Method of delivery and pregnancy outcomes in Asia: the WHO global survey on maternal and perinatal health 2007–08

*Pisake Lumbiganon, Malinee Laopaiboon, A Metin Gülmezoglu, João Paulo Souza, Surasak Taneepanichskul, Pang Ruyan, Deepika Eranjanie Attygalle, Naveen Shrestha, Rintaro Mori, Nguyen Duc Hinh, Hoang Thi Bang, Tung Rathavy, Kang Chuyun, Kannitha Cheang, Mario Festin, Venus Udomprasertgul, Maria Julieta V Germar, Gao Yanqiu, Malabika Roy, Guillermo Carroli, Katherine Ba-Thike, Ekaterina Filatova, José Villar, for the World Health Organization Global Survey on Maternal and Perinatal Health Research Group**

Summary

Background There has been concern about rising rates of caesarean section worldwide. This Article reports the third phase of the WHO global survey, which aimed to estimate the rate of different methods of delivery and to examine the relation between method of delivery and maternal and perinatal outcomes in selected facilities in Africa and Latin America in 2004–05, and in Asia in 2007–08.

Methods Nine countries participated in the Asia global survey: Cambodia, China, India, Japan, Nepal, Philippines, Sri Lanka, Thailand, and Vietnam. In each country, the capital city and two other regions or provinces were randomly selected. We studied all women admitted for delivery during 3 months in institutions with 6000 or fewer expected deliveries per year and during 2 months in those with more than 6000 deliveries. We gathered data for institutions to obtain a detailed description of the health facility and its resources for obstetric care. We obtained data from women's medical records to summarise obstetric and perinatal events.

Findings We obtained data for 109 101 of 112 152 deliveries reported in 122 recruited facilities (97% coverage), and analysed 107 950 deliveries. The overall rate of caesarean section was 27·3% (n=29 428) and of operative vaginal delivery was 3·2% (n=3465). Risk of maternal mortality and morbidity index (at least one of: maternal mortality, admission to intensive care unit [ICU], blood transfusion, hysterectomy, or internal iliac artery ligation) was increased for operative vaginal delivery (adjusted odds ratio 2·1, 95% CI 1·7–2·6) and all types of caesarean section (antepartum without indication 2·7, 1·4–5·5; antepartum with indication 10·6, 9·3–12·0; intrapartum without indication 14·2, 9·8–20·7; intrapartum with indication 14·5, 13·2–16·0). For breech presentation, caesarean section, either antepartum (0·2, 0·1–0·3) or intrapartum (0·3, 0·2–0·4), was associated with improved perinatal outcomes, but also with increased risk of stay in neonatal ICU (2·0, 1·1–3·6; and 2·1, 1·2–3·7, respectively).

Interpretation To improve maternal and perinatal outcomes, caesarean section should be done only when there is a medical indication.

Funding US Agency for International Development (USAID); UNDP/UNFPA/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP), WHO, Switzerland; Ministry of Health, Labour and Welfare of Japan; Ministry of Public Health, China; and Indian Council of Medical Research.

Introduction

Several factors, including the increased perception of safety, have contributed to a worldwide increase in rates of caesarean section.[1] In many countries, these rates have reached epidemic proportions, motivating a debate about whether the high rates are appropriate.[2] Unnecessary caesarean section is a classic example of the mismatch between evidence and practice in obstetrics. This debate also draws attention to the complexities that attempts to change practice entail.[3,4] On the one hand, some are concerned about possible additional maternal and perinatal morbidity caused by unnecessary caesarean sections. On the other hand, assessment of whether the caesarean section operation poses an intrinsic risk to the mother or the baby is difficult. Ethical and practical constraints prevent assessment of intrinsic risks related to caesarean sections with use of a randomised controlled trial.

In developing countries, improvement of maternal and perinatal health strongly depends on strengthening of health systems.[5] When resources are scarce, caesarean sections that are not medically indicated could, if done in large numbers, represent a serious resource drain. At the same time as unnecessary overuse of surgical practices is being assessed in some countries, millions of women in other countries who need these procedures do not have access to them, putting their own and their children's lives at risk.[6]

This Article reports the third phase of the WHO global survey project—a study that was implemented in the Americas (2005), Africa (2005), and Asia (2007–08) to alleviate the scarcity of information for planning and assessment of maternal and perinatal health services, specifically, intrapartum care. The survey in Latin America suggested that, at the level of facilities, increasing rates of caesarean section do not necessarily lead to

Published Online January 12, 2010 DOI:10.1016/S0140-6736(09)61870-5

See Online/Comment DOI:10.1016/S0140-6736(10)60055-4

*Members listed at end of paper

Department of Obstetrics and Gynaecology, Faculty of Medicine (Prof P Lumbiganon MD), **and Department of Biostatistics and Demography, Faculty of Public Health** (M Laopaiboon PhD), **Khon Kaen University, Khon Kaen, Thailand; UNDP/UNFPA/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction, WHO, Geneva, Switzerland** (A M Gülmezoglu MD, J P Souza MD, K Ba-Thike MD, E Filatova MD, J Villar MD); **College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand** (Prof S Taneepanichskul MD, V Udomprasertgul PhD); **Maternal and Child Health Department of Public Health School, Peking University, Beijing, China** (P Ruyan MD, K Chuyun MD, G Yanqiu MD); **Family Health Bureau, Ministry of Health, Colombo, Sri Lanka** (D E Attygalle MD); **School of Pharmaceutical and Bio-medical Sciences, Faculty of Science and Technology Pokhara University, Kaski, Nepal** (Prof N Shrestha MSc); **Osaka Medical Center and Research Institute for Maternal and Child Health, Osaka, Japan** (R Mori MD); **National Obstetrics and Gynaecology Hospital, Hanoi, Vietnam** (N D Hinh MD); **WHO Country Office, Hanoi, Vietnam** (H T Bang MD); **National Maternal and Child Health Center, Phnom Penh, Cambodia** (T Rathavy MD);

WHO Country Office, Phnom Penh, Cambodia (K Cheang MD); **University of Philippines, College of Medicine, Manila, Philippines** (Prof M Festin MD, M J V Germar MD); **Indian Council of Medical Research, Ansari Nagar, New Delhi, India** (M Roy MD); **and Centro Rosarino de Estudios Perinatales Rosario, Argentina** (G Carroli MD)

Correspondence to:
Dr A Metin Gülmezoglu, Department of Reproductive Health and Research World Health Organization, Avenue Appia 20, Geneva 27, CH-1211 Switzerland
gulmezoglum@who.int

improved outcomes and could be associated with harm.[7] The WHO global survey in Asia aimed to obtain regional estimates of different methods of delivery in facilities, studying the relation between method of delivery and maternal and perinatal outcomes. By undertaking the study in a randomly selected number of health facilities that have not participated in research before, we aimed to develop a network with capacity to collect routine data and participate in collaborative research across countries and regions.

Methods

Study design

Methodological details of the global survey have been published elsewhere.[8] Briefly, this is a multicountry, facility-based survey that collected data for all delivering women in randomly selected facilities worldwide. WHO subregions, classified by the number of children younger than 5 years and adult mortality rates, were used as a proxy for the burden of maternal and perinatal mortality. A stratified multistage cluster sampling design was used to obtain a sample of countries and health institutions worldwide. From each subregion, four countries were selected, with probability proportional to population size. When a subregion had fewer than four countries, all countries within that subregion were included. This process resulted in 12 subregions having four countries each, and two subregions having three countries each.[8] Owing to financial and practical constraints, we could not undertake the survey in developed countries of the region (unless they volunteered to—eg, Japan) and some of the selected countries (eg, Indonesia). Nine Asian countries were included: Cambodia, China, India, Japan, Nepal, Philippines, Sri Lanka, Thailand, and Vietnam. In each country, two regions or provinces, in addition to the capital city, were randomly selected by computer, with probability of selection proportional to their size. Once a province had been selected, we obtained a census of all facilities with more than 1000 births per year and those doing caesarean sections. If there were more than seven facilities, seven were randomly selected by computer, with probability of selection proportional to the number of births per year. If there were fewer than seven facilities, all were selected. In each of the selected institutions, we studied all women admitted for delivery during 3 months in institutions with 6000 or fewer expected deliveries per year and during 2 months in those with more than 6000 expected deliveries per year.

Data collection was started in China in October, 2007, and concluded in the Philippines in May, 2008. We obtained written permission from all ministries of health of the participating countries and the directors of the selected facilities. We obtained data for all individuals from medical records and did not identify participants. The Ethics Review Committee of WHO and of each country independently approved the protocol.

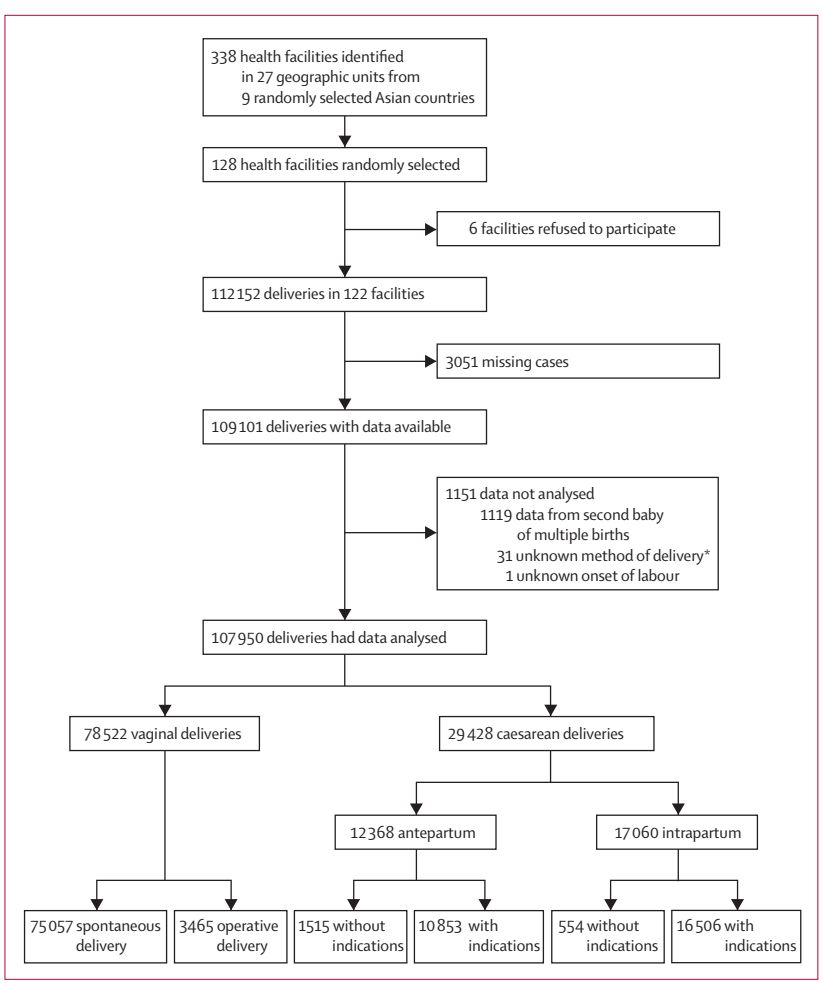

Figure 1: **Study profile**
*Includes 28 cases of laparotomy for uterus rupture.

Data collection

We collected data for institutions and for individuals. For institutions, data included characteristics of maternal and perinatal care, including the availability of laboratory tests; anaesthesiology resources; services for intrapartum care, delivery, and care of the newborn baby; and presence or absence of basic emergency medical and obstetric care facilities, intensive care units (ICUs), and human and training resources. We gathered data only once to obtain a detailed description of the health facility and its resources for obstetric care. The hospital coordinator completed a form in consultation with the director or head of obstetrics. For individuals, we obtained data from women's medical records to complete a two-page precoded form, summarising obstetric and perinatal events. Data collected included demographic characteristics, maternal risk, current pregnancy, method of delivery, and outcomes (maternal and perinatal) up to hospital discharge. All women giving birth at the facility during the study period were included. Trained staff reviewed the medical records of all women and their

	Vaginal delivery		Caesarean section					Total
	Spontaneous	Operative	Overall	Antepartum without indications	Antepartum with indications	Intrapartum without indications	Intrapartum with indications	
Cambodia	4319 (77·6%)	431 (7·7%)	14·7%	2 (0·04%)	144 (2·6%)	12 (0·2%)	657 (11·8%)	5565 (5·2%)
China	7649 (52·6%)	179 (1·2%)	46·2%	1356 (9·3%)	2855 (19·6%)	341 (2·4%)	2161 (14·9%)	14541 (13·5%)
India	19586 (79·3%)	719 (2·9%)	17·8%	16 (0·1%)	892 (3·6%)	48 (0·2%)	3421 (13·9%)	24682 (22·9%)
Japan	2445 (74·1%)	200 (6·1%)	19·8%	2 (0·1%)	457 (13·9%)	0	196 (5·9%)	3300 (3·1%)
Nepal	6447 (75·9%)	323 (3·8%)	20·3%	3 (0·04%)	522 (6·2%)	5 (0·1%)	1189 (14·0%)	8489 (7·9%)
Philippines	10427 (78·4%)	372 (2·8%)	18·8%	5 (0·04%)	1064 (8·0%)	19 (0·1%)	1408 (10·6%)	13295 (12·3%)
Sri Lanka	9900 (65·9%)	526 (3·5%)	30·6%	83 (0·6%)	3021 (20·1%)	29 (0·2%)	1465 (9·8%)	15024 (13·9%)
Thailand	6007 (61·6%)	420 (4·3%)	34·1%	33 (0·3%)	1309 (13·4%)	15 (0·2%)	1961 (20·1%)	9745 (9·0%)
Vietnam	8277 (62·2%)	295 (2·2%)	35·6%	28 (0·2%)	576 (4·3%)	112 (0·8%)	4021 (30·2%)	13309 (12·3%)
Total	75 057 (69·5%)	3465 (3·2%)	27·3%	1515 (1·4%)	10 853 (10·1%)	554 (0·5%)	16 506 (15·3%)	107 950 (100%)

Table 1: **Numbers of women by country and method of delivery**

babies before discharge from the hospital, and abstracted data daily to their forms for individual data collection. The hospital coordinator supervised data collection, resolving or clarifying unclear medical notes before forms were sent for data entry. Attending staff updated incomplete records before discharge.

We developed a hospital complexity index, summarising an institution's capacity to provide different levels of care, dependent on its ratings for eight categories: building, general medical care, laboratory, anaesthesiology, screening tests, human resources, basic obstetric services, and continuous medical education. We classified hospitals without any of these services or resources as low level (rating score 0), those that had both essential and optional services and resources as high level (rating score 2), and those that did not have some of the optional services or resources, but had all essentials, as medium level (rating score 1). We judged hospitals with a total score of 9 or less of low complexity, those with scores of between 10 and 12 of medium complexity, and those with scores of 13 or more of high complexity. Criteria for data abstraction were defined in the manual of operations, which was available for staff training and monitoring of data quality, keeping to a minimum the need for judgment and interpretation. The manual contained definitions of all terms used and synonyms of medical and obstetric terms, and described questions and precoded corresponding answers.

Statistical analysis

All data were continuously entered by country data managers or hospital coordinators with a web-based system (MedSciNet AB, Stockholm, Sweden) in collaboration with WHO between October, 2007, and May, 2008. We calculated the survey coverage by comparing the number of delivery forms completed during the study period with the total number of deliveries, as independently recorded in the hospital logbooks. We used frequencies to describe methods of delivery for each country and facility characteristics, and

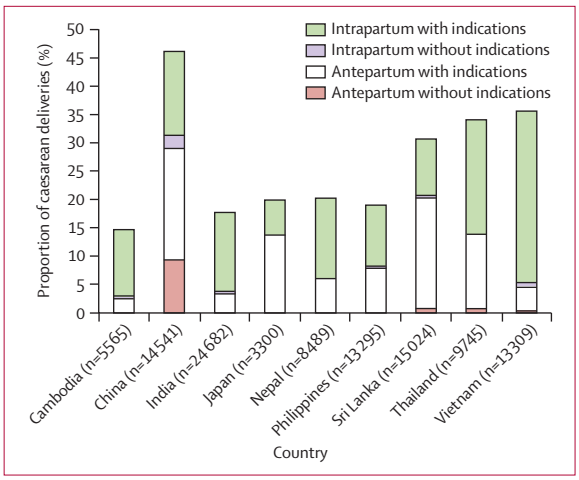

Figure 2: **Proportion of caesarean deliveries by four classifications and countries**

characteristics of mothers and babies for each group of delivery method. We assessed the association of each maternal outcome of death, admission to ICU, blood transfusion, hysterectomy, and mortality and morbidity index (which was defined as the presence of at least one of: maternal mortality, admission to ICU, blood transfusion, hysterectomy, or internal iliac artery ligation); and perinatal outcomes of perinatal mortality, fetal deaths, neonatal mortality up to hospital discharge, stay in neonatal ICU for 7 days or longer, and perinatal mortality and morbidity index (defined as the presence of perinatal death or stay in neonatal ICU for 7 days or longer), with methods of delivery by use of odds ratios (OR) and 95% CIs.

Univariate analysis was done separately for assessment of the association of methods of delivery and other characteristics of mothers, babies, and facilities individually on each outcome. The crude ORs were always corrected for the clustering effect of the facility. Individual-level and facility-level variables that were significantly associated with the outcome in the univariate

For more on **MedSciNet** see http://www.medscinet.com/who

	Vaginal delivery		Caesarean section				Total (n=107 950)
	Spontaneous (n=75 057)	Operative (n=3465)	Antepartum without indications (n=1515)	Antepartum with indications (n=10 853)	Intrapartum without indications (n=554)	Intrapartum with indications (n=16 506)	
General characteristics							
Marital status (single)	4973 (6·6%)	196 (5·7%)	4 (0·3%)	425 (3·9%)	7 (1·3%)	552 (3·3%)	6157 (5·7%)
Maternal age (years)							
≤16	550 (0·7%)	19 (0·6%)	0	22 (0·2%)	1 (0·2%)	63 (0·4%)	655 (0·6%)
17–34	68 713 (91·6%)	3091 (89·2%)	1378 (91·0%)	8841 (81·5%)	500 (90·3%)	14 772 (89·5%)	97 295 (90·2%)
≥35	5780 (7·7%)	355 (10·2%)	137 (9·0%)	1989 (18·3%)	53 (9·5%)	1667 (10·1%)	9981 (9·3%)
Primigravida	32 479 (43·3%)	1948 (56·2%)	671 (44·3%)	3372 (31·1%)	251 (45·3%)	7743 (46·9%)	46 464 (43·0%)
Last pregnancy							
Last baby birthweight (previous delivery [g])							
<1500	904 (1·2%)	91 (2·6%)	1 (0·1%)	161 (1·5%)	0	93 (0·6%)	1250 (1·2%)
≥1500–2499	9292 (12·3%)	501 (14·5%)	26 (1·7%)	1486 (13·7%)	22 (3·9%)	1654 (10·0%)	12 981 (12·0%)
≥2500–3999	63 900 (85·2%)	2808 (81·1%)	1383 (91·3%)	8664 (79·8%)	510 (92·1%)	14 040 (85·1%)	91 305 (84·6%)
≥4000–4499	873 (1·2%)	56 (1·6%)	95 (6·3%)	457 (4·2%)	21 (3·8%)	621 (3·8%)	2123 (2·0%)
≥4500	69 (0·1%)	6 (0·2%)	9 (0·6%)	83 (0·8%)	1 (0·2%)	87 (0·5%)	255 (0·2%)
Caesarean delivery in the last pregnancy	1034 (1·4%)	127 (3·7%)	43 (2·8%)	3996 (36·8%)	21 (3·8%)	3347 (20·3%)	8568 (7·9%)
Complications during current pregnancy							
Prelabour rupture of membranes	8388 (11·2%)	425 (12·3%)	129 (8·5%)	732 (6·7%)	112 (20·2%)	3100 (18·8%)	12 886 (11·9%)
Pregnancy-induced hypertension	2158 (2·9%)	222 (6·4%)	38 (2·5%)	838 (7·7%)	16 (2·9%)	845 (5·1%)	4117 (3·8%)
Pre-eclampsia	1096 (1·5%)	134 (3·9%)	7 (0·5%)	543 (5·0%)	1 (0·2%)	517 (3·1%)	2298 (2·1%)
Eclampsia	183 (0·2%)	36 (1·0%)	1 (0·1%)	73 (0·7%)	0	96 (0·6%)	389 (0·4%)
Breech or other non-cephalic presentation	805 (1·1%)	725 (20·9%)	0	1637 (15·1%)	0	2172 (13·2%)	5339 (5·0%)
Referred for complication related to pregnancy or delivery	13 719 (18·3%)	698 (20·1%)	100 (6·6%)	2781 (25·6%)	49 (8·8%)	2828 (17·1%)	20 175 (18·7%)

Data are number (% of country total) for method of delivery columns and (% of study total) for total column.

Table 2: **Characteristics of women classified by method of delivery**

analysis ($p<0·05$) were successively included in a multivariate model. In the multivariate analysis, each model of the outcomes of interest included method of delivery defined in six categories: vaginal spontaneous (reference category); operative vaginal; antepartum caesarean delivery with and without indications; and intrapartum caesarean delivery with and without indications, and the variables found to be significant in the univariate analyses. Variables for both individuals and facilities that did not show significance at the 5% level in the resulting model were then removed one by one until all remaining variables were significant. Gestational age was always included irrespective of statistical significance when we considered perinatal outcomes. For all models fitted, we used generalised linear and latent mixed models (GLLAMM) for the multilevel analysis by using procedure GLIMMIX in SAS (version 9.1). The procedure accounted for clustering effects within facilities. The multilevel analysis was also done for perinatal outcomes in subgroups of fetal presentations (cephalic, breech, and others). Risks of maternal and perinatal outcomes associated with method of delivery were presented by adjusted ORs with corresponding 95% CIs.

Role of the funding sources

The sponsors of the study had no role in study design, data collection, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Figure 1 shows the study profile. In the nine randomly selected Asian countries, we selected 27 geographical units. There were 388 health facilities in these units, of which we randomly selected 128 facilities. Six facilities declined to participate, leaving 122 in the survey. 112 152 deliveries were reported in these 122 facilities during the study period. Our survey collected data for 109 101 deliveries (97% coverage). We checked the data quality by randomly selecting 5% of the records and asking the hospital coordinators to extract the same data from medical records again, and compared these data with the original record. The mean agreement was 92% (range 81–98). We excluded 31 patients with unknown method of delivery, 1119 second babies of multiple births, and one with unknown onset of labour, leaving 107 950 analysable deliveries.

www.thelancet.com Published online January 12, 2010 DOI:10.1016/S0140-6736(09)61870-5

China, India, and the Philippines had the highest numbers of facilities (seven per province), whereas India, Sri Lanka, and China had the highest numbers of deliveries (table 1). 84 (69%) facilities were in urban areas and 104 (85%) were in the public system. Most of the hospitals were secondary or tertiary referral hospitals; however, 83 (68%) had low facility complexity resources. 87 (71%) hospitals had anaesthesiology resources 24 h per day in the facility, and in 75 (62%), financial incentives were offered for undertaking caesarean section. The overall rate of caesarean section of this survey in Asia was 27·3%. China had the highest overall rate followed by Vietnam, Thailand, and Sri Lanka (table 1). China also had the highest rate of caesarean section without indication (11·7%), followed by Vietnam (1·0%), Sri Lanka (0·8%), and Thailand (0·5%; table 1 and figure 2). Since the pattern of caesarean section was substantially different in China from the other countries (figure 2), we undertook a sensitivity analysis for the maternal and newborn outcomes, excluding data from China. We noted no changes to the results (data not shown), and the results are reported for all nine countries together. The commonly reported indications for caesarean section were previous caesarean section (24·2%), cephalopelvic disproportion (22·6%), fetal distress (20·5%), and breech or other abnormal presentation (12·5%).

Table 2 shows characteristics of women by method of delivery. We noted a higher proportion of single marital status and very low birthweight infant (<1500 g) in women who delivered vaginally than in those who delivered by caesarean section. Delivery by caesarean section in the last pregnancy was more common in women who delivered by caesarean section than in those who had vaginal delivery (table 2). The rates of complications during current pregnancy were similar between women who delivered vaginally or by caesarean section (table 2).

For maternal mortality, only operative vaginal delivery had significantly increased risk compared with spontaneous vaginal deliveries (adjusted OR 3·1, 95% CI 1·5–6·5). The risk for antepartum caesarean section without indication could not be estimated because there were no maternal deaths in this group. Operative vaginal delivery and all types of caesarean section had significantly increased risk of admission to ICU compared with spontaneous vaginal delivery (table 3). Operative vaginal delivery, antepartum caesarean section with indications, and intrapartum caesarean section with and without indication had significantly increased risks of blood transfusion compared with spontaneous vaginal delivery (table 3). The risk of hysterectomy was increased in mothers who delivered by operative vaginal delivery, antepartum caesarean section with indications, and intrapartum caesarean section with indications (table 3). We recorded no cases of hysterectomy in women who delivered by antepartum caesarean section without indications and intrapartum caesarean section without indications, so the risk could not be estimated. Operative vaginal delivery and all types of caesarean section were associated with significantly increased risk of maternal mortality and morbidity index compared with spontaneous vaginal

	n/N (%)	Adjusted OR (95%CI)
Death*		
Spontaneous (reference)	53/75 057 (0·1%)	1
Operative vaginal delivery	9/3465 (0·3%)	3·1 (1·5–6·5)
Antepartum CS without indications	0/1515	..
Antepartum CS with indications	11/10 853 (0·1%)	1·1 (0·5–2·3)
Intrapartum CS without indications	1/554 (0·2%)	4·8 (0·6–36·0)
Intrapartum CS with indications	23/16 506 (0·1%)	1·6 (0·9–2·8)
Admission to ICU†		
Spontaneous (reference)	442/75 057 (0·5%)	1
Operative vaginal delivery	76/3465 (2·0%)	2·4 (1·8–3·3)
Antepartum CS without indications	5/1515 (0·3%)	9·9 (3·8–25·8)
Antepartum CS with indications	391/10 853 (3·6%)	42·8 (34·5–53·1)
Intrapartum CS without indications	35/554 (6·2%)	67·0 (42·0–106·7)
Intrapartum CS with indications	1489/16 506 (9·0%)	55·7 (47·1–65·8)
Blood transfusion‡		
Spontaneous (reference)	785/75 057 (1·0%)	1
Operative vaginal delivery	78/3465 (2·3%)	2·1 (1·6–2·8)
Antepartum CS without indications	3/1515 (0·3%)	0·8 (0·3–2·6)
Antepartum CS with indications	352/10 853 (3·2%)	4·1 (3·4–4·8)
Intrapartum CS without indications	7/5854 (1·4%)	3·9 (1·8–8·5)
Intrapartum CS with indications	541/16 506 (3·3%)	4·7 (4·1–5·3)
Hysterectomy§		
Spontaneous (reference)	28/75 057 (0·04%)	1
Operative vaginal delivery	4/3465 (3·3%)	2·8 (0·9–7·9)
Antepartum CS without indications	0/1515	..
Antepartum CS with indications	35/10 853 (0·3%)	6·9 (4·1–11·6)
Intrapartum CS without indications	0/554	..
Intrapartum CS with indications	37/16 506 (0·2%)	5·8 (3·5–9·6)
Maternal mortality and morbidity index¶		
Spontaneous (reference)	1215/75 057 (1·6%)	1
Operative vaginal delivery	146/3465 (4·2%)	2·1 (1·7–2·6)
Antepartum CS without indications	9/1515 (0·6%)	2·7 (1·4–5·5)
Antepartum CS with indications	744/10 853 (6·9%)	10·6 (9·3–12·0)
Intrapartum CS without indications	40/554 (7·2%)	14·2 (9·8–20·7)
Intrapartum CS with indications	1947/16 506 (11·8%)	14·5 (13·2–16·0)

OR=odds ratio. CS=caesarean section. ICU=intensive care unit. *Adjusted for malaria, severe anaemia, other medical disorders, any condition suggesting HIV/AIDS, pre-eclampsia, eclampsia, suspected fetal growth impairment, vaginal bleeding in second half of pregnancy, and referred for complication related to pregnancy or delivery. †Adjusted for maternal age, year of education, birthweight, HIV, chronic hypertension, cardiac/renal diseases, malaria, severe anaemia, other medical disorders, prelabour rupture of membranes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, and country. ‡Adjusted for maternal age, year of education, primiparous, birthweight, cervix surgery, chronic respiratory disease, sickle-cell anaemia, severe anaemia, other medical diseases, pregnancy-induced hypertension, pre-eclampsia, eclampsia, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, and country. §Adjusted for chronic hypertension, severe anaemia, and vaginal bleeding in second half of pregnancy. ¶Maternal mortality and morbidity index=death or admission to ICU, blood transfusion, hysterectomy, or internal iliac artery ligation. Adjusted for maternal age, year of education, primiparous, birthweight, history of neonatal death or stillbirth, HIV, chronic hypertension, cardiac/renal diseases, sickle-cell anaemia, severe anaemia, other medical disorders, prelabour rupture of membranes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, vaginal bleeding in second half of pregnancy, any antenatal antibiotic treatment, referred for complication related to pregnancy or delivery, and country.

Table 3: **Risk of maternal mortality and morbidity by method of delivery**

delivery (table 3). Intrapartum caesarean section (both with and without indications) had higher risk of maternal mortality and morbidity than did antepartum caesarean section (table 3). Deliveries by all types of caesarean section had significantly increased risks of maternal mortality and morbidities except for perineal tears of third and fourth degree, for which as expected caesarean section had a protective effect compared with vaginal delivery (data not shown).

	n/N (%)	Adjusted OR (95%CI)
Perinatal mortality*		
Spontaneous (reference)	1072/75 057 (1·4%)	1
Operative vaginal delivery	126/3465 (3·6%)	1·6 (1·2–2·0)
Antepartum CS without indications	1/1515 (0·1%)	0·3 (0·04–2·3)
Antepartum CS with indications	143/10 853 (1·3%)	1·1 (0·9–1·3)
Intrapartum CS without indications	0/554	..
Intrapartum CS with indications	284/16 506 (1·7%)	1·5 (1·2–1·7)
Fetal death†		
Spontaneous (reference)	673/74 945 (0·9%)	1
Operative vaginal delivery	68/3448 (2·0%)	1·1 (0·8–1·6)
Antepartum CS without indications	1/1515 (0·1%)	0·4 (0·06–3·2)
Antepartum CS with indications	61/10 853 (0·6%)	0·6 (0·5–0·8)
Intrapartum CS without indications	0/554	..
Intrapartum CS with indications	130/16 504 (0·8%)	0·8 (0·6–1·0)
Neonatal mortality up to hospital discharge‡		
Spontaneous (reference)	399/73 726 (0·5%)	1
Operative vaginal delivery	58/3320 (1·8%)	2·5 (1·7–3·7)
Antepartum CS without indications	0/1514	..
Antepartum CS with indications	82/10 767 (0·8%)	1·7 (1·3–2·3)
Intrapartum CS without indications	0/580	..
Intrapartum CS with indications	154/16 319 (1·0%)	2·6 (2·1–3·2)
Stay for ≥7 days in neonatal ICU§		
Spontaneous (reference)	1092/75 057 (1·5%)	1
Operative vaginal delivery	110/3465 (3·2%)	1·9 (1·5–2·4)
Antepartum CS without indications	5/1515 (0·3%)	0·4 (0·2–1·1)
Antepartum CS with indications	458/10 853 (4·2%)	2·4 (2·0–2·8)
Intrapartum CS without indications	5/554 (0·9%)	1·3 (0·5–3·1)
Intrapartum CS with indications	436/16 506 (2·6%)	2·4 (2·1–2·8)
Perinatal mortality and morbidity index¶		
Spontaneous (reference)	2117/75 057 (2·8%)	1
Operative vaginal delivery	232/3465 (6·7%)	1·9 (1·6–2·3)
Antepartum CS without indications	6/1515 (0·4%)	0·4 (0·2–0·9)
Antepartum CS with indications	593/10 853 (5·5%)	1·9 (1·7–2·2)
Intrapartum CS without indications	5/554 (0·9%)	0·9 (0·4–2·3)
Intrapartum CS with indications	707/16 479 (4·3%)	2·1 (1·9–2·3)

OR=odds ratio. CS=caesarean section. ICU=intensive care unit. *Adjusted for year of education, birthweight, history of neonatal death or stillbirth, severe anaemia, pre-eclampsia, eclampsia, vaginal bleeding in second half of pregnancy, breech or other non-cephalic presentation, referred for complication related to pregnancy or delivery, induced labour, country, and gestational age. †Adjusted for year of education, birthweight, sickle-cell anaemia, severe anaemia, eclampsia, suspected fetal growth impairment, vaginal bleeding in second half of pregnancy, breech or other non-cephalic presentation, referred for complication related to pregnancy or delivery, and gestational age. ‡Adjusted for year of education, birthweight, breech or other non-cephalic presentation, referred for complication related to pregnancy or delivery, country, and gestational age. §Adjusted for year of education, birthweight, caesarean delivery, chronic hypertension, condyloma acuminatum, other medical disorders, prelabour rupture of membranes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, suspected fetal growth impairment, vaginal bleeding in second half of pregnancy, any antenatal antibiotic treatment, breech or other non-cephalic presentation, referred for complication related to pregnancy or delivery, induced labour, country, and gestational age. ¶Perinatal mortality and morbidity index=perinatal mortality or stay for 7 or more days in neonatal ICU. Adjusted for year of education, birthweight, history of neonatal death or stillbirth, caesarean delivery, chronic hypertension, chronic respiratory disorders, diabetes mellitus, condyloma acuminatum, other medical disorders, prelabour rupture of membranes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, suspected fetal growth impairment, vaginal bleeding in second half of pregnancy, any antenatal antibiotic treatment, breech or other non-cephalic presentation, referred for complication related to pregnancy or delivery, country, and gestational age.

Table 4: **Perinatal outcomes for singleton and first child of multiple births by method of delivery**

Risk of perinatal mortality was significantly increased compared with spontaneous vaginal delivery in infants born by operative vaginal delivery and intrapartum caesarean section with indications (table 4). Only infants delivered by antepartum caesarean section with indications had a significantly lower risk of fetal death than those born vaginally, whereas risk of fetal death did not differ significantly for other methods of delivery compared with spontaneous vaginal delivery (table 4). For neonatal mortality up to hospital discharge, infants born by operative vaginal delivery, antepartum caesarean section with indications, and intrapartum caesarean section with indications had significantly increased risk compared with spontaneous vaginal delivery (table 4). We recorded no cases of neonatal mortality up to hospital discharge for women delivering by caesarean section without indication, and the risk compared with spontaneous vaginal delivery could not be estimated.

Infants born by operative vaginal delivery and intrapartum and antepartum caesarean section with indications had significantly increased risk of stay for 7 days or longer in neonatal ICU compared with spontaneous vaginal delivery (table 4). Operative vaginal delivery and antepartum and intrapartum caesarean section with indications had significantly increased risk of perinatal mortality and morbidity index (table 4). For breech and other abnormal presentation, caesarean section with indication, either antepartum or intrapartum, significantly reduced risk of perinatal mortality but had significantly increased risk of stay in neonatal ICU for 7 days or longer (table 5).

Discussion

In the 122 Asian health facilities studied, more than one in four women underwent caesarean section. Facilities in China, Sri Lanka, Vietnam, and Thailand had higher aggregated rates of caesarean section than did those in Cambodia, India, Japan, Nepal, and the Philippines. Operative vaginal delivery and caesarean section were independently associated with increased risk of maternal mortality and morbidity index. Caesarean section without a medical indication was associated with increased risk of maternal mortality and morbidity. Caesarean section for breech presentation was associated with improved perinatal outcomes.

With use of a slightly different analytical approach, this survey confirms the findings of the previous survey undertaken in Latin America.[9] Together these findings provide strong multiregional support for the recommendation of avoiding unnecessary caesarean

www.thelancet.com Published online January 12, 2010 DOI:10.1016/S0140-6736(09)61870-5

sections. A randomised controlled trial[10] to assess the benefits and risks of caesarean section might not be a realistic approach in view of the immediate and long-term physical and psychological effects of different methods of delivery on the woman and her baby and the lack of agreement between health professionals. In the absence of a randomised trial, we have to rely on observational studies to elucidate various benefits and risks of this operation. Intrinsic risk associated with the caesarean section operation is not easy to separate from the medical and obstetrical indications that lead to the procedure. In the previous survey, the intrinsic risk was investigated by dividing the method of delivery into three categories: vaginal, elective caesarean section, and intrapartum caesarean section with elective caesarean section as a proxy. We identified six categories as described in the results. Assisted vaginal delivery represents a high-risk situation, and combination of such deliveries with spontaneous vaginal deliveries as the reference group might not be appropriate. Second, we noticed that several births that were recorded as elective had an indication for caesarean section. The group with no medical indication therefore is probably a more appropriate group to assess the intrinsic risk associated with this procedure.

The most important finding of the survey is the increased risk of maternal mortality and severe morbidity, which was analysed as a composite outcome (the maternal mortality and morbidity index), in women who undergo caesarean section with no medical indication. The findings for the individual outcomes that make up the composite outcome suggest that the increased risk is mainly attributable to increased admission to ICU and blood transfusion. Although we acknowledge that both ICU admission and blood transfusion depend on the availability of those services and the potentially differing thresholds for giving blood and for admission of women to ICU or referral to higher levels of care, this outcome is nevertheless important.

Quantification of the risk across facilities and countries might not be appropriate because there will be differences from setting to setting. However, the results show that women receiving the operation are at increased risk of adverse events. We can therefore conclude that women who choose to have caesarean section, and the doctors who recommend the operation with no medical indication, have to make that decision with the understanding of the increased risks. The procedure also costs more than does a vaginal birth. In the UK, each additional vaginal birth instead of caesarean section would save more than £1200.[11] The costs include actual direct cost, use of operating theatre facilities, use of anaesthesia, human resources (theatre nurses, anaesthesiologists), and use of postoperative facilities. In low-income countries with an unmet need for caesarean section, the issue of this procedure being a resource drain is even more important than it is in high-income countries. If this operation is limited to medical indications and unnecessary use is avoided, resources will be used for a need and will not be taken from other parts of the health system.

The situation regarding potential risk of caesarean section is less clear when the woman has medical or obstetric indications for the procedure. We made several statistical adjustments to try to separate the possible effect of caesarean section in the maternal and perinatal outcomes. After all adjustments, women with medical indications for the operation had an increased risk of morbidity and mortality. One possible interpretation is that the increased risk results from the interaction between baseline morbidity and the morbidity specific to caesarean section. Alternatively, the statistical adjustment might have been unable to isolate the effect of the baseline morbidity—ie, the observed increased risk of

	n/N (%)	Adjusted OR (95%CI)
Cephalic presentation		
Perinatal mortality*		
Spontaneous (reference)	914/74 250 (1·2%)	1
Operative vaginal delivery	38/2740 (1·4%)	2·0 (1·4–2·9)
Antepartum CS without indications	1/1515 (0·1%)	0·3 (0·05–2·5)
Antepartum CS with indications	115/9213 (1·3%)	1·3 (1·0–1·7)
Intrapartum CS without indications	0/554	..
Intrapartum CS with indications	206/14 333 (1·4%)	1·9 (1·6–2·2)
Fetal death†		
Spontaneous (reference)	557/74 146 (0·8%)	1
Operative vaginal delivery	21/2737 (0·8%)	1·6 (1·0–2·6)
Antepartum CS without indications	1/1515 (0·1%)	0·5 (0·06–3·5)
Antepartum CS with indications	50/9213 (0·5%)	0·9 (0·6–1·2)
Intrapartum CS without indications	0/554	..
Intrapartum CS with indications	85/14 332 (0·6%)	1·1 (0·8–1·4)
Neonatal mortality up to hospital discharge‡		
Spontaneous (reference)	357/73 111 (0·5%)	1
Operative vaginal delivery	17/2705 (0·6%)	2·5 (1·5–4·4)
Antepartum CS without indications	0/1514	..
Antepartum CS with indications	65/9145 (0·7%)	2·0 (1·4–2·7)
Intrapartum CS without indications	0/554	..
Intrapartum CS with indications	121/14 214 (0·9%)	3·1 (2·4–4·0)
Stay for ≥7 days in neonatal ICU§		
Spontaneous (reference)	1067/74 250 (1·4%)	1
Operative vaginal delivery	72/2740 (2·6%)	2·3 (1·7–3·0)
Antepartum CS without indications	5/1515 (0·3%)	0·4 (0·2–1·1)
Antepartum CS with indications	381/9213 (4·1%)	2·4 (2·0–2·8)
Intrapartum CS without indications	5/554 (0·9%)	1·3 (0·5–3·2)
Intrapartum CS with indications	346/14 333 (2·4%)	2·4 (2·1–2·8)
Perinatal mortality and morbidity index¶		
Spontaneous (reference)	1938/74 250 (2·6%)	1
Operative vaginal delivery	108/2740 (3·9%)	2·2 (1·8–2·8)
Antepartum CS without indications	6/1515 (0·4%)	0·4 (0·2–1·0)
Antepartum CS with indications	489/9213 (5·3%)	2·1 (1·8–2·4)
Intrapartum CS without indications	5/554 (0·9%)	1·0 (0·4–2·4)
Intrapartum CS with indications	541/14 333 (3·8%)	2·3 (2·0–2·5)

(Continues on next page)

	n/N (%)	Adjusted OR (95%CI)
(Continued from previous page)		
Breech and other presentations		
Perinatal mortality‖		
Spontaneous (reference)	158/805 (19·6%)	1
Operative vaginal delivery	88/725 (12·1%)	0·6 (0·4–0·9)
Antepartum CS with indications	28/1637 (1·7%)	0·2 (0·1–0·3)
Intrapartum CS with indications	78/2172 (3·6%)	0·3 (0·2–0·4)
Fetal death**		
Spontaneous (reference)	116/797 (14·6%)	1
Operative vaginal delivery	47/711 (6·6%)	0·5 (0·3–0·7)
Antepartum CS with indications	11/1637 (0·7%)	0·07 (0·03–0·1)
Intrapartum CS with indications	45/2171 (2·1%)	0·2 (0·1–0·3)
Neonatal mortality up to hospital discharge††		
Spontaneous (reference)	42/613 (6·9%)	1
Operative vaginal delivery	41/615 (6·7%)	1·3 (0·7–2·3)
Antepartum CS with indications	17/1619 (1·1%)	0·4 (0·2–0·9)
Intrapartum CS with indications	33/2104 (1·6%)	0·6 (0·3–1·0)
Stay for ≥7 days in neonatal ICU‡‡		
Spontaneous (reference)	25/805 (3·1%)	1
Operative vaginal delivery	38/725 (5·2%)	1·7 (1·0–3·1)
Antepartum CS with indications	77/1637 (4·7%)	2·0 (1·1–3·6)
Intrapartum CS with indications	90/2172 (4·1%)	2·1 (1·2–3·7)
Perinatal mortality and morbidity index§§		
Spontaneous (reference)	179/805 (22·2%)	1
Operative vaginal delivery	124/725 (17·1%)	0·7 (0·5–1·0)
Antepartum CS with indications	104/1637 (6·4%)	0·4 (0·3–0·6)
Intrapartum CS with indications	166/2172 (7·6%)	0·6 (0·4–0·8)

OR=odds ratio. CS=caesarean section. ICU=intensive care unit. *Adjusted for year of education, birthweight of previous baby, history of neonatal death or stillbirth, severe anaemia, pre-eclampsia, eclampsia, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, induced labour, country, and gestational age. †Adjusted for year of education, birthweight of previous baby, sickle-cell anaemia, severe anaemia, eclampsia, suspected fetal growth impairment, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, incentive for caesarean section, and gestational age. ‡Adjusted for year of education, birthweight of previous baby, referred for complication related to pregnancy or delivery, country, and gestational age. §Adjusted for year of education, birthweight of previous baby, previous caesarean delivery, chronic hypertension, diabetes mellitus, condyloma acuminatum, other medical disorders, prelabour rupture of membranes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, suspected fetal growth impairment, any antenatal antibiotic treatment, referred for complication related to pregnancy or delivery, induced labour, country, and gestational age. ¶Perinatal mortality and morbidity index=perinatal mortality or stay for 7 days or more in neonatal ICU. Adjusted for maternal age, year of education, birthweight, cervix surgery, chronic hypertension, chronic respiratory disorders, diabetes mellitus, severe anaemia, condyloma acuminatum, other medical disorders, prelabour rupture of membranes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, suspected fetal growth impairment, vaginal bleeding in second half of pregnancy, any antenatal antibiotic treatment, referred for complication related to pregnancy or delivery, country, and gestational age. ||Adjusted for fistula, eclampsia, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, country, and gestational age. **Adjusted for sickle-cell anaemia, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, and gestational age. ††Adjusted for referred for complication related to pregnancy or delivery, induced labour, and gestational age. ‡‡Adjusted for condyloma acuminatum, prelabour rupture of membranes, vaginal bleeding in second half of pregnancy, any antenatal antibiotic treatment, country, and gestational age. §§Adjusted for birthweight, fistula, prelabour rupture of membranes, eclampsia, vaginal bleeding in second half of pregnancy, referred for complication related to pregnancy or delivery, induced labour, country, and gestational age.

Table 5: **Perinatal outcomes for singleton and first child of multiple births by fetal presentation at delivery and method of delivery**

mortality and morbidity could be attributed to the baseline conditions that caused the procedure to be undertaken. We detected a similar relation for assisted vaginal deliveries.

Findings from our survey confirm the protective effect of caesarean section on perinatal mortality for cases of breech or other presentations.[12] This result should be considered as additional evidence for strongly recommending avoidance of vaginal deliveries for breech presentations, while promoting the use of external cephalic version for term breech presentation even if the woman is already in labour.[13]

This study has several strengths. First, it is one of the largest observational studies to address the issue of benefits and harms of caesarean section, complementing the earlier surveys undertaken in Latin America[7,9] and Africa (unpublished). Second, the random selection of two provinces in addition to the capital province, and then random selection of participating facilities with more than 1000 deliveries per year, ensured avoidance of selection bias. A secondary aim of the project was to strengthen the capacity of a network of health facilities in routine data collection and collaborative research. The random selection process was crucial in working with facilities that had not previously participated in research projects. The high data-extraction quality suggested by the random data checks was very encouraging. In several participating countries, including China and India, data were entered online within facilities, which helped with the resolution of data queries. Afghanistan and Pakistan have been added to this network of facilities in 24 countries where the survey has been undertaken, and these 26 countries will implement the next survey that will focus on maternal and neonatal near miss in the next phase of the project in 2010–11.

Our study has some limitations. First, we had information about mortality and morbidities only until discharge from hospital; some outcomes might therefore have been underestimated, especially for women delivering vaginally who are usually discharged earlier than women having caesarean section. The calculated odds ratio might overestimate the risk of caesarean section. Although we had adjusted for many potential confounding factors, there might be some other factors that we did not have information about and could not adjust for. Second, data were abstracted from the patients' records. We were not able to confirm the absence of some of the risk factors if they had not been recorded. Third, our survey included only hospitals with caesarean facilities having 1000 or more deliveries every year. The results therefore cannot be generalised to smaller facilities. The results, especially rates of caesarean section, should not be regarded as representative rates and outcomes for entire countries or regions.

In view of the strengths and the limitations, our results are corroborated by other observational studies assessing the risks of caesarean section for mothers[14] and infants from different settings.[15] We conclude that caesarean section should be done only when there is a medical indication to improve the outcome for the mother or the baby. Women and their carers who plan to undertake

caesarean section delivery should discuss the potential risks to make an informed decision if they still wish to have a caesarean delivery.

Contributors

PL, ML, AMG, and JPS coordinated the study. EF participated in the preparatory activities, developing the study materials, and site visits. JV was the lead investigator in the first phase of the project undertaken in Latin America and Africa. In the Asia survey, JV supported the preparatory activities such as modifications in the forms, manuals, and training planning. PL, ML, AMG and JPS planned and undertook the analysis and wrote the report with input from all country investigators and GC (regional coordinator of the Latin American survey). KB-T undertook site visits, training, and contributed to the writing of the report. PR, GY, KChu, MR, NDH, RM, KChe, TR, DEA, ST, NS, MF, HTB, VU, and MJVC contributed to study design, data collection, data analysis, data interpretation, and writing of the report. All authors read and approved the final report.

Country teams

Cambodia Tung Rathavy (country coordinator), Prak Savuth, Prak Somaly, Neang Somana, Ou Saroeun, Muth Rin (National Maternal and Child Health Center), Ek Meng Ly, Riel Nary (Calmette Hospital); Koam Phaly, Tia Sorphy (Phnom Penh Municipal Referral Hospital); *Kampong Cham* Peang Nara (Provincial coordinator), Thann Chandavy, Bun Savy, Ouk Varang (Kampong Cham Referral Hospital), Uch Sokrathavy, Leav Vouchnea (Clinic Ouk Varang). *China* Pang Ruyan, Gao Yanqiu, Kang Chuyun (country coordinator); *Beijing* Pan Ying, Qiu Ling, Ma Yuanying, Wang Qiong, Guo Guangping, Zhang Yan, Wan Ying; Li Xiaoying, Chi Xinzuo, Qi Quansheng, Li Dan (Capital Medical University Xuanwu Hospital), Lin Li, Wang Huiying, Zhou Xin, Zhao Yanli (Capital Medical University Friendship Hospital), Luan Xiuli, Jin Sheng, Cao Xia, Yang Heping (Fengtai Nanyuan Hospital), Fan Li, Zhou Baolin, Liu Dongxia, Fang Fang (Qiaonan Department of Fengtai Hospital), Li Qiuyun, Zhang Hua, Zhu Yunxia, Bian Qian (Capital Medical University You'an Hospital), Yang Zhijuan, Chen Jingfeng, Wang Ying, Hu Xulin (Qiaobei Department of Fengtai Hospital), Zhang Xiaojin, Ji Xiuming, Liu lida, Jin Daqing (Pinggu Hospital); *Zhejiang* Zhang Tan, Fan Qihui, Ji Fei, Zhang Chunyu (Ningbo Women and Children Hospital), Chen Yunfeng, Li Yonghua, Lai Yinnv, Zhang Lingxiu (Xiangshan County Red Cross Hospital), Yu Xiaoling, Chai Lvsheng, Chen Xiuqing, Wu Yanhua (Ruian Maternal and Child Health Hospital), Weng Xiuqin, Dai Jie, You Feiyun, Hu Xiaoying (Ruian People's Hospital), Lin Xu, Zhao Xiaofang, Wang LiPing, Chen Fang (Ou'hai Third people's Hospital), Cai Hui, Chen Li, Ye Xiaofei, Lu Zhangxia (Ruian Tangxia Center Hospital), Shen Peng, Wang Huliang, Chen Peifei, Wei Guohua, Zhu Shenhua (Haining Maternal and Child Health Hospital); *Yunnan* Dong Shuhua, Zhang Hongyun, Lu Guizhen, Yang Li (Yunnan Obstetric and Gynecology Hospital), Li Hongbin, Zhu Jiazhen, Yangfang, Li Na (Kunming Oriental Hospital), Zeng Yujing, Qi Juxiang, Huang Chunli, Li Liyan (Yunnan Ping'an Chinese and Western Medicine Hospital), Zhang Mingyu, Yuan Zhiyun, Li Qin, Yang Yu (Yunnan Second People's Hospital), Zhang Zhongming, Chen Suying, Li Taorong, Luo Yunlong, (Jianshui County People's Hospital), Li Kaixiang, Wang Jinhua, Mao Yuyan, Cao Heyou (Xiangyun County People's Hospital) Duan Yuzhuo, Zhao Juhua, Shi Guihua, Ye Shimin (Heqing County Maternal and Child Health Hospital). *India* Malabika Roy (country coordinator); *Delhi* Pravin Kumar (state coordinator), Sudha Sahlan, Kiran Guleria, Reena Yadav, Indra Yadav, Neeraj Sharma, Madhurika Agrawal, Kusum Kashap, Sudha Choudhury; *Gujarat* Ajesh Desai (state coordinator), Vandana U Patel, H B Saini, Malini R Desai, Rajal Thaker, Lalit Prabha Gupta, Firoz G Bhuvar, Pravinbhai Baldania; *Madhya Pradesh* Archana Mishra (state coordinator), Renuka Gohiya, Neeraj Bedi, Suman Diwakar, Pankaj Budholia, R K Jain, G P Dwivedi, Rakesh Kumar Jain; *data management* Indra Kambo, Shalini Singh, Anju Sinha, B S Dhillon, Rajinder Singh, Niharika Diaman, Moni Bhatia, Sabari Nandi, Richa Dawar, Ila Jain, Rachna Agarwal, Arti Singh, Dhiraj Aggarwal, Monica Verma, Smriti Kaur Arora, Bhavana Agarwal, Ram Niwas, Upasana Bhumbla, Vipin Choudhury, Alka Dua, Roshni Agrawal, Awadhesh Kr Maurya, Rita Bhandula, Anjali Sharma, Alfred David, Ranjana Singhal, Ketki Anerao, Ami Shah, Madhavi M Bhavsar, Rizwana Solanki, Priyesh Sanesara, Hetal Atul Pandya, Nilesh R Chauhan, Vijay Kansara, Pushpa Yadav, Vivek Sanghavi, Hitesh Parmar, Mayur Patel, Narendra Vekariya, Vaghela Puroshottam Kalaji, Shobhana Thomas, Rahim Bhuvar, Bhupatbhai Chopada, Bhupatbhai Baldania, Rikhan A Anjariya, Sandhya Rangari, Nisha Badve, Tapidas Chadokar, Raju Sahu, Gayatri Srivastava, Preeti Dev Pujari, Niti Verma, Abneesh Kumar Tiwari, Chaya Sharma, Lekha Tiwari, Surendra Parashar, Deepak Bhramabhatt, Sheeteh Patel, Rita Yadu, Divya Mishra, Dipti Varma, Meena Bhargava, D Rajeshwari, Prerana Lakhwani, Alok Khanna, Satya Prakash Shrivastava, Nirpesh Singh. *Japan* Rintaro Mori (country coordinator), Masanori Fujimura, Shohei Harada, Shigeko Horiuchi, Takahiko Kubo, Yasuhide Nakamura, Kenzo Takahashi; *Tokyo* Marie Furuta (prefecture coordinator); *Nagano and Okayama* Shuko Nagai (prefecture coordinator), Chisako Mitsuichi (Japanese Red Cross Katsushika Maternity Hospital), Yasuhiko Higuchi (International Catholic Hospital), Masaaki Suzuki (San-Ikukai Hospital), Takeo Ito (Tokyo Adventist Hospital), Nobutaka Shimada (Kiyosenomori Hospital), Shiro Abe (Tokyo Metropolitan Otsuka Hospital), Koichi Iino (Iino Hospital), Noritane Ueda (Ina Central Hospital), Kaoru Miyake (Miyake Clinic), Fumiyuki Yamasaki (Kurashiki Medical Center); *data management* Naohiro Yonemoto, Saki Amamiya, Karin Saito, Miki Saito. *Nepal* Naveen Shrestha (country coordinator), Binjwala Sjrestha (provincial coordinator), Sudha Sharma (Maternity Hospital, Kathmandu), Jyoti Sharma (TUTH), Druba Uprety (BPKIHS), Uma Kant Jha (Mechi Zonal Hospital), Yogendra Mishra (Koshi Zonal Hospital), Deepa Yadav (Sagarmatha Zonal Hospital), Ganesh Bahadur Singh (Seti Zonal Hospital), Arjun Prasad Shrestha (Mahakali Zonal Hospital); *data management* Sajana Ranjit (Maternity Hospital), Sumitra Sagar, Amar Nath Amatya, Bijaya Shrestha, Sarmila Subedi, (Maternity Hospital), Anip Joshi, Parbati Siwakoti, Jamuna Sayami Indra Shankar Ranjit, (TUTH), Pramila Mukhiya, Kalyani Subba, Krishna Bhandari (BPKIHS), Prabhu Sah, Amrita Shrestha, Sunita Kumari Rauniyar (Mechi Zonal Hospital), Anju Khanal, Mamata Sigdel (Koshi Zonal Hospital), Meera Rai, Laxmi Chaudhary (Sagarmatha Zonal Hospital), Sunita Khatri, Anju Kumari Mahato (Seti Zonal Hospital), Kishori Shrestha, Kusum Shahi (Mahakali Zonal Hospital), Pushkar Silwal, Jyotsana Rimal, Anupama Limbu, Anju Rai, Deepak Adhikari, Tumsa Shrestha, Beena Shrestha (MEH Consultants). *Philippines* Maria Julieta V Germar (country coordinator); *Manila* Christia Padolina (provincial coordinator), Zenaida Abalos (Jose Fabella Hospital), Lourdes Capito (Philippine General Hospital), Rey Delos Reyes (Jose Reyes Memorial Hospital), Nelissa Ramos (Tondo Medical Center), Carol Martin (Ospital ng Maynila), Venus Cuartero (Gat Andres Bonifacio Medical Center), Zaida Gamilla (Santo Tomas University Hospital); *Region III Luzon: Bulacan* Alejandro San Pedro (provincial coordinator), Bernadette Austria (Bulacan Provincial Hospital), Tyrone Concepcion (Rogaciano Mercado Memorial Hospital), Emma Nito (Baliuag District Hospital), Gliceria Babala (Bulacan Maternity and Children's Hospital); *Region XI Mindana: Davao* Darleen Estuart (provincial coordinator), Gerardo Cunanan (Davao Medical Center), Romulo Busuego (Davao Regional Hospital), Agnes Bugashi (Davao Del Sur Provincial Hospital), Jack Estuart (Brokenshire Hospital) Jose Goitain (San Pedro Hospital of Davao), Cynthia Gomez (Davao Doctors Hospital); *data management* Haidee Juban, Ermie Torralba, Ana Laderas. *Sri Lanka* Deepika Eranjanie Attygalle (country coordinator), Vinita Karunaratne, D K N N Hemachandra, K K W Karandagoda (Castle Street Hospital for Women), U L R M Perera (De Zoysa Maternity Hospital), W G Gunawardane, L Muhandiram (Colombo South Teaching Hospital), D L De Lanerolle (Sri Jayawardenapura Teaching Hospital), S L Denivage, R M T S K Senevirathna (Base Hospital Awissawella), P L Gunasekera (Base Hospital Horana), P Siribaddana (Durdans Hospital), Vijith Ranasinghe Gunasekera (General Hospital Matara), M W M K Mediwaka (Base Hospital Kamburupitiya), S M P Manjula (Teaching Hospital Mahamodara), Mithree Chandrarathna (Base Hospital Balapitiya), Samitha Jayendra Kadahettige (Base Hospital Hambanthota), Pakkeer Mohideen Mohomed Shaheed (General Hospital Ampara), K Arulanandem (Teaching Hospital Batticaloa);

data management Ranil Yasantha Vithanage, Kumudu Hasantha Wickramasinghe. *Thailand* Surasak Taneepanichskul (country coordinator), Venus Udomprasertgul (country data manager); *Bangkok* Chongkol Tangusaha (provincial coordinator), Boonsong Rawangban (Nopparat Rajathanee General Hospital), Manopchai Thamkhamtho (Siriraj Hospital), Ekachai Kovavisarach (Rajavithi Hospital), Wiwat Iamurairat (Sirindhorn Hospital); *Songkhla* Tippawan Liabsuetrakul (provincial coordinator), Prawit Wannaro (Hai Yai Hospital), Thadpong Promvijit (Songkhla Hospital), Tippawan Liabsuetrakul (Songklanagarind Hospital); *Sisaket* Pravi Ampant (provincial coordinator), Piyawat Angkawanit (Sisaket Hospital), Wanchai Laosatienkij (Kantraluck Hospital), Tanong Veerasangpong (Uthumpornpisai Hospital), Prawit Sereekajornjaru (Khukhan Hospital), Ratchadaporn Roonjaroen (Khunhaan Hospital); *data management* Rerngsak Boonbundarlchai, Sukarin Wimuktayon, Natawan Deelertyuenyong, Sasithorn Chaemthavorn, Suttharuethai Choenkhwuanma, Boontiem Theppitaksak. *Vietnam* Nguyen Duc Hinh (country coordinator), Luu Thi Hong, Le Hoang, Nguyen Hong Linh; *Hanoi* Dang Thi Hang (provincial coordinator), Le Hoang, Le Thanh Thuy, Nguyen Thi Bich Hien, Nguyen Le Hong Phong, Nguyen Thi Loi, Nguyen Thi Bich Ngoc, Nguyen Tien Quang; *Binh Phuoc* Nguyen Thi Bach Tuyet (provincial coordinator), Nguyen Duc Tho; *Nghe An* Le Thi Hoai Chung (provincial coordinator), Nguyen Tien Quang, Huynh Thanh Binh, Lo Thi Kiem, Phan Huu Khoa, Nguyen Dinh luu, Nguyen Ngoc Ly, Nguyen Viet Thuy; *data management* Duong Lan Dung, Pham Phuong Lan, Nong Minh Hoang, Nguyen Anh Thu, Vu Bich Ngoc, Truong Thi Hai, Doan Thu Hoai, Trinh Kim Ly, Nguyen Thuy Trang, Trinh Thuy Hang, Lai Thi Thanh Mai.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

We thank Nirun Intarut for support during the data monitoring and analysis; Mary Ellen Stanton of USAID for her support and technical input to the project; Mai Fujii who assisted the implementation of the survey; S Marthinsson who developed the online data entry system and assisted in the training of country personnel; Leiv Bakketeig who assisted the first training meeting; Daniel Wojdyla and Liana Campodonico at Centro Rosarino de Estudios Perinatales, Rosario, Argentina for providing relevant information from the earlier surveys and methodological support; the WHO South-East Asia and Western Pacific Regional Office Staff at Delhi and Manila for their support to the operationalisation of the survey; and WHO country office staff and the counterparts at the ministries of health for providing permissions and administrative support to the project. The study was financially supported by the United States Agency for International Development (USAID); UNDP/UNFPA/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP), WHO, Geneva, Switzerland; Ministry of Health, Labour and Welfare of Japan; Ministry of Public Health, Beijing, China; and Indian Council of Medical Research, Delhi, India.

References

1 Al Mufti R, McCarthy A, Fisk NM. Survey of obstetricians' personal preference and discretionary practice. *Eur J Obstet Gynecol Reprod Biol* 1997; **73:** 1–4.

2 Belizan JM, Althabe F, Barros FC, Alexander S. Rates and implications of caesarean sections in Latin America: ecological study. *BMJ* 1999; **319:** 1397–400.

3 Althabe F, Belizan JM, Bergel E. Episiotomy rates in primiparous women in Latin America: hospital based descriptive study. *BMJ* 2002; **324:** 945–46.

4 Behague DP, Victora CG, Barros FC. Consumer demand for caesarean sections in Brazil: informed decision making, patient choice, or social inequality? A population based birth cohort study linking ethnographic and epidemiological methods. *BMJ* 2002; **324:** 942–45.

5 Maine D. Detours and shortcuts on the road to maternal mortality reduction. *Lancet* 2007; **370:** 1380–82.

6 Langer A, Villar J. Promoting evidence based practice in maternal care. *BMJ* 2002; **324:** 928–29.

7 Villar J, Valladares E, Wojdyla D, et al. Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. *Lancet* 2006; **367:** 1819–29.

8 Shah A, Faundes A, Machoki M, et al. Methodological considerations in implementing the WHO Global Survey for Monitoring Maternal and Perinatal Health. *Bull World Health Organ* 2008; **86:** 126–31.

9 Villar J, Carroli G, Zavaleta N, et al. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. *BMJ* 2007; **335:** 1025.

10 Lavender T, Kingdon C, Hart A, Gyte G, Gabbay M, Neilson JP. Could a randomised trial answer the controversy relating to elective caesarean section? National survey of consultant obstetricians and heads of midwifery. *BMJ* 2005; **331:** 490–91.

11 The National Collaborating Centre for Women's and Children's Health. Caesarean section clinical guideline. London: RCOG Press, 2004.

12 Hofmeyr GJ, Hannah ME. Planned caesarean section for term breech delivery. *Cochrane Database Syst Rev* 2003; **3:** CD000166.

13 Hofmeyr GJ, Kulier R. External cephalic version for breech presentation at term. *Cochrane Database Syst Rev* 2000; **2:** CD000083.

14 Deneux-Tharaux C, Carmona E, Bouvier-Colle MH, Breart G. Postpartum maternal mortality and cesarean delivery. *Obstet Gynecol* 2006; **108:** 541–48.

15 Tita AT, Landon MB, Spong CY, et al. Timing of elective repeat cesarean delivery at term and neonatal outcomes. *N Engl J Med* 2009; **360:** 111–20.