

Improved Perinatal Health through Qualified Antenatal Care in Urban Phnom Penh, Cambodia

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Abstract

Objectives: The aim of this study is to examine the utilities of antenatal care with comprehensive health education qualified in Phnom Penh for the health of mothers and infants during perinatal and postpartum periods. Attention was given to the existing socioeconomic disparities among women in this urban area, and the utilities were discussed irrespective of socioeconomic status.

Methods: A total of 436 pregnant women in an urban area in Phnom Penh were selected using a complete survey in randomly sampled villages and were followed up. Participating in antenatal care with comprehensive health education at least three times was regarded as the use of “qualified antenatal care” during pregnancy. In this study, we investigated the independent associations of the use of qualified antenatal care with the following outcome variables after the adjustment for the influence of socioeconomic variables: postpartum maternal health knowledge, postpartum maternal anemia, low birth weight, and infant immunization.

Results: Of the 314 subjects who completed the follow-up examination, 66.8% used qualified antenatal care during pregnancy. The use of qualified antenatal care was positively associated with postpartum maternal health knowledge (OR=2.38, 95%CI: 1.12–5.05), and reductions in the incidences of postpartum anemia (OR=0.22, 95%CI: 0.05–0.95) and low birth weight (OR=0.06, 95%CI: 0.01–0.39) after the adjustment of the influence of socioeconomic status. The infants born to mothers who used qualified antenatal care had significantly higher coverage of BCG, DPT₁, and DPT₃ immunizations ($P<0.001$, $P<0.001$, and $P<0.01$, respectively), independent of their socioeconomic conditions.

Conclusion: This study shows the solid utilities of qualified antenatal care in Phnom Penh for perinatal health.

Key words: antenatal care, health education, perinatal health, health literacy, immunization

Introduction

There has been little progress in improving access to antenatal care services in countries in Asia (1). Besides the benefits of identifying high-risk pregnancies and providing

timely assessment and treatment, one of the expected utilities of antenatal care is the utilization of antenatal care services as an entry point for gaining health knowledge and accessing other health services (1, 2). Focusing on the utilities of antenatal care related to the events after delivery is particularly useful when healthcare services are scarce in general.

For the healthy growth of infants, maternal health knowledge is an important factor (3–6). The health and nutritional status of mothers are closely related to infant health when breast feeding is prioritized (7, 8). Immunization is considered useful not only for the prevention of particular diseases but also for the promotion of general health conditions of children (9–12). Maternal health knowledge, health status, and use of

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immunization are regarded as key factors for securing perinatal health.

In Phnom Penh, the capital city of Cambodia, antenatal care with comprehensive health education during pregnancy has become open to all urban residents at a minimal cost averaging 2000 Riel (equivalent to US\$ 0.50) per visit. The services in Phnom Penh include group education for antenatal, perinatal, and postpartum health, individual antenatal examination, and individual health education to improve the health of mothers and newborns. Antenatal care with maternal education has become more accessible, being within a 30-minute walking distance for residents. This was the result of the encouragement from the government of Cambodia to promote antenatal care (13). Since the introduction of a low user fee and city wide provision of antenatal care services, the number of users increased, and a high level of satisfaction from the participants was reported (14). Since the year 2000, the use of services at least three times has been recommended by the district health authorities in Phnom Penh, and was defined as the use of "qualified antenatal care". Although efforts have been made to make individual antenatal care to meet needs of communities, the utilities of "qualified antenatal care" in resource-scarce communities are of a concern.

There is an apparent socioeconomic inequality in maternal and child health in urban areas in Asia (15, 16). The socioeconomic status of women and their families are closely related to the use of health services and health knowledge (17–20). For health promotion in urban communities, including those that are socioeconomically disadvantaged, the utilities of antenatal care services regardless of socioeconomic conditions of individual families need to be determined.

Pregnant women in urban villages in Phnom Penh, Cambodia were followed up to obtain information on the utilities of qualified antenatal care practiced according to the criteria of the Phnom Penh authorities. The utilities were examined by investigating the associations of the use of qualified antenatal care with postpartum maternal health knowledge, postpartum maternal anemia, low birth weight of newborns, and the use of immunization for infants, regardless of the family's socioeconomic conditions.

Methods

Subjects

The subjects were selected by using a complete survey in villages randomly sampled within two strata in urban Phnom Penh, 10 villages with a transient population and 14 villages from residential areas. A door-to-door census, carried out by a study team consisting of a medical doctor and nurse-midwives, was conducted in these villages in December 2003 to register all pregnant women with the support of the village chiefs and the communal authority. All women of reproductive age were contacted. Women reported their pregnancies and women suspecting themselves of being pregnant were invited to participate in this study for further examination. After obtaining informed consent, the study team conducted obstetric examinations using interviews and the Leopold method. Urine-based human chorionic gonadotropin pregnancy tests were used to

confirm their pregnancies. A total of 436 women were identified as being pregnant.

After deliveries, a follow-up survey was performed, during the period from 7 July to 23 August 2004, to examine the health of the women. The data was collected by a team consisting of two medical doctors, two nurse-midwives, a laboratory technician, and the village chiefs. The health professionals of the study team had been involved in outreach immunization campaigns in the study areas and were familiar with the behavioral patterns of the populations. They were instructed on the purpose of the survey, and undertook training to gain the skills required for data collection.

A total of 314 women participated in the follow-up examination. All the subjects gave written, informed consent for participation in the examination. Among the women listed in December 2003, 111 had moved away from their villages to look for work, for resettlement, or to return to their hometowns, and 11 refused to participate in the study. The chief of each village reported no maternal deaths.

Antenatal care

The subjects of this study had access to one of the nine health facilities providing antenatal care services that was within a 30-minute walking distance. Antenatal care services were available every day at each of these health facilities. The cost of each visit was 3000–5000 Riels (US\$ 0.75–1.25) for the first visit, 1000–3000 Riels (US\$ 0.25–0.75) for the second visit, and 1000–2000 Riels (US\$ 0.25–0.50) for subsequent visits. The pregnant women paid individually at each health facility for their every visit. To facilitate the use of antenatal care services by pregnant women, posters were displayed at health facilities and other public places. Notices were disseminated to individual community members through village health workers, the heads of villages, and health professionals visiting villages for outreach activities of child immunization.

A group maternal education program was provided for pregnant women who visited health facilities for antenatal care consultation. The contents included information on complications in pregnancy, the risk signs of pregnancy complications, vaccinations for pregnant women, the prevention of sexually transmitted infection and human immunodeficiency virus, nutritional needs during pregnancy and the postpartum period, breast feeding, an immunization schedule for children, and essential nutrients for infants. This group education session was available from the women's first visit to their subsequent visits during their pregnancy.

In addition to individual health examination using fetomaternal health check-ups, individual consultations for health education were carried out. The knowledge and comprehension of mothers concerning perinatal health were individually examined, and additional instructions tailored to improve each woman's knowledge were provided. Thirty iron-folate tablets were provided for supplementation per visit (200 mg of ferrous sulfate and 0.40 mg of folic acid/tablet), at the first, second, and third visits. Although the information given during the group maternal education program sessions at each of the visits of antenatal care was similar, additional personal consultation and instructions strengthened the functional knowledge and skills of

the subjects. Furthermore, mutual relationships between health professionals and pregnant women had developed by later visits for antenatal care, prior to the delivery dates.

A recommendation to use the antenatal care program at least three times was given individually to the pregnant women in the study area at their first consultation for antenatal care. This recommendation has been given since the year 2000 as a standard advice for pregnant women.

Study variables

After the deliveries, a survey was conducted in accordance with the protocol approved by the Cambodian Ethics Committee for Health Research. The survey examines the use of antenatal care, socioeconomic characteristics of pregnant women, pregnancy- and maternity-related characteristics, postpartum maternal health knowledge, postpartum anemia, birth weight of newborns, and immunization of infants.

The mothers reported the number of times they visited health facilities for antenatal care consultation during their pregnancy. The subjects who received antenatal care consultation at least three times were regarded as using “qualified antenatal care” during pregnancy.

Regarding maternity-related characteristics, the age at delivery, parity (number of deliveries), the date of delivery, and the status of breast feeding after delivery were reported. The number of months between enrollment in the study and delivery, and the number of days from delivery to the postpartum follow up examination and interview were calculated. Height and weight of the mothers were also measured at the postpartum examination.

Regarding the socioeconomic characteristics of the subjects, the number of years of education the mothers had, monthly income per household member, and the occupations of mothers were reported and used as socioeconomic variables.

The following factors were used to evaluate the range of aspects of perinatal health: pregnancy outcome, postpartum maternal health knowledge, postpartum anemia, birth weight of newborns, and the completion of immunization for newborns.

The outcomes of the pregnancies were reported by the subjects from written information recorded by health professionals at the time of delivery. The outcomes were categorized as follows: live birth, stillbirth, spontaneous abortion, induced abortion, and other. Cases of perinatal death and neonatal death were also recorded.

Postpartum maternal health knowledge was evaluated on the mother’s agreement with the following statements: 1) antenatal care is useful to prevent pregnancy-related problems, 2) hypertension, edema of the legs, albuminuria (*Toeuk Naum Pray* in Khmer language), and convulsions during late pregnancy are signs of eclampsia, 3) delivery at a health facility is safer than delivery at home, 4) breastfeeding is better than milk formula for babies less than 6 months of age, 5) participation in routine immunization programs prevents some diseases in children, and 6) vitamin A prevents night blindness: Their knowledge was also evaluated in terms of their familiarity with immunization programs for children: 7) Bacillus of Calmette and Guérin (BCG), that is, anti-tuberculosis vaccine, 8) polio vaccine, 9) diphtheria, pertussis, and tetanus vaccine, and 10)

measles vaccine. With each correct answer in response to statements 1, 3, 4, 5 and 6, and when mothers named the correct signs or diseases in response to statements 2, 7, 8, 9 and 10, one point was given. The sum of these points was used as the “maternal and child health knowledge score,” where a higher score indicates a greater knowledge. Cronbach’s alpha was 0.62. The scores were divided into two categories by the median: “low” corresponding to scores of 0–6 and “high” corresponding to scores of 7–10.

Each subject’s blood hemoglobin concentration was determined using capillary blood collected from the fingertip and a HemoCue Hb 201+ analyzer (Hemocue AB, Angelholm, Sweden). Less than 12.0 g of hemoglobin per dl within 90 days after delivery was defined indicated postpartum anemia (21).

The weights of the newborn babies were recorded based on the report cards completed by health professionals attending the delivery. Those weighing less than 2500 g at birth were defined as “low birth weight”.

Whether the infants received the following immunizations was recorded in the child’s immunization cards: BCG, DPT₁ (first dose of diphtheria, pertussis, and tetanus vaccine), and DPT₃ (third dose of diphtheria, pertussis, and tetanus vaccine). BCG was recommended just after birth, while DPT₁ vaccination was recommended six weeks after birth, and DPT₃ eight weeks after DPT₁.

Analyses

The mean values and distribution of maternity-related and socioeconomic variables among women who did and did not use qualified antenatal care were compared by t-test and chi-square test. Distributions of perinatal health variables among women who did and did not use qualified antenatal care were compared using the chi-square test. Logistic regression was used to examine the independent associations of the utilization of qualified antenatal care with outcome variables after adjustment for the influence of socioeconomic variables. A probability of $P < 0.05$ was considered to show statistically significant associations.

Results

Of the 314 pregnant women followed up in this study, 304 had singleton births including two cases of stillbirth. There were six cases of spontaneous abortion, one case of induced abortion, one case of molar pregnancy, one women delivered twins, and one pregnancy had not yet come to term. The data of the 304 women with singleton births and their most recent baby were analyzed.

The mean frequency of participation in antenatal care services, including both before and after the registration of the list of subjects of this study, was 3.7 times (SD=2.6). Fifty-five subjects (18.1%) did not use any antenatal care services, and 46 (15.1%), 80 (26.3%), 87 (28.6%), and 36 (11.8%) women utilized antenatal care services 1–2, 3–4, 5–6, and 7 and more times during the most recent pregnancy. Among the users of antenatal care services, 93.6% of them reported satisfaction with the quality of services. None of the study subjects declared any side effects or other problems related to the taking of iron-folate tablets.

Table 1 Maternity-related and socioeconomic characteristics of subjects grouped by use of qualified antenatal care during pregnancy (n=304)

Characteristics	Use of qualified antenatal care [‡]			
	Yes (n=203)		No (n=101)	
	n (%)	Mean±SD	n (%)	Mean±SD
<i>Maternity-related variables</i>				
Maternal age at delivery (years)		26.3±5.2		28.0±6.7 *
Parity (number of deliveries)		2.0±1.3		2.9±1.8 ***
Term from registration of the study to delivery (months)		2.4±2.2		2.8±1.9
Days after last delivery (days)		123.6±65.4		111.6±59.9
Body mass index at postpartum examination		21.9±3.3		21.6±3.9
Exclusive breast feeding within first 6 months (n=296)				#
No	93 (46.3)		31 (32.6)	
Yes	108 (53.7)		64 (67.4)	
<i>Socioeconomic variables</i>				
Years of education of mother				###
None	20 (9.9)		37 (36.6)	
1–6	59 (29.1)		46 (45.5)	
≥7	124 (61.1)		18 (17.8)	
Monthly income per household member (in US\$)				###
<30	84 (41.4)		68 (67.3)	
30–59	60 (29.6)		23 (22.8)	
≥60	59 (29.1)		10 (9.9)	
Occupation of mother				###
Unskilled job	70 (34.5)		40 (39.6)	
Housewife	95 (46.8)		60 (59.4)	
Skilled job	38 (18.7)		1 (1.0)	

[‡] Use of antenatal care with comprehensive health education at least three times during pregnancy.

* $P < 0.05$, *** $P < 0.001$ (comparison between women with/without qualified antenatal care using t-test).

$P < 0.05$, ### $P < 0.001$ (comparison between women with/without qualified antenatal care using chi-square test).

Table 2 Percentage distributions of postpartum maternal health knowledge, postpartum anemia, low birth weight, and coverage of infant immunization grouped by use of qualified antenatal care[‡] during pregnancy

	Use of qualified antenatal care [‡]				
	Yes		No		
	N	%	n	%	
Postpartum health knowledge regarding maternal and child health (n=304)					
High (score, 7–10)	122	60.1	30	29.7	***
Low (score, 0–6)	81	39.9	71	70.3	
Postpartum anemia (<12.0 g hemoglobin/dl) (n=108)					
No	51	75.0	16	40.0	***
Yes	17	25.0	24	60.0	
Birth weight of newborn (g) (n=234)					
≥2500	184	98.4	41	87.2	**
<2500	3	1.6	6	12.8	
BCG Immunization (n=289)					
Yes	188	94.9	51	56.0	***
No	10	5.1	40	44.0	
DPT ₁ Immunization (n=239)					
Yes	150	91.5	34	45.3	***
No	14	8.5	41	54.7	
DPT ₃ Immunization (n=144)					
Yes	81	77.1	10	25.6	***
No	24	22.9	29	74.4	

** $P < 0.01$, *** $P < 0.001$, (Comparison between women with/without qualified antenatal care using chi-square test).

[‡] Use of antenatal care with comprehensive health education at least three times during pregnancy.

Table 3 Associations among the use of qualified antenatal care[‡] during pregnancy, socioeconomic factors, and postpartum health knowledge regarding maternal and child health (n=304)

	High level of postpartum health knowledge (score, 7–10)			
	OR	95%CI	aOR [#]	95%CI
Antenatal care attendance during recent pregnancy				
Never	1.00		1.00	
Once or twice	1.56	0.66–3.68	1.31	0.53–3.25
≥3 times (qualified antenatal care)	4.41	2.26–8.61	*** 2.38	1.12–5.05 *
Years of education of mother				
None	1.00		1.00	
1–6	2.00	0.96–4.17	1.75	0.82–3.72
≥7	8.06	3.94–16.5	*** 6.31	2.83–14.0 ***
Monthly income per household member (in US\$)				
<30	1.00		1.00	
30–59	1.09	0.64–1.86	0.61	0.32–1.15
≥60	1.82	1.02–3.25	* 0.74	0.36–1.49
Occupation of mother				
Unskilled job	1.00		1.00	
Housewife	1.20	0.73–1.96	1.08	0.62–1.87
Skilled job	2.80	1.29–6.09	** 1.20	0.51–2.86

[‡] Use of antenatal care with comprehensive health education at least three times during pregnancy.

[#] Adjusted odds ratio: The following variables were used as independent variables of a logistic regression model to estimate a high level of postpartum health knowledge: use of qualified antenatal care during pregnancy, years of education of mother, monthly income per household member, and occupation of mother.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table 4 Associations among the use of qualified antenatal care[‡] during pregnancy, socioeconomic factors, and postpartum anemia (n=108)

	Postpartum anemia			
	OR	95%CI	aOR [#]	95%CI
Antenatal care attendance during recent pregnancy				
Never	1.00		1.00	
Once or twice	1.18	0.33–4.20	1.12	0.25–5.00
≥3 times (qualified antenatal care)	0.24	0.08–0.70	** 0.22	0.05–0.95 *
Years of education of mother				
None	1.00		1.00	
1–6	0.43	0.15–1.23	** 0.46	0.13–1.71
≥7	0.20	0.07–0.55	0.37	0.09–1.56
Monthly income per household member (in US\$)				
<30	1.00		1.00	
30–59	0.28	0.10–0.78	* 0.72	0.19–2.72
≥60	0.28	0.09–0.87	* 1.18	0.24–5.80
Occupation of mother				
Unskilled job	1.00		1.00	
Housewife	1.87	0.79–4.41	1.16	0.41–3.28
Skilled job	—		—	

[‡] Use of antenatal care with comprehensive health education at least three times during pregnancy.

[#] Adjusted odds ratio: The following variables were used as independent variables of a logistic regression model to estimate postpartum anemia: use of qualified antenatal care during pregnancy, years of education of mother, monthly income per household member, occupation of mother, breastfeeding, and number of days postpartum.

The mothers who delivered a baby within 90 days of the follow-up examination were included in this analysis.

* $P < 0.05$, ** $P < 0.01$.

Table 1 shows maternity-related and socioeconomic characteristics of subjects grouped by the use of qualified antenatal care.

Maternal health knowledge scores ranged from 2 to 9, with a median of 6.5 and a mean of 6.3 (SD=1.7). Postpartum maternal blood hemoglobin concentration ranged from 6.5 to 16.5 g/dl, with a mean of 12.5 g/dl (SD=1.7). The prevalence of

postpartum anemia at the time of the interview was 31.4%. Birth weight ranged from 1750 to 4250 g and 9 of the 234 newborn babies (3.8%) were classified as having low birth weight. Of the newborn babies, 82.7% received BCG immunizations, and 77.0% and 63.2% of the infants aged 43 days and older and 99 days and older received DPT₁ and DPT₃, respectively.

Table 5 Associations among the use of qualified antenatal care[‡] during pregnancy, socioeconomic factors, and incidence of low birth weight (n=234)

	Low Birth Weight			
	OR	95%CI	aOR [#]	95%CI
Antenatal care attendance during recent pregnancy				
Never	1.00		1.00	
Once or twice	0.26	0.04–1.59	0.27	0.04–1.90
≥3 times (qualified antenatal care)	0.06	0.01–0.28	*** 0.06	0.01–0.39 *
Years of education of mother				
None	1.00		1.00	
1–6	0.82	0.15–4.52	3.90	0.36–42.6
≥7	0.17	0.02–1.30	2.91	0.41–20.7
Monthly income per household member (in US\$)				
<30	1.00		1.00	
30–59	1.10	0.24–5.06	0.54	0.07–4.38
≥60	0.82	0.15–4.60	0.78	0.10–6.14
Occupation of mother				
Unskilled job	1.00		1.00	
Housewife	0.21	0.04–1.05	0.83	0.06–11.0
Skilled job	0.32	0.04–2.79	0.18	0.01–3.23

[‡] Use of antenatal care with comprehensive health education at least three times during pregnancy.

[#] Adjusted odds ratio: The following variables were used as independent variables of a logistic regression model to estimate low birth weight: use of qualified antenatal care during pregnancy, years of education of mother, monthly income per household member, and occupation of mother.

* $P < 0.05$, *** $P < 0.001$.

Table 6 Associations among the use of qualified antenatal care[‡], socioeconomic factors, and coverage of infant immunization

	BCG (n=289)		DPT ₁ (n=239)		DPT ₃ (n=144)	
	aOR [#]	95%CI	aOR [#]	95%CI	aOR [#]	95%CI
Antenatal care attendance during recent pregnancy						
Never	1.00		1.00		1.00	
Once or twice	2.92	1.07–7.93 *	1.93	0.64–5.80	1.12	0.24–5.27
≥3 times (qualified antenatal care)	12.60	4.80–33.1 ***	10.13	3.75–27.3 ***	7.09	2.02–24.8 **
Years of education of mother						
None	1.00		1.00		1.00	
1–6	3.00	1.27–7.10 *	5.38	1.85–15.6 **	2.50	0.54–11.5
≥7	15.66	3.77–65.1 ***	13.11	3.78–45.5 ***	5.55	1.21–25.4 *
Monthly income per household member (in US\$)						
<30	1.00		1.00		1.00	
30–59	2.23	0.78–6.37	1.61	0.57–4.52	0.40	0.13–1.19
≥60	3.02	0.55–16.6	3.43	0.75–15.7	1.78	0.44–7.15
Occupation of mother						
Unskilled job	1.00		1.00		1.00	
Housewife	1.78	0.77–4.12	2.03	0.82–5.04	1.46	0.56–3.82
Skilled job	0.85	0.08–8.69	0.88	0.15–5.13	1.19	0.27–5.20

[‡] Use of antenatal care with comprehensive health education at least three times during pregnancy.

[#] Adjusted odds ratio: The following variables were used as independent variables of a logistic regression model to estimate coverage of infant immunization: use of qualified antenatal care during pregnancy, years of education of mother, monthly income per household member, occupation of mother, birth order, and age of infant.

The subject infants aged 43 days old and older and 99 days old and older were included in the analysis of DPT₁ and DPT₃, respectively.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table 2 shows the percentage distributions of postpartum maternal health knowledge regarding maternal and child health, postpartum anemia, low birth weight, and infant immunization grouped by the use or non-use of qualified antenatal care during pregnancy.

Table 3 shows the crude and adjusted associations among the use of qualified antenatal care during pregnancy, socioeconomic characteristics, and postpartum maternal health knowl-

edge. The use of qualified antenatal care during pregnancy was independently associated with high knowledge scores after adjustment for the influence of education, household income, and occupation (adjusted OR=2.38; 95%CI: 1.12–5.05, with reference to women who never received any antenatal care).

Table 4 shows the crude and adjusted associations among the use of qualified antenatal care, socioeconomic characteristics, and postpartum anemia. The use of qualified antenatal care

during pregnancy was independently associated with postpartum anemia after adjustment for the influence of education, household income, occupation, breastfeeding status, and number of days after delivery (adjusted OR=0.22; 95%CI: 0.05–0.95, with reference to women who never received any antenatal care).

As shown in Table 5, the use of qualified antenatal care during pregnancy was associated with a reduced risk of low birth weight after adjusting for education, household income, and occupation (adjusted OR=0.06; 95%CI: 0.01–0.39, reference to women never attended antenatal care).

Table 6 shows the results of logistic regression, which indicates the use of qualified antenatal care during pregnancy was independently associated with BCG (adjusted OR=12.60; 95%CI: 4.80–33.1), DPT₁ (adjusted OR=10.13; 95%CI: 3.75–27.3), and DPT₃ (adjusted OR=7.09; 95%CI: 2.02–24.8, with reference to women who never received any antenatal care) immunizations of the infants after adjusting the influence of socioeconomic factors.

Discussion

This study, performed in an urban area in Phnom Penh, Cambodia, indicated the utilities of qualified antenatal care (using antenatal care with comprehensive health education at least three times during pregnancy) for postpartum maternal health knowledge and reductions in both postpartum anemia and low birth weight. The use of qualified antenatal care was also associated with the coverage of BCG, DPT₁, and DPT₃ immunizations.

All the pregnant women in the subject villages were followed up, including those who had and had not visited the health facilities for antenatal care. The involvement of a transient population enabled us to analyze the effectiveness of the use of antenatal care in disadvantaged populations. Participation of health professionals who had regular contact onsite with the communities, in addition to the contact at health facilities, facilitated a follow-up of the subjects remaining in the study area as complete as possible.

There is a controversy in relation to the use of antenatal care and perinatal health care in terms of the quantity and quality of the services. The results of some studies suggest a relationship between the use of antenatal care and neonatal birth weight (22–24). Others did not show a relationship between the use of antenatal care and perinatal outcome (25). The results of this study showed critical associations between the frequency of antenatal care attendance and perinatal health.

Odds ratios used to estimate the perinatal health of subjects using antenatal care services once or twice, or three times or more in reference to those not using the services suggested a range of outcomes owing by antenatal care. There were critical differences between the odds ratio for once or twice, or three times or more, with respect to using antenatal care services for postpartum anemia. There were neither associations nor tendencies between using antenatal care once or twice and a reduction in the incidence of postpartum anemia. A significant relationship between the use of three times or more antenatal care and a reduction in the incidence of postpartum

anemia was observed. There were gradient relationships among the frequency of antenatal care use, once or twice, or three times or more, postpartum health knowledge, the low birth weight of newborns, and the coverage of infant immunizations. This suggests the influence of using antenatal care once or twice is weak, while the influence is significantly strengthened by using the service three times or more. Information on the range of relationships with perinatal health according to the number of programs attended helps design programs with different contents for women with different past experiences in antenatal care and attendance histories.

The use of antenatal care at least three times was associated with a lower risk of postpartum anemia within 90 days of delivery, which was independent of other influencing factors. This result was regarded to be related to the iron supplementation from 90 iron-folate tablets received at three antenatal care visits. The following dietary practice advice given at the antenatal care may have also been related to the prevention of anemia after delivery.

The women who used qualified antenatal care were younger and had a fewer number of deliveries than those who did not use the qualified antenatal care. It is understandable that women with less experience with delivery used antenatal care more frequently. However, the results of perinatal health outcome indicated that influences from earlier pregnancies are less likely to exist. Visits of health professionals to the communities of the subjects at the registration to this study did not induce nor reduce antenatal care visits because there was no association between the term from the registration of the study to the delivery and the use of qualified antenatal care. The body mass indexes (BMIs) of the subject mothers at postpartum among those with and without qualified antenatal care had a similar level. BMIs do not directly relate to differences of antenatal health conditions in the health status of mothers during pregnancy and perinatal health outcome are less likely to be observed. Attention to other conditions that might influence perinatal health should be given before making any conclusions on the association between qualified antenatal care and perinatal health outcome.

The compliance of women to the services is important when considering the quality of antenatal care. The level of satisfaction with the services among the subjects was high, and should be taken into consideration. Health advice by the subjects was related to better perinatal health status and literacy. The quality of antenatal care services along with the providers showing a positive attitude by acting appropriately to meet the needs of the women is related to the satisfaction of users (26–29). Services by locally employed personnel who are familiar with the lifestyles and culture of the people living in the villages enhanced the confidence of the subjects by enabling mutually satisfying care.

Individual communication and tailor-made approaches contributed to improving functional health literacy (30). At individual antenatal care visits in Phnom Penh, services were provided as a combination of a group health education, individual health education, and health examinations. This enabled tailor-made education to meet the actual needs of the women with diverse backgrounds and experiences.

The long-term effects of such care on the healthy growth of children are worth mentioning. Although little attention is usually made to postpartum care and the postpartum health status of mothers (31), our results show the value of antenatal care on postpartum health status of mothers, regardless of the women's social class. Contacts with health professionals for antenatal care during pregnancy were regarded as an entry point for other health services. The use of immunization was facilitated by the use of antenatal care regardless of socioeconomic status. Intensive education during pregnancy on the benefits of the immunization for infants has increased women's access to immunization services. Other studies have shown inconsistent results in the association between antenatal care and infant immunization (32, 33). These studies were regarded to show that the long-term benefits of education differ according to the participants' baseline functional literacy and quality of education. The long term benefits of antenatal care according to the functional literacy of women should be further studied.

Considering the widening socioeconomic inequalities in urban areas, the utilities of health services regardless of the users' social class, are particularly valued in resource-scarce countries. Improvements in functional health literacy during pregnancy followed by antenatal care services were identified as positives, even without the women's formal education experiences (34). The study showed the significance of education during pregnancy having a positive influence on the maternal health knowledge after delivery. Of particular importance is the positive effect on mothers of limited formal education and income.

In terms of reducing socioeconomic inequalities in health, antenatal care with a comprehensive health education to those in lower socioeconomic conditions should be further encour-

aged. The role of health service providers and community leaders in encouraging women in disadvantaged conditions to participate in qualified antenatal care should be further strengthened. Programs with the member's help disseminate perinatal health recommendations by using methods relevant to individual communities. Outreach programs and community self-help programs with some minimum subsidies are some examples.

The utilities of qualified antenatal care during pregnancy, and the use of antenatal care with comprehensive education program at least three times were demonstrated, regardless of the socioeconomic conditions of the families. For further improvement in perinatal health, a solid school education system attended by women, and the encouragement of the use of antenatal care by pregnant women using various promotional activities should continue to be stimulated. In addition, the formation of practical guidelines, based on evidence, to implement antenatal care is necessary and should be enforced at all times.

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References

- (1) Abou-Zarh CL, Wardlaw TM. Antenatal Care in Developing Countries: Promises, Achievements and Missed Opportunities, Analysis of Trends, Levels and Differentials, 1990–2001. Geneva: World Health Organization; 2003.
- (2) Fikree FF, Ali T, Dyrocher JM, Rahbar MH. Health service utilization for perceived postpartum morbidity among poor women living in Karachi. *Soc Sci Med.* 2004;59:681–694.
- (3) Reyes H, Perez-Cuevas R, Salmeron J, Tome P, Guiscafre H, Gutierrez G. Infant mortality due to acute respiratory infections: the influence of primary care processes. *Health Policy and Planning.* 1997;12:214–223.
- (4) Buor D. Mother's education and childhood mortality in Ghana. *Health Policy.* 2003;64:297–309.
- (5) Basu AM, Stephenson R. Low levels of maternal education and the proximate determinants of childhood mortality: a little learning is not a dangerous thing. *Soc Sci Med.* 2005; 60:2011–2023.
- (6) Heaton TB, Forste R, Hoffmann JP, Flake D. Cross-national variation in family influences on child health. *Soc Sci Med.* 2005;60:97–108.
- (7) Fawzi WW, Forman MR, Levy A, Graubard BI, Naggan L, Berrendes HW. Maternal anthropometry and infant feeding practice in Israel in relation to growth in infancy: the North African Infant Feeding Study. *Am J Clin Nutr.* 1997;65:1731–1737.
- (8) Ross JS, Harvey PWJ. Contribution of breastfeeding to vitamin A nutrition of infants: a simulation model. *Bulletin of the World Health Organization.* 2003;81:80–86.
- (9) Desgrees du Lou A, Pison G, Aaby P. The role of immunizations in the recent decline in childhood mortality and the changes in the female/male mortality ratio in rural Senegal. *Am J Epidemiol.* 1995;142:643–652.
- (10) Kristensen I, Aaby P, Jensen H. Routine vaccinations and child survival: follow-up study in Guinea-Bissau. *BMJ.* 2000; 20:1435–1438.
- (11) Aaby P, Garly ML, Bale C, Martins C, Lisse I, Jensen H. Routine vaccinations and child survival in war situation with high mortality: effect of gender. *Vaccine.* 2002;21:15–20.
- (12) Veirum JE, Sodemann M, Biai S, Jakobsen M, Garly ML, Hedegaard K, et al. Routine vaccinations associated with divergent effects on female and male mortality at the paediatric ward in Bissau, Guinea-Bissau. *Vaccine.* 2005;23:1197–1204.
- (13) Koum K, Hy S, Tiv S, Sieng T, Obara H, Matsui M, et al. Characteristics of antepartum and intrapartum eclampsia in the National Maternal and Child Health Center in Cambodia.

- J Obstet Gynecol Res. 2004;30:74–79.
- (14) Akashi H, Yamada T, Huot E, Kanal K, Sugimoto T. User fee at a public hospital in Cambodia: effects on hospital performance and provider attitudes. *Soc Sci Med.* 2004;58:553–564.
 - (15) Nair NS, Rao RS, Chandrashekar S, Acharya D, Bhat HV. Socio-demographic and maternal determinants of low birth-weight: a multivariate approach. *Indian J Pediatr.* 2000;67:9–14.
 - (16) Tangcharoensathien V, Harnvoravongchai P, Pitayarangsarit S, Kasemsup V. Health impacts of rapid economic changes in Thailand. *Soc Sci Med.* 2000;51:789–807.
 - (17) Anson O. Utilization of maternal care in rural HeBei Province, the People's Republic of China: individual and structural characteristics. *Health Policy.* 2004;70:197–206.
 - (18) Toan NV, Hoa HT, Trong PV, Hojer B, Persson LA, Sundstrom K. Utilisation of reproductive health services in rural Vietnam: are there equal opportunities to plan and protect pregnancies? *J Epidemiol Community Health.* 1996;50:451–455.
 - (19) Pallikadavath S, Foss M, Stones RW. Antenatal care: provision and inequality in rural north India. *Soc Sci Med.* 2004;59:1147–1158.
 - (20) Navaneetham K, Dharmalingam A. Utilization of maternal health care services in Southern India. *Soc Sci Med.* 2002;55:1849–1869.
 - (21) Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency in the United States. *Morbidity and Mortality Weekly Report* 1998;47(RR-3):1–29.
 - (22) Blondel B, Marshall B. Poor antenatal care in 20 French districts: risk factors and pregnancy outcome. *J Epidemiol Community Health.* 1998;52:501–506.
 - (23) Letamo G, Majelantle MG. Factors influencing low birth weight and prematurity in Botswana. *J Biosoc Sci.* 2001;33:391–403.
 - (24) Goldani MZ, Barbieri MA, Silva AA, Bettioli H. Trends in prenatal care use and low birth weight in southeast Brazil. *Am J Public Health.* 2004;94:1366–1371.
 - (25) Fujita N, Matsui M, Srey S, Po CS, Uong S, Koum K. Antenatal care in the capital city of Cambodia: current situation and impact on obstetric outcome. *J Obstet Gynecol Res.* 2005;31:133–139.
 - (26) Duong DV, Binns CW, Lee AH, Hipgrave DB. Measuring client-perceived quality of maternity services in rural Vietnam. *International Journal for Quality in Health Care.* 2004;16:447–452.
 - (27) Upul S, Dulitha NF, Ishani R. Factors determining client satisfaction with hospital-based perinatal care in Sri Lanka. *Tropical Medicine and International Health.* 2006;11:1442–1451.
 - (28) Smith MA, Bartell JM. Changes in usual source of care and perceptions of health care access, quality and use. *Medical Care.* 2004;42:975–984.
 - (29) Trevena LJ, Simpson JM, Nutbeam D. Soup kitchen consumer perspectives on the quality and frequency of health service interactions. *International Journal of Quality in Health Care.* 2003;15:495–500.
 - (30) Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International.* 2000;15:259–267.
 - (31) Sserunjogi L, Scheutz F, Whyte SR. Postnatal anemia: neglected problems and missed opportunities in Uganda. *Health Policy and Planning.* 2003;18:225–231.
 - (32) Partha D, Bhattacharya BN. Determinants of child immunization in four less-developed states of north India. *J Child Health Care.* 2002;6:34–50.
 - (33) Bolam A, Manandhar DS, Shrestha P, Ellis M, Costello AML. The effects of postnatal health education for mothers on infant care and family planning practices in Nepal: a randomized controlled trial. *BMJ.* 1998;316:805–811.
 - (34) Ohnishi M, Nakamura K, Takano T. Improvement in maternal health literacy among pregnant women who did not complete compulsory education: policy implications for community care services. *Health Policy.* 2005;72:157–164.