	1.06	0.2165	0.95	0.3046	1.38
Staff have attended training in the past 6 months (1=yes)	0.0766	0.50	0.0804	0.53	-0.0886	-0.56	0.1303	0.89
No. of changes of director since 1998	-0.0094	-0.85	-0.0097	-0.88	-0.0109	-0.96	-0.0167	-1.87*
No. of years director has been practicing	0.0041	1.26	0.0039	1.23	0.0050	1.44		
2. Geographic and health facilities in the district								
Northeast (1=yes)	0.0603	0.62	0.0624	0.64	0.1088	1.04	0.1131	1.85*
North (1=yes)	-0.0277	-0.34	-0.0241	-0.30	-0.0159	-0.18		
South (1=yes)	0.2671	2.59**	0.2687	2.60**	0.3465	3.17**	0.2982	3.71**
No. of villages in the district	-0.0029	-2.14*	-0.0028	-2.12*	-0.0033	-2.17*		
Distance to referral hospital (km)	0.0002	0.50			0.0002	0.27		
Distance to the nearest private hospital (km)	-0.0003	-0.42	-0.0001	-0.25	0.0003	0.45		
No. of private hospitals in the district	0.0985	1.53	0.1013	1.58	0.0668	0.76		
No. of private hospitals in the province	-0.0173	-2.01*	-0.0172	-2.01*	-0.0230	-2.46**		
No. of primary care units in the catchment area	0.0038	0.82	0.0037	0.81	0.0091	1.67*		
Population in catchment area / 10,000	-0.0002	-0.03	-0.0004	-0.09	-0.0393	-2.07*		
Population in catchment area per doctor /10,000	0.0147	0.34	0.0155	0.36	0.1419	2.43**		
Population in catchment area per nurse /10,000	-0.6846	-1.34	-0.6762	-1.32	-0.7041	-1.12	-0.7226	-2.21*
3. Socio-demographic structure								
No. of households in the district /1,000	0.0038	0.12	0.0050	0.16	-0.0143	-0.41		
Household size	0.1151	1.00	0.1148	1.00	0.0433	0.36	0.1111	1.50
Population in Tambon / 10,000	0.0680	0.80	0.0640	0.75	0.1258	1.33		
Proportion of females	11.9708	3.34**	11.9014	3.33**	12.8607	3.48**	11.8932	3.92**
Proportion of females aged 15-49	-2.2915	-0.90	-2.2962	-0.90	-2.7655	-1.04		
Proportion of population aged 60+	-2.5932	-1.40	-2.6210	-1.41	-3.0715	-1.57	-2.6690	-2.20*
Proportion of Muslim population	-0.2682	-1.57	-0.2714	-1.59	-0.2709	-1.57	-0.3234	-2.11*
Proportion of villages with lower secondary school	-0.0310	-0.17	-0.0288	-0.15	-0.0316	-0.16	0.0257	0.15
Proportion of villages with upper secondary school	-0.1128	-0.39	-0.1112	-0.39	-0.1650	-0.57	0.0269	0.10
Non-students with lower secondary education / population	-0.1517	-0.81	-0.1446	-0.77	-0.1985	-1.03	-0.1862	-1.11
Non-students with upper secondary education / population	-1.5314	-1.25	-1.5330	-1.25	-0.7487	-0.76	-0.8452	-1.06
Non-students with diploma degree / population	2.8065	0.77	2.7569	0.76	-0.2658	-0.07		
Non-students with degree higher than diploma / population	0.6793	0.18	0.6647	0.17	2.2965	0.58	3.1553	1.12
Proportion of households with a member working in agricultural sector	0.3370	1.98*	0.3378	1.99*	0.3113	1.76*		
Proportion of households with a member working as private employee	-0.3063	-1.31	-0.3103	-1.33	-0.4107	-1.68*	-0.3220	-1.81*
Proportion of households owning a business	0.0449	0.13	0.0511	0.15	0.0531	0.15		

(Continued on page 17)

Table 1 (Continued)

Variables	Total hospitals				Community hospitals			
	Before the balancing test		After dropping variables that do not pass the balancing test		Before the balancing test		After dropping variables that do not pass the balancing test	
	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics
4. Hospital resources, capacity and infrastructure								
New hospital or hospital opened after 1995 (1=yes)	-0.5135	-2.47**	-0.5131	-2.48**	-0.5216	-2.52**		
No. of doctors (excluding gyn-ob)	-0.0132	-0.25	-0.0122	-0.23	0.0568	0.23		
No. of gynecologists and obstetricians					0.0793	0.30		
No. of anesthetists	-0.0565	-0.52	-0.0608	-0.56				
No. of other healthcare workers and technical staff	-0.0019	-0.52	-0.0019	-0.55	-0.0026	-0.63		
No. of other staff	-0.0006	-2.03*	-0.0005	-2.08*	-0.0018	-2.41**		
Total no. of doctors in the hospital	0.0101	0.20	0.0094	0.19	-0.0017	-0.01		
Total no. of nurses in the hospital	-0.0015	-1.15	-0.0015	-1.16	-0.0029	-0.98		
No. of beds in the hospital	0.0022	1.70*	0.0022	1.74*	-0.0019	-0.98		
No. of ICUs	0.0032	0.61	0.0034	0.67	-0.0946	-2.65**		
No. of defibrillators	-0.0160	-1.01	-0.0157	-0.99	0.0184	0.63		
No. of respirators	0.0041	0.79	0.0039	0.75	0.0935	3.55**		
No. of ultrasound machines	0.0227	0.66	0.0231	0.67	0.0058	0.13		
No. of EKG machines	-0.0061	-1.09	-0.0062	-1.10	0.0120	0.56		
Budget allocated from government in 2006 (Bht100 mil.)	0.1415	1.32	0.1433	1.34	0.2603	1.09		
Income generated in 2006 (Bht100 mil.)	-0.0268	-0.62	-0.0263	-0.61	0.0062	0.06		
No. of outpatients /10,000	0.0074	1.05	0.0067	0.98	0.0121	1.27		
No. of inpatients admitted /10,000	-0.0312	-0.63	-0.0308	-0.62	-0.0206	-0.40		
New antenatal patients /1,000	0.0465	0.68	0.0453	0.66	0.0748	0.86		
Total child deliveries /1,000	-0.0324	-0.42	-0.0227	-0.30	-0.0830	-0.65		
Community hospital (1=yes)	-0.1720	-1.03	-0.1808	-1.09				
Constant	-5.9951	-3.07**	-5.9401	-3.05**	-5.9116	-2.9**	6.4566	-4.31**
N	671		671		595		672	
LR chi2	146.26		146.01		127.61		60.80	
Prob > chi2	0.000		0.000		0.000		0.000	
Log likelihood	-387.073		-387.20		-335.81		-430.93	
Pseudo R2	0.1589		0.1586		0.160		0.065	

Notes: t-statistics. * p<0.05, ** p<0.01

Table 2 Participation in SMH Program before 2005

Variables	Total hospitals				Community hospitals			
	Before the balancing test		After dropping variables that do not pass the balancing test		Before the balancing test		After dropping variables that do not pass the balancing test	
	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics
1. Director and his/her response to policy								
Pass Hospital Accreditation evaluation (1=yes)	0.0645	1.00	0.0602	0.95	0.0935	1.28	0.0359	0.61
Hospital has SMH policy (1=yes)	0.1103	0.40	0.1143	0.41	0.0057	0.02	-0.0174	-0.07
Director announces SMH policy (1=yes)	0.2630	1.17	0.2777	1.22	0.2163	0.90	0.3359	1.57
Staff have attended training in the past 6 months (1=yes)	0.2258	1.41	0.2117	1.32	0.0637	0.36	0.2416	1.60
No. of changes of director since 1998	-0.0040	-0.35	-0.0048	-0.44	-0.0068	-0.55	-0.0137	-1.52
No. of years director has been practicing	0.0054	1.65*	0.0056	1.76*	0.0059	1.57		
2. Geographic and health facilities in the district								
Northeast (1=yes)	0.0436	0.44	0.1625	2.10*	0.0902	0.82	0.0763	1.25
North (1=yes)	0.0367	0.45	0.1110	1.52	0.0687	0.74		
South (1=yes)	0.6768	5.34**	0.7724	6.66**	0.8119	5.71**	0.6098	5.83***
No. of villages in the district	-0.0028	-2.03*	-0.0030	-2.24*	-0.0032	-1.97*		
Distance to referral hospital (km)	-0.0004	-0.74	0.0010	1.69*	-0.0005	-0.70		
Distance to the nearest private hospital (km)	0.0010	1.47	0.0899	1.50	0.0014	1.77*		
No. of private hospitals in the district	0.1282	2.02*	-0.0265	-3.30**	0.1113	1.24		
No. of private hospitals in the province	-0.0224	-2.66**	0.0048	1.03	-0.0308	-3.19**		
No. of primary care units in the catchment area	0.0058	1.25	0.0026	0.54	0.0113	1.85*		
Population in catchment area / 10,000	0.0036	0.62			-0.0355	-1.74*		
Population in catchment area per doctor /10,000	-0.0182	-0.43	-0.8375	-1.98*	0.0955	1.56	-0.7447	-2.34**
Population in catchment area per nurse /10,000	-0.7345	-1.54	0.1625	2.10*	-0.7461	-1.20	0.0763	1.25
3. Socio-demographic structure								
No. of households in the district /1,000	0.0184	0.59	0.0006	0.02	0.0037	0.10		
Household size	0.2276	1.95*	0.1761	1.54	0.1497	1.17	0.1350	1.73*
Population in Tambon / 10,000	0.0195	0.22	0.0753	0.89	0.0546	0.53		
Proportion of females	12.9874	3.59**	11.2983	3.20**	14.2986	3.66**	8.4368	2.79**
Proportion of females aged 15-49	0.9035	0.34			2.1622	0.75		
Proportion of population aged 60+	-2.4169	-1.24	-2.5475	-1.74*	-1.8578	-0.86	-2.6478	-2.09*
Proportion of Muslim population	-0.0714	-0.30	-0.1797	-0.80	0.0338	0.12	-0.1275	-0.58
Proportion of villages with lower secondary school	-0.1791	-0.92	-0.2310	-1.20	-0.0592	-0.28	-0.0351	-0.20
Proportion of villages with upper secondary school	0.2703	0.94	0.2824	1.01	0.2110	0.69	0.3325	1.28
Non-students with lower secondary education / population	-0.1241	-0.65	-0.0500	-0.27	-0.0921	-0.44	-0.1492	-0.87
Non-students with upper secondary education / population	0.8062	0.73	0.2456	0.33	1.0289	0.87	0.5307	0.63
Non-students with diploma degree / population	-2.3638	-0.63			-5.3575	-1.23		
Non-students with degree higher than diploma / population	2.0179	0.48			3.8845	0.85	0.5787	0.20
Proportion of households with a member working in agricultural sector	0.4229	2.45**			0.3619	1.90*		
Proportion of households with a member working as private employee	-0.2401	-1.03			-0.2854	-1.11	-0.3866	-2.15*
Proportion of households owning a business	-0.1921	-0.56			-0.2045	-0.55		

(Continued on page 19)

Table 2 (Continued)

Variables	Total hospitals				Community hospitals			
	Before the balancing test		After dropping variables that do not pass the balancing test		Before the balancing test		After dropping variables that do not pass the balancing test	
	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics	Marginal effect	t-statistics
4. Hospital resources, capacity and infrastructure								
New hospital or hospital opened after 1995 (1=yes)	-0.5827	-3.05**	-0.5835	-2.98**	-0.6669	-3.07**		
No. of doctors (excluding gyn-ob)	-0.0033	-0.06	-0.0102	-0.19	0.1287	0.45		
No. of gynecologists and obstetricians					0.1599	0.53		
No. of anesthetists	-0.0475	-0.45	-0.0447	-0.43				
No. of other healthcare workers and technical staff	0.0086	1.58	0.0074	1.48	0.0114	1.23		
No. of other staff	0.0003	1.00	0.0002	0.92	-0.0008	-0.95		
Total no. of doctors in the hospital	-0.0063	-0.12	0.0004	0.01	-0.0993	-0.36		
Total no. of nurses in the hospital	-0.0019	-1.45	-0.0020	-1.64	-0.0040	-1.21		
No. of beds in the hospital	0.0017	1.34	0.0023	1.82*	-0.0004	-0.21		
No. of ICUs	0.0014	0.25	0.0000	0.01	-0.0843	-2.25*		
No. of defibrillators	0.0016	0.10	0.0007	0.05	0.0140	0.45		
No. of respirators	0.0072	1.25	0.0067	1.18	0.0567	2.04*		
No. of ultrasound machines	-0.0272	-0.79	-0.0283	-0.83	-0.0070	-0.15		
No. of EKG machines	-0.0127	-2.14*	-0.0118	-2.00*	-0.0036	-0.16		
Budget allocated from government in 2006 (Bht100 mil.)	0.1064	1.00	0.1088	1.05	0.3050	1.17		
Income generated in 2006 (Bht100 mil.)	0.0071	0.18	0.0071	0.18	-0.0065	-0.05		
No. of outpatients /10,000	0.0033	0.46	0.0011	0.17	0.0066	0.66		
No. of inpatients admitted /10,000	-0.0785	-1.35	-0.0764	-1.36	-0.0588	-0.89		
New antenatal patients /1,000	0.0296	0.41	0.0429	0.61	0.0368	0.38		
Total child deliveries /1,000	-0.0823	-1.02	-0.1189	-1.56	0.0478	0.34		
Community hospital (1=yes)	-0.2564	-1.39	-0.2484	0.18				
Constant	-8.0292	-4.02**	-6.5697	1.83*	-8.9145	-4.07**	-4.9037	-3.27**
N	671		671		595		672	
LR chi2	220.74		207.98		206.84		133.82	
Prob > chi2	0.000		0.000		0.000		0.000	
Log likelihood	-348.541		-354.92		-307.299		-392.56	
Pseudo R2	0.2405		0.2266		0.2518		0.1456	

Notes: t-statistics. * p<0.05, ** p<0.01

34. The results show that these variables do not pass the balancing tests and thus were dropped from the Program participation equations. Some of them are statistically significant determinants of Program participation. For example, the number of beds statistically determined Program participation since that number implies the size of a hospital and usually relates with how well the hospital is equipped.

Mean Impact on Maternal Death

35. Tables 3 and 4 show the mean impact of the SMH Program on the number of maternal deaths based on Program participation estimated in Tables 1 and 2. We used two indicators: the total number of maternal deaths in the district per child delivery x 1,000, and maternal deaths taking place in hospital per child delivery x 1,000. With different weights and matching method, we found that the SMH Program had no impact on the proportion of maternal deaths to child deliveries. The result is not surprising as the Program does not allocate more resources to participating hospitals. Moreover, from the interview conducted in hospitals in every region,[2] many of the directors of the hospitals did not anticipate that the SMH Program would reduce the number of maternal deaths; they thought that the Program set the guidelines for standard maternal and child care. The guidelines have improved the quality of care, but do not reduce the number of maternal deaths. The directors and nurses reported that the causes of maternal death were mainly hemorrhage and hypertension. In many cases, pregnant women did not receive antenatal care. As the result, they did not know that they were at high risk of maternal death.

36. From the interviews, we also found that hospitals do not seriously follow the 11-step guidelines set by DOH even after passing the process evaluation. For example, the doctor-nurse ratio for child delivery should be 1:3 as stated in the guidelines, but almost all of the hospitals use two nurses for natural child delivery. However, some hospitals used only one nurse for that task.

37. To monitor women for 42 days after giving birth is not an easy task for any hospital, whether it has passed the Program evaluation or not. We found from the interviews that women who worked as unskilled laborers were more likely to move between a big city such as Bangkok and their home provinces. When they are pregnant, women do not have time for prenatal care; they like to give birth in their hometown and have their mother take care of the newborns. If the pregnant women are at high risk of miscarriage or death, the hospitals do not have a chance to monitor such conditions before and after they give birth.

38. People who live in mountainous areas, particularly along the border of Thailand and Myanmar, have quite a difficult time in accessing an urban hospital. Some villages have no road access; pregnant women have to walk for up to eight hours before getting a truck that will take them to the hospital, which may require a ride of more than four hours to get there. To rent a truck to get to the hospital costs too much for them to afford it. These women are, therefore, less likely to receive antenatal care. One doctor mentioned that a pregnant woman is at risk of death if she lives in a mountainous area and coincidently wants to give birth while it is raining. Such conditions make the trip even more difficult and more time-consuming to travel from a village in a mountainous area to an urban hospital. The possibility of death is extremely high if the woman is hemorrhaging. The doctor referred to this kind of maternal death as a "classical case." No aspect of the SMH Program is aimed at reducing such classical cases of mortality.

Mean Impact on Cost[3]

39. The cost outcomes include costs related to length of stay for giving birth, labor cost, and the costs of in and out referral. The labor cost includes the cost of doctors and nurses attending each child delivery. As we did not know the unit cost of nurses and doctors in the hospital, we used the number of attending nurses and doctors to represent a labor cost index. Since the cost for the care provided by a doctor should be higher than that by a nurse, we converted the doctor's cost into a doctor-nurse equivalent cost. We assumed two cases for making the conversion: a case where one doctor is converted into the equivalent of 1.5 nurses, and a case where one doctor is converted into two nurses. The total doctor-nurse equivalent cost is summed to the labor cost index.

40. The results show that the SMH Program before 2004 reduced the length of stay for giving birth when we used the single nearest neighborhood, five nearest neighborhoods, and caliper matchings. However, the impact of Program participation before 2005 on length of stay for giving birth is not statistically significant.

41. After dropping the variables that did not pass the balancing test, we found that Program participation reduces the labor costs for child delivery when we used the single nearest neighborhood and caliper matching. For a community hospital, the Program had an impact on labor cost when we used log linear regression matching, a cost index quite sensitive to the weight and matching used.

Table 3 Mean Impact on Maternal Death Taking Place in Hospital

Matching and weight	Total hospitals				Community hospitals			
	Before the balancing test		After dropping variables that do not pass the balancing test		Before the balancing test		After dropping variables that do not pass the balancing test	
	ATET	t- statistics	ATET	t- statistics	ATET	t- statistics	ATET	t- statistics
Program participation before 2004								
Single nearest neighbor	-0.1665	-1.7007*	-0.0479	-0.4052	-0.1158	-0.9445	0.0635	0.5695
Five nearest neighbors	-0.0534	-0.5574	-0.0512	-0.4543	-0.0330	-0.3642	-0.0113	-0.1220
Caliper (0.05)	-0.0506	-0.6632	-0.0553	-0.7126	-0.0162	-0.2007	-0.0255	-0.3717
Kernel, normal, bandwidth (0.01)	-0.0400	-0.3317	-0.0550	-0.4717	-0.0103	-0.0977	-0.0207	-0.1789
Kernel, normal, bandwidth (0.1)	-0.0455	-0.3988	-0.0480	-0.4156	-0.0271	-0.2557	-0.0123	-0.1231
LLR bandwidth (0.01)	-0.0419	-0.3483	-0.0660	-0.4603	-0.1129	-0.3763	-0.0215	-0.2194
LLR bandwidth (0.1)	-0.0478	-0.6298	-0.0513	-0.6697	-0.0217	-0.2878	-0.0161	-0.2170
Program participation before 2005								
Single nearest neighbor	0.0403	0.3328	0.1178	1.0556	0.0675	0.6262	0.0841	0.8427
Five nearest neighbors	0.0847	0.8296	0.0842	0.6599	0.0629	0.6538	0.0358	0.4000
Caliper (0.05)	0.0838	1.1263	0.0716	0.9299	0.0818	1.1821	0.0274	0.3774
Kernel, normal, bandwidth (0.01)	0.0711	0.7110	0.0979	0.8741	0.0767	0.7229	0.0354	0.3942
Kernel, normal, bandwidth (0.1)	0.0580	0.5321	0.0395	0.3399	0.0574	0.5013	0.0217	0.2038
LLR bandwidth (0.01)	0.0635	0.1172	0.1028	0.1678	0.0838	0.8089	0.0416	0.2645
LLR bandwidth (0.1)	0.0635	0.7820	0.0471	0.5439	0.0620	0.8378	0.0257	0.4276

Notes: t-statistics calculated using bootstrap standard errors. * p<0.05 and ** p<0.01

Table 4 Mean Impact on Maternal Death in the District

Matching and weight	Total hospitals				Community hospitals			
	Before the balancing test		After dropping variables that do not pass the balancing test		Before the balancing test		After dropping variables that do not pass the balancing test	
	ATET	t- statistics	ATET	t- statistics	ATET	t- statistics	ATET	t- statistics
Program participation before 2004								
Single nearest neighbor	-0.1481	-0.9187	-0.0659	-0.5161	-0.0730	-0.5309	0.0679	0.6258
Five nearest neighbors	-0.0307	-0.3095	-0.0447	-0.4557	-0.0336	-0.3032	0.0194	0.2304
Caliper (0.05)	-0.0423	-0.4603	-0.0466	-0.5016	-0.0130	-0.1472	-0.0208	-0.2283
Kernel, normal, bandwidth (0.01)	-0.0300	-0.2657	-0.0479	-0.4224	-0.0039	-0.0340	-0.0089	-0.0683
Kernel, normal, bandwidth (0.1)	-0.0401	-0.2666	-0.0425	-0.3284	-0.0280	-0.2566	-0.0098	-0.0910
LLR bandwidth (0.01)	-0.0322	-0.2949	-0.0616	-0.2938	-0.0886	-0.0762	-0.0080	-0.0760
LLR bandwidth (0.1)	-0.0333	-0.3569	-0.0372	-0.4101	-0.0233	-0.2794	-0.0093	-0.1191
Program participation before 2005								
Single nearest neighbor	0.0981	0.7176	0.1433	1.0552	0.0787	0.6153	0.1138	1.0206
Five nearest neighbors	0.1216	1.3771	0.1251	1.1835	0.0592	0.4318	0.0532	0.5905
Caliper (0.05)	0.1224	1.2777	0.1145	1.2027	0.0949	1.1587	0.0511	0.6436
Kernel, normal, bandwidth (0.01)	0.1107	0.8828	0.1382	1.1038	0.0823	0.6841	0.0582	0.5449
Kernel, normal, bandwidth (0.1)	0.0873	0.7468	0.0758	0.6620	0.0675	0.6350	0.0484	0.4632
LLR bandwidth (0.01)	0.1059	0.8216	0.1438	1.1261	0.0934	0.2928	0.0641	0.4693
LLR bandwidth (0.1)	0.1004	1.2741	0.0913	1.1161	0.0667	0.8730	0.0476	0.6142

Notes: t-statistics calculated using bootstrap standard errors. * p<0.05 and ** p<0.01

42. The average impacts of Program participation on in and out referral are quite significant among community hospitals participating in the Program before 2004. The Program increased referred in cases and decreased referred out cases of participating community hospitals. Networking and referring among hospitals are standard processes for step k of the SMH Program implementation guidelines. Program participation encourages community hospitals to refer high-risk pregnancy cases to general or regional hospitals or community hospitals that have more specialists and equipment. It also encourages general hospitals to refer cases of difficult births to regional hospitals. When a referral was made at an early stage of pregnancy, the risk to the woman's life would be lower than otherwise. If a high-risk pregnancy case does not receive antenatal care, the detection of the high risk will occur at the time of labor. Referral of a woman as an emergency case involves a high probability of maternal death.

43. It is quite surprising that the results show that community hospitals refer pregnant women to community hospitals only. We expected that the full sample should have the same results as a community hospital. The phenomenon probably can be explained by the new system of financing referral cases. Thailand started its UC in 2001. The way hospitals are financed has changed significantly. However, because of administrative problems concerning money transfers between hospitals, many hospitals would not want to admit a referral patient. In addition, the cost of a referral was not settled; such behavior was serious so policymakers had to solve this problem by setting rules for referral payments. For inpatients, the "refer-out" hospitals do not bear any referral cost. The "refer-in" hospitals receive additional payment through the diagnosis-related groups (DRGs) system, which may encourage community hospitals to refer patients among themselves.

VI. CONCLUSIONS

44. From our analysis, we found that the number of changes of the director of a hospital, geographic factors, size of catchment area, socio-demographic structure of the district, and hospital resources are statistically significant determinants of SMH Program participation before 2004 and 2005. Using various weighting and matching methods, we found that the SMH Program has had no impact on the proportion of maternal death per child delivery. The Program, however, can reduce costs (i.e., length of stay for giving birth and labor costs) of the participating hospitals. Given that the Program does not allocate more resources to the participating hospitals, adherence to its guidelines can reduce the cost of child delivery without increasing the death rate. This could be considered a success for the Program. The findings also show that the Program encourages referrals. However, referral among community hospitals may be adversely affected by the way the National Health Security Office finances referral cases.

45. Based on the hospital interviews that were taken in 2007, we realize that many of the hospital staff did not know whether their hospital passed the process evaluation. Old staff moved to other hospitals and new staff replaced them. Delivery room nurses like the SMH Program in the sense that it sets guidelines for maternal care. When new nurses start working, they can follow the same guidelines. If the guidelines are followed seriously, we can consider this a successful aspect of the Program. Some hospitals choose to follow the guideline occasionally.

46. In our study, we did not focus on how serious the process evaluation was taken. We admit what was evaluated by DOH and the Provincial Public Health Office. We also admit that the quality of process evaluation could vary across provinces depending upon the standard of the Provincial Public Health Office. Even though DOH set guidelines for such evaluation, discretion is unavoidable.

47. The research finding is quite consistent with the view of the directors of the hospital about the Program's impact on maternal death. The Program has its own advantage as we found in this study; however, if we could go back to 1998, many Program implementation steps should have been changed or improved. Policymakers should have been more serious about implementation and evaluation. Process evaluation should have been done by an independent institution, instead of DOH or the Provincial Public Health Office. The guidelines for the data collection and report system should have been set. It should have been clear to the hospitals what would be their reward or punishment if they passed or failed the evaluation.

48. Achieving Goal 5 of the MDGs will not be too difficult for Thailand, but not because of the SMH Program directly. Other factors are playing a more significant role, such as the inclusion of most of the population under universal healthcare coverage, and the emphasis that DOH places on maternal health by indirectly putting pressure on those hospitals where such cases occur.

ENDNOTES

[1] From birth registration database.

[2] We interviewed the relevant people at one regional hospital, one general hospital and five community hospitals in each region during the same period (the questionnaire interview). Interviewees comprised directors of the hospitals or nurses in the child delivery room, or nurses in the antenatal care unit.

[3] Tables showing the impact on cost are available upon request: contact Worawan@tdri.or.th.

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