Incidence and predictors of severe obstetric morbidity: case-control study

Mark Waterstone, Susan Bewley, Charles Wolfe

Abstract

Objective To estimate the incidence and predictors of severe obstetric morbidity.

Design Development of definitions of severe obstetric morbidity by literature review. Case-control study from a defined delivery population with four randomly selected pregnant women as controls for every case.

Setting All 19 maternity units within the South East Thames region and six neighbouring hospitals caring for pregnant women from the region between 1 March 1997 and 28 February 1998.

Participants 48 865 women who delivered during the time frame.

Results There were 588 cases of severe obstetric morbidity giving an incidence of 12.0/1000 deliveries (95% confidence interval 11.2 to 13.2). During the study there were five maternal deaths attributed to conditions studied. Disease specific morbidities per 1000 deliveries were 6.7 (6.0 to 7.5) for severe haemorrhage, 3.9 (3.3 to 4.5) for severe pre-eclampsia, 0.2 (0.1 to 0.4) for eclampsia, 0.5 (0.3 to 0.8) for HELLP (Haemolysis, Elevated Liver enzymes, and Low Platelets) syndrome, 0.4 (0.2 to 0.6) for severe sepsis, and 0.2 (0.1 to 0.4) for uterine rupture. Age over 34 years, non-white ethnic group, past or current hypertension, previous postpartum haemorrhage, delivery by emergency caesarean section, antenatal admission to hospital, multiple pregnancy, social exclusion, and taking iron or anti-depressants at antenatal booking were all independently associated with morbidity after adjustment.

Conclusion Severe obstetric morbidity and its relation to mortality may be more sensitive measures of pregnancy outcome than mortality alone. Most events are related to obstetric haemorrhage and severe pre-eclampsia. Caesarean section quadruples the risk of morbidity. Development and evaluation of ways of predicting and reducing risk are required with particular emphasis paid on the management of haemorrhage and pre-eclampsia.

Introduction

Maternal mortality has been used as a measure of the success of obstetric intervention but is now too rare for use in local practice in the developed world.[1] Severe maternal morbidity has been suggested as an alternative measure.[2 3] Most previous studies of severe maternal morbidity have been small (ranging from 2180[2] to 13 429 deliveries[4]) and undertaken in a maximum of two units,[4] though one study examined intensive care admissions of obstetric patients in two regions of France.[5] Most have been retrospective studies,[2 3 6] with only one prospective study,[3] and all were hospital based. They have used clinical definitions,[2 4] counted admissions to intensive care,[3 6] or investigated only the characteristics of women receiving obstetric intensive care.[3 5–15] Definitions have differed and have included management decisions that are open to bias, depending on the facilities available and local customs. Consequently, the reported incidence of severe maternal morbidity varies from 0.05 %[3] to 1.09 %.[4] There are no data on the predictors of severe maternal morbidity.

We report on a multicentre population based study using reproducible clinical definitions. We estimated the incidence of severe obstetric morbidity and, by the use of a control population, investigated its predictors.

Department of Public Health Medicine, Guy's, King's College, and St Thomas's Hospitals Schools of Medicine and Dentistry, Capital House, London SE1 3QD

Mark Waterstone *research fellow*

Charles Wolfe *reader*

Women's Health Directorate, Guy's and St Thomas's NHS Trust, St Thomas's Hospital, London SE1 7EH

Susan Bewley *clinical director*

Correspondence to: C Wolfe charles.wolfe@kcl.ac.uk

BMJ 2001;322:1089–94

Methods

Developing definitions

We searched Medline using key words (severe maternal morbidity, obstetric intensive care, obstetric haemorrhage, uterine rupture, obstetric sepsis, HELLP (Haemolysis, Elevated Liver enzymes, and Low Platelets) syndrome, eclampsia, maternal mortality). We selected definitions that were clinically based and routinely measurable and that did not include management processes. When no definition relevant to the specific condition was available (for example, sepsis) we modified the standard definition to take into account the physiological changes in pregnancy. We focused on morbidity associated specifically with pregnancy and for which the management usually involves maternity care professionals. We excluded those conditions that are difficult to diagnose accurately or ascertain completely, the most important examples being pulmonary and amniotic fluid emboli. The box details the conditions investigated and their definitions in this study.

Sampling frame for cases and controls

Cases included women from the South East Thames region who delivered after 24 weeks' gestation between 1 March 1997 and 28 February 1998 and met the definition criteria for severe morbidity. Controls were women from the same region who delivered without severe morbidity. Cases were identified from all 19 maternity units within the region and from six neighbouring hospitals to ascertain residents who delivered out of region. Cases were identified from multiple sources (maternity computer databases, labour ward and postnatal ward diaries, staff reporting, and medical records). A single investigator (MW) visited the hospitals every two to four weeks and reviewed all the medical records.

Social categories were grouped with the UK registrar general's categories: I and IIa (non-manual) and IIb, III, IV, and V (manual).[21] Ethnic origin was grouped into white, black (black African and Caribbean), and other (all other ethnic groups). As measures of socioeconomic status (for example, marital status, male partner's employment) alone are inadequate for pregnant women, data were collected on indicators of social exclusion. This concept is currently in use by the UK government.[22] We considered social exclusion to be

Definition of severe obstetric morbidity

Severe pre-eclampsia
Blood pressure 170/110 mm Hg on two occasions 4 hours apart or >170/110 mm Hg once plus ≥0.3 g in 24 hours proteinuria or ≥ + + on dipstick
OR
Diastolic blood pressure >90 mm Hg plus proteinuria (as above) on one occasion plus one of the following signs/symptoms:
Oliguria (<30 ml/h for 2 hours)
Visual disturbances (flashing lights or blurred vision)
Epigastric/right upper quadrant pain or tenderness
Thrombocytopenia (<100x10⁹/l)
Pulmonary oedema

Eclampsia[16]
Convulsions during pregnancy or in the first 10 days postpartum together with at least two of the following features within 24 hours after the convulsions:
Hypertension (≥170/110 mm Hg)
Proteinuria (≥ + on random dipstick analysis or ≥0.3 g in 24 hours)
Thrombocytopenia (<100x10⁹/l)
Increased aspartate aminotransferase (≥42 U/l)

HELLP syndrome[17]
Haemolysis (abnormal peripheral smear or raised total bilirubin concentration (≥20.5 μmol/l)), raised liver enzyme activity (raised aspartate aminotransferase (≥70 U/l)) or raised γ-glutamyltransferase (≥70 U/l), and low platelets (<100x10⁹/l))

Severe haemorrhage[18]
Estimated blood loss >1500 ml, peripartum fall in haemoglobin concentration ≥40 g/l or acute transfusion of 4 or more units of blood

Severe sepsis[19 20]
Sepsis is systemic response to infection manifested by two or more of:
Temperature >38°C or <36°C (unless after prolonged caesarean)
Heart rate >100 beats/minute
Respiratory rate >20/min or $PaCO_2$ <32 mm Hg
White cell count >17x10⁹/l or <4x10⁹/l or >10% immature forms
Plus bacteraemia (that is, positive blood cultures) or positive swab culture
Severe sepsis is sepsis associated with one of:
Organ dysfunction—for example, acute renal failure
Hypoperfusion—for example, lactic acidosis, oliguria, or acute alteration in mental state
Hypotension—that is, systolic blood pressure <90 mm Hg or drop of ≥40 mm Hg in the absence of other causes of hypotension

Uterine rupture
Acute dehiscence of the uterus leading to the emergency delivery of the infant

present when any of the following were identified in the notes: concealed pregnancy, age <16 years, poor housing, low income ("on income support" written in notes), previous minor/child in local authority or state care (either currently or in past), in trouble with the law (currently or previously), living alone (partner abroad or "unsupported" written in notes), unbooked, unwanted pregnancy, currently or previously in foster care, care order being considered on potential child, social worker involved, and drug or alcohol dependency. Table 1 summarises the demographic data for all the women.

We used power calculations to estimate the total number of women required. If we used a rise from 5% to 20% in incidence of postpartum hypertension[23] we would require only 180 women in total (cases and controls) for a power of 90% at the 5% level. The estimated number of deliveries in the study region was 50 000, which, using the previous estimates of incidence of severe obstetric morbidity, would have given us between 25 and 545 cases. We collected data over one year to avoid seasonal variations in the calculation of incidence.

We selected four controls per case to increase the power to detect any differences in predictive factors between cases and controls. We generated a random list of all the unit numbers (1-19) with each unit's chance of being selected weighted to take into account the number of deliveries per year to remove selection bias towards the smaller units. The unit numbers were grouped consecutively into four for each case. In each unit, a further two digit random number was generated to select the woman to act as a control. This number matched the delivery number, with 1 being the first woman to deliver that week. A "week" ran from 0000 hours on Saturday and finished at 2359 on Friday.

Statistical analysis

We considered four forms of severe maternal morbidity: severe haemorrhage, severe pre-eclampsia (including HELLP syndrome and eclampsia), severe sepsis, and uterine rupture. For each of these the incidence of severe maternal morbidity was calculated with 95% confidence intervals. Unconditional logistic regression models were constructed with Stata (StataCorp, College Station, Texas, release 5, 1997) with severe maternal morbidity as the dependent variable. In the analysis of individual conditions we used all the controls. Unadjusted odds ratios were estimated with logistic regression for each of the data variables collected. Those variables with a significance level of $P<0.05$ were then included in a multivariate analysis. We also included variables that were thought to be clinically important but, because of factors such as small numbers, were not significant in the univariate analysis.

Age was grouped into 5 year bands. In univariate analysis the only significant age band was 35 years and over, and this was therefore used in the multivariate analysis. Women who had more than one condition

Table 1 Demographic data for cases and controls. Figures are numbers (percentage) of women

	Cases (n=588)	Controls (n=2350)
Ethnic group (%):		
White	448 (76.2)	1986 (84.5)
Black	98 (16.6)	263 (11.2)
Other	42 (7.2)	101 (4.3)
Mean (SD) age (years)	29.6 (5.8)	28.7 (5.6)
Class (%):		
Non-manual	342 (58.2)	1347 (57.3)
Manual	111 (18.8)	524 (22.3)
Unemployed	85 (14.5)	268 (11.4)
Unknown	50 (8.5)	209 (8.9)
Marital status (%):		
Married	349 (59.3)	1398 (59.5)
Single supported	199 (33.8.0)	801 (34.1)
Single unsupported	32 (5.5)	108 (4.6)
Divorced	8 (1.4)	35 (1.5)
Unknown	0	9 (0.4)
Parity (%):		
0	247 (42.0)	752 (32.0)
1	153 (26.0)	705 (30.0)
2	82 (14.0)	423 (18.0)
≥3	106 (18.0)	470 (20.0)

Table 2 Severe obstetric morbidity

Category of morbidity	No of women	Percentage of deliveries
All cases	588	1.20
Pre-eclampsia:		
Severe pre-eclampsia	187	
Eclampsia	12	
HELLP syndrome	25	
All	224	0.46
Haemorrhage:		
Estimated blood loss >1500 ml	180	
Haemoglobin drop ⩾40 g/l	96	
Transfused ⩾4 units blood	51	
All	327	0.67
Severe sepsis	17	0.04
Uterine rupture	12	0.03
Others*	8	

*Acute fatty liver of pregnancy (n=3), anaphylaxis, severe hypertension, isolated pulmonary oedema, complications related to anaesthetic (cardiac arrest, total spinal block).

(for example, both severe pre-eclampsia and severe haemorrhage) were considered only once in the incidence figures, and the most severe morbidity was counted. These cases were, however, used in the univariate and multivariate analyses for each condition involved. We adjusted odds ratios for severe maternal morbidity for all of the variables shown in table 3. A detailed list of the factors used for multivariate analysis is available from the authors.

Results

There were 48 865 deliveries and 588 cases identified, giving an incidence of severe obstetric morbidity of 12.0 per 1000 deliveries (95% confidence interval 11.2 to 13.2). During the same time period there were five maternal deaths directly attributable to the study conditions (three from sepsis, one from haemorrhage, one from HELLP), giving a severe morbidity to mortality ratio of 118:1 (97 to 140)

Table 2 shows the incidence of severe morbidity by condition. Although the population of south east England is not the same as throughout the United Kingdom, we could extrapolate these incidence figures to the whole of the United Kingdom. With 2 197 640 deliveries over three years in the United Kingdom,[1] there would have been 14 724 cases of severe haemorrhage, 10 109 of the combined hypertensive conditions, 879 of severe sepsis, and 659 of uterine rupture.

Risk factors associated with the individual conditions studied are shown in table 3. Few factors were independently significantly associated with the development of severe sepsis or uterine rupture. When we excluded data from the women with more than one condition the results were no different.

Discussion

In this large multicentre study that used standardised definitions the incidence of severe obstetric morbidity was 12 per 1000 deliveries, with a severe morbidity-:mortality ratio of 118:1. This incidence is higher than previously estimated, although the conditions studied do vary between studies.[2 3 6] The incidence of eclampsia was similar to that reported for the whole of the United Kingdom by the BEST survey.[23]

Case definition

We deliberately excluded thromboembolic disease, which is recognised as the leading cause of maternal mortality in the United Kingdom[1] but is difficult to diagnose accurately when it is not fatal. The method of diagnosis differs from unit to unit, and some units in our region may rely entirely on clinical suspicion. Furthermore, as most cases occur in the postnatal period many women present to physicians and may never see an obstetrician. In view of these factors it would be impossible to ascertain if cases gathered represented an accurate reflection of the incidence. We did develop definitions in this study for severe thromboembolism but no cases were identified.

Table 3 Adjusted odds ratios for all cases and for each specific condition. Figures are odds ratios (95% confidence interval)

Risk factors	All cases	Severe PET	Severe haemorrhage	Severe sepsis	Uterine rupture
Age ⩾35 years	1.46 (1.11 to 1.92)	1.83 (1.24 to 2.70)	1.41 (1.03 to 1.95)	NA	NA
Blood pressure at booking	1.23 (1.12 to 1.34)	1.36 (1.21 to 1.52)	1.18 (1.06 to 1.31)	NA	NA
Black	1.16 (0.85 to 1.58)	1.83 (1.22 to 2.74)	0.97 (0.66 to 1.42)	0.33 (0.03 to 3.38)	NA
Other race	1.93 (1.24 to 2.99)	2.43 (1.36 to 4.34)	1.82 (1.09 to 3.03)	7.02 (1.49 to 33.15)	NA
Social exclusion	2.64 (1.69 to 4.11)	1.99 (1.07 to 3.72)	2.91 (1.76 to 4.82)	2.96 (0.53 to 16.58)	2.89 (0.22 to 37.71)
Smoker	0.68 (0.49 to 0.93)	0.47 (0.26 to 0.84)	0.65 (0.44 to 0.96)	3.56 (1.16 to 10.87)	NA
Previous PET	1.52 (1.02 to 2.27)	3.79 (2.13 to 6.74)	NA	6.61 (1.81 to 24.18)	1.30 (0.28 to 6.10)
Previous PPH	2.41 (1.53 to 3.77)	NA	2.74 (1.69 to 4.44)	NA	NA
Hypertension	1.10 (0.63 to 1.95)	1.92 (1.04 to 3.56)	0.82 (0.37 to 1.80)	NA	NA
Diabetes	1.76 (0.43 to 7.20)	6.10 (1.13 to 32.75)	1.85 (0.38 to 9.14)	NA	NA
Multiple pregnancy	2.21 (1.24 to 3.96)	3.27 (1.61 to 6.63)	2.29 (1.20 to 4.37)	3.05 (0.34 to 27.52)	NA
Antenatal admission	1.75 (1.37 to 2.23)	1.82 (1.30 to 2.54)	1.85 (1.39 to 2.47)	NA	NA
Taking iron at booking	5.53 (2.28 to 13.41)	2.53 (0.67 to 9.59)	5.98 (2.28 to 15.65)	29.48 (2.50 to 347.83)	NA
Taking antiepileptics at booking	5.31 (1.40 to 20.13)	4.99 (0.85 to 29.15)	5.75 (1.28 to 25.72)	16.17 (0.40 to 661.17)	35.50 (0.12 to 10472)
Taking antidepressants at booking	4.30 (0.91 to 1.88)	NA	10.55 (2.19 to 50.71)	NA	NA
IOL because overdue	1.36 (0.99 to 1.88)	NA	1.38 (0.95 to 1.99)	NA	4.84 (1.11 to 21.22)
IOL on medical grounds	2.45 (1.68 to 3.57)	NA	1.33 (0.87 to 1.07)	NA	8.61 (1.47 to 50.33)
Oxytocin augmentation	0.99 (0.76 to 1.28)	NA	1.61 (1.20 to 2.15)	NA	NA
Manual removal of placenta	9.60 (5.67 to 16.28)	NA	13.12 (7.72 to 22.30)	NA	14.62 (1.35 to 158.80)
Emergency caesarean	4.31 (3.39 to 5.49)	NA	3.09 (2.29 to 4.17)	11.85 (4.42 to 31.73)	NA

PET=pre-eclamptic conditions including HELLP syndrome and eclampsia, PPH=postpartum haemorrhage, IOL=induction of labour, NA=not applicable as condition not included in multivariate analysis because not significant in univariate analysis.

There is debate surrounding what constitutes the optimum definition of severe obstetric morbidity. The definitions that we developed and used represent a spectrum of severity of the morbidity under study and are open to modification. An example of this is severe haemorrhage. The definition has components that cover measurable blood loss, fall in haemoglobin concentration, and transfusion. Further work will be able to identify those elements of the definition that are associated with poorer outcomes.

Incidence

The estimates of incidence probably underestimate the true incidence as case ascertainment is unlikely to be complete, especially if events occur outside the delivery suite and are not recognised; this may be particularly true of less serious cases. However, we used several measures to minimise this loss of ascertainment. Data were collected contemporaneously, reducing the number of cases lost because of an inability to find notes or information. There were several site visits at frequent intervals to collect data, and information about cases was obtained from several sources.

Predictors

The main predictors of severe maternal morbidity were demographic (age over 34 years, non-white, and social exclusion), general medical (diabetes, hypertension), and obstetric factors (previous postpartum haemorrhage, multiple pregnancy, antenatal admission, emergency caesarean section). Anaemia may be a predictor as taking iron supplements at booking increased the risk of severe morbidity fivefold overall.

One could argue that very few of these predictors are amenable to change, but they may be useful in the identification of women who require extra vigilance. Previous studies have observed an increased risk of morbidity in women aged 35 years and over when they delivered their first child.[24–30] The trend to defer childbearing in the developed world may lead to increasing maternal morbidity, and women should be advised that deferring childbearing has maternal as well as fetal risks. Social exclusion is a major public health issue that applies worldwide. This is another study highlighting the fact that those least advantaged are most likely to suffer harm.[27 31] Smoking has a protective effect on severe morbidity in general and haemorrhage and pre-eclampsia in particular but is a predictor for severe sepsis. The protection against pre-eclampsia has been noted previously,[32 33]but the deleterious effects of smoking on the fetus are well documented.[32] The five and tenfold risk of severe haemorrhage with antiepileptic and antidepressant drugs, respectively, is unexplained.

The predictors most amenable to change are those linked to obstetric interventions, specifically the risk from induction of labour (odds ratio 2.35) and emergency caesarean section (4.31). The adjusted odds ratio of developing severe sepsis after an emergency caesarean section was 11.85. Efforts to reduce the rapidly rising rate of caesarean section would be justified by the consequent reduction of severe maternal morbidity.

The only significant predictors of uterine rupture were induction of labour and manual removal of the placenta. This may, however, be a function of the small numbers of cases observed. Though a previous caesarean section was a significant predictor on univariate analysis this association was no longer significant after we adjusted for other risk factors.

The severe maternal morbidity:mortality ratio is a possible new indicator of maternal care and could be used to compare improvements in treatments more accurately than mortality data alone. Over 1 in 100 pregnant women suffer a life threatening event, and there are 118 events for each direct maternal death, most of which are related to obstetric haemorrhage and pre-eclampsia. This major health risk to childbearing women has been relatively underinvestigated. Severe obstetric morbidity is measurable and may be a more meaningful way to measure improvements in health care.

What is already known on this topic

Maternal mortality is used internationally as a measure of the quality of obstetric intervention, although it is now rare in the developed world

Hospital based series estimating the incidence of severe obstetric morbidity have used different definitions

Estimated incidence of severe obstetric morbidity ranges from 0.05 to 1.09

What this study adds

With clear definitions and population based estimates of some severe obstetric morbidities this study estimated the overall incidence of severe obstetric morbidity as 1.2 % of deliveries

Two thirds of the cases are related to severe haemorrhage, one third to hypertensive disorders

Risk factors for severe maternal morbidity include maternal age >34, social exclusion, non-white, hypertension, previous postpartum haemorrhage, induction of labour, and caesarean section

We thank all the clinicians and women who participated in this study for their time and Paul Seed and Richard Hooper, who provided statistical advice.

Contributors: MW developed the proposal, collected and analysed data, and wrote the paper. SB and CW developed the proposal and wrote paper. CW is guarantor. Dr Peter Brocklehurst participated in the design and reviewed the manuscript.

Funding: MW was funded by a research fellowship from the Research and Development Department of the South Thames NHS Executive.

Competing interests: None declared.

1 Department of Health. *Why mothers die. Report on confidential enquiries into maternal deaths in the United Kingdom 1994-1996*. 1st ed. London: Stationery Office; 1998.
2 Stones W, Lim W, Al-Azzawi F, Kelly M. An investigation of maternal morbidity with identification of life-threatening 'near miss' episodes. *Health Trends* 1991;23:13-5.
3 Fitzpatrick C, Halligan A, McKenna P, Coughlan BM, Darling MRM, Phelan D. Near miss maternal mortality (letter). *Irish Med J* 1992;85:37.
4 Mantel GD, Buchmann E, Rees H, Pattison C. Severe acute maternal morbidity: a pilot study of a definition for a near-miss. *Br J Obstet Gynaecol* 1998;105:985-90.
5 Bouvier-Colle M-H, Salanave B, Ancel P-Y, Varnoux N, Fernandez H, Papiernik E, et al. Obstetric patients treated in intensive care units and maternal mortality. *Eur J Obstet Gynaecol Reprod Biol* 1996;65:121-5.
6 Bewley S, Creighton S. 'Near miss' obstetric enquiry. *J Obstet Gynaecol* 1997;17:26-9.

7 Collop NA, Sahn SA. Critical illness in pregnancy. An analysis of 20 patients admitted to a medical intensive care unit. *Chest* 1993;103: 1548-52.
8 Johannson R, Anthony J, Dommisse J. Obstetric intensive care at Groote Schuur Hospital, Cape Town. *J Obstet Gynaecol* 1995;15:174-7.
9 Mabie WC, Sibai BM. Treatment in an obstetric intensive care unit. *Am J Obstet Gynecol* 1990;162:1-4.
10 Platteau P, Enkin M, Moodley J, Muckart DJ. Obstetric and gynaecological patients in an intensive care unit: a 1 year review. *Trop Doct* 1997;27:202-6.
11 Lapinsky SE, Kruczynski K, Seaward GR, Farine D, Grossman RF. Critical care management of the obstetric patient. *Can J Anaesth* 1997;44:325-9.
12 Kilpatrick SJ, Matthay MA. Obstetric patients requiring critical care. A five year review. *Chest* 1992;101:1407-12.
13 Monaco TJ, Spielman FJ, Katz VL. Pregnant patients in the intensive care unit: a descriptive analysis. *South Med J* 1993;86:414-7.
14 Ng TI, Lim E, Tweed WA, Arulkumaran S. Obstetric admissions to the intensive care unit—a retrospective review. *Ann Acad Med Singapore* 1992;21:804-6.
15 Umo-Etuk J, Lumley J, Holdcroft A. Critically ill parturient women and admission to intensive care: a 5 year review. *Int J Gynaecol Obstet* 1996;5:79-84.
16 Sibai BM. Eclampsia. VI. Maternal-perinatal outcome in 254 consecutive cases. *Am J Obstet Gynecol* 1990;163:1049-55.
17 Sibai BM, Ramadan MK, Usta I, Salama M, Mercer BM, Friedman SA. Maternal morbidity and mortality in 442 pregnancies with hemolysis, elevated liver enzymes, and low platelets (HELLP syndrome). *Am J Obstet Gynecol* 1993;169:1000-6.
18 Benedetti J. Obstetric hemorrhage. In: Clark SL, Cotton DB, Hankins GDV, Phelan JP, eds. *Critical care obstetrics*. 2nd ed. Boston: Blackwell Scientific, 1991:573-606.
19 Bone RC, Balk RA, Cerra FB, Dellinger RP, Fein AM, Knaus WA, et al. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. *Chest* 1992;101:1644-55.
20 Bone RC, Sibbald WJ, Sprung CL. The ACCP-SCCM consensus conference on sepsis and organ failure. *Chest* 1992;101:1481-3.
21 Office of Population Censuses and Surveys. *Classification of occupation*. 1st ed. London: HMSO; 1990.
22 Cabinet Office. *Social exclusion*. www.cabinet-office.gov.uk/seu/index.htm.
23 Nisell H, Lintu H, Lunell NO, Mollerstrom G, Pettersson E. Blood pressure and renal function seven years after pregnancy complicated by hypertension. *Br J Obstet Gynaecol* 1995;102:876-81.
24 Tan KT, Tan KH. Pregnancy and delivery in primigravidae aged 35 and over. *Singapore Med J* 1994;35:495-501.
25 Roberts C, Algert C, March L. Delayed childbearing—are there any risks? *Med J Aust* 1994;160:539-44.
26 Peipert J, Bracken M. Maternal age: an independent risk factor for cesarean delivery. *Obstet Gynecol* 1993;81:200-5.
27 Jonas O, Roder D, Chan A. The association of maternal and socioeconomic characteristics in metropolitan Adelaide with medical, obstetric and labour complications and pregnancy outcomes. *Aust NZ J Obstet Gynaecol* 1992;32:1-5.
28 Jonas O, Chan A, Roder D, Macharper T. Pregnancy outcomes in primigravid women aged 35 years and over in South Australia, 1986-1988. *Med J Aust* 1991;154:246-9.
29 Tuck S, Ydkin P, Turnbull A. Pregnancy outcome in elderly primigravidae with and without a history of infertility. *Br J Obstet Gynaecol* 1988;95:230-7.
30 Lehmann D, Chism J. Pregnancy outcome in medically complicated and uncomplicated patients aged 40 years or older. *Am J Obstet Gynecol* 1987;157:738-42.
31 Peacock J, Bland J, Anderson H. Preterm delivery: effects of socioeconomic factors, psychological stress, smoking, alcohol, and caffeine. *BMJ* 1995;311:531-5.
32 Cnattingius S, Mills JL, Yuen J, Eriksson O, Salonen H. The paradoxical effect of smoking in preeclamptic pregnancies: smoking reduces the incidence but increases the rates of perinatal mortality, abruptio placentae, and intrauterine growth restriction. *Am J Obstet Gynecol* 1997;177:156-61.
33 Klonoff-Cohen H, Edelstein S, Savitz D. Cigarette smoking and preeclampsia. *Obstet Gynecol* 1993;81:541-4.

(Accepted 20 February 2001)

Commentary: Obstetric morbidity data and the need to evaluate thromboembolic disease

Deirdre J Murphy

Division of Obstetrics and Gynaecology, St Michael's Hospital, Bristol BS6 7HH

Deirdre J Murphy *consultant senior lecturer in maternal medicine*

The reports on the Confidential Enquiries into Maternal Deaths in the United Kingdom continue to inform healthcare professionals on issues of deficiency in the care of pregnant women.[1] High quality guidelines are produced in an attempt to standardise safe obstetric practices in all maternity units across the United Kingdom. It is increasingly difficult to evaluate the impact of guidelines on improvements in obstetric care with maternal mortality as the main outcome measure because maternal deaths are now rare in the developed world. "Near misses" or severe maternal morbidity have been suggested as alternative measures of the quality of obstetric care.[2 3] Studies to date have been mainly single centre case series, based on admissions to intensive care units. Many critically ill obstetric patients are now treated in a high dependency setting on labour wards and would no longer feature in studies of this type.

Waterstone and colleagues have reported on the results of a population based study of severe obstetric morbidity. They aimed to develop reproducible definitions and define the epidemiology of severe obstetric morbidity in the South East Thames region, which may be generalisable to other areas of the United Kingdom. They report a high overall rate of severe obstetric morbidity (1.2%), which reflects the main conditions associated with maternal death—severe haemorrhage, pre-eclampsia, and sepsis. The most obvious deficiency of the research is the exclusion of thromboembolic disease from the list of morbidities studied. Thromboembolic disease has been the leading cause of maternal mortality in recent reports from the inquiry,[1] and it is disappointing that this important cause of both mortality and morbidity has not been evaluated. The authors present compelling arguments for the omission, highlighting the difficulties in identifying cases of thromboembolic disease. It is clearly appropriate that we establish a system that allows accurate reporting of all cases of suspected and proved thromboembolic events related to pregnancy. The important sources of referral and assessment will need to be targeted—general practitioners, accident and emergency admissions, and general medical wards. A similar system has been attempted for amniotic fluid embolism,[4] but it will obviously take some time before complete ascertainment can be assured.

The high overall rate of severe morbidity and the predictors identified have important implications for the debate on place of birth. A previous study in the south west of England found little consistency in the criteria used for screening women who want a home birth.[5] The current study quantifies an overall estimate of risk and identifies clear risk factors for severe morbidity on which to base informed counselling of women who want to consider home birth. In contrast, hospital based care may exacerbate maternal risk because of the widespread increase in rates of emergency caesarean section, a factor associated with a fourfold increase in risk of severe morbidity within this study. What is most worrying is that this association was adjusted for maternal age, demographic factors, and

underlying obstetric complications and therefore reflects the additional risk of the procedure itself.

The ratio of severe maternal morbidity to mortality has been suggested as a possible new indicator of quality of maternal care. While this approach could be useful in allowing comparisons between different centres, interventions, and approaches to care, it is important that this does not result in league tables that fail to take account of differences in the risk profile of the populations served.

This paper moves forward from an evaluation of obstetric care purely in terms of mortality and admissions to intensive care. We will undoubtedly see refinements to the definitions and more innovative approaches to the ascertainment of difficult outcomes such as thromboembolic disease and amniotic fluid embolism. It provides a useful template on which to plan comparative studies in other populations with the potential to focus on issues relating to health inequality, place of birth, mode of delivery, and the effectiveness of practice guidelines.

1 Department of Health. *Report on confidential enquiries into maternal deaths in the United Kingdom 1994-1996*. London: Stationery Office, 1998.
2 Fitzpatrick C, Halligan A, McKenna P, Coughlan BM, Darling MRN, Phelan D. Near miss maternal mortality (letter). *Irish Med J* 1992;85:37.
3 Drife JO. Maternal "near-miss' reports? *BMJ* 1993;307:1087-8.
4 Tuffnell DJ, Johnson H. Amniotic fluid embolism: the UK register. *Hosp Med* 2000;61:532-4.
5 Campbell R. Review and assessment of selection criteria used when booking pregnant women at different places of birth. *Br J Obstet Gynaecol* 1999;106:550-6.

Increasing prevalence of obesity in primary school children: cohort study

Mary C J Rudolf, Pinki Sahota, Julian H Barth, Jenny Walker

Community Paediatrics, Leeds Community and Mental Health Trust, Leeds LS2 9NP
Mary C J Rudolf *community paediatrician*

School of Health Sciences, Leeds Metropolitan University, Leeds LS1 3HE
Pinki Sahota *senior lecturer in nutrition and dietetics*

continued over

BMJ 2001;322:1094–5

Reports suggest that the prevalence of obesity among children is increasing. Reilly et al reported that, even by the age of 5, the prevalence of obesity was higher than that expected from the national standards[1] and that this persisted into the teenage years.[2]

Participants, methods, and results

From 1996 to 1999 an auxologist (JW) measured children in 10 primary schools in Leeds participating in a health promotion programme.[3] Children in years 3 and 4 (age 7-9 years) were measured in July 1996 and again in July 1997 and 1998. These children were marginally more advantaged than average for Leeds, with 1-42% of pupils from ethnic minorities and 7-29% entitled to free school meals (a measure of social disadvantage).

Height was measured to 0.1 cm with a free standing Magnimeter stadiometer (Raven, Dunmow). Weights were recorded to 0.1 kg without shoes or jumpers. The mean of three triceps measurements was taken.[4] Body mass index (weight (kg)/(height (m)^2)) was calculated and converted to standard deviation scores using the revised 1990 reference standards[5] and the Tanner Whitehouse (1975) standards for skinfold thickness.[4] The following conventional cut-off points were applied: body mass index standard deviation score greater than 1.04 (85th centile) for overweight and greater than 1.64 (95th centile) for obesity. Using these definitions the expected percentages were 15% for overweight and 5% for obesity, relative to British children in 1990. Observed levels were compared with expected levels using χ^2 goodness of fit test.

All but 21 children agreed to participate. Overall, 608 children were measured in 1996, 540 in 1997, and 499 in 1998 (some of whom were not measured in 1997). In addition 86 new children joined the study in 1997 and 1998. In total 694 children were measured, resulting in 1762 measurements.

The table shows the proportion of children with body mass index and triceps measurements above the 85th and 95th centiles according to age. A significant increase in the proportion of overweight and obese children was observed in those aged 9, 10, and 11 years.

Comment

A noticeable increase in the prevalence of obesity has been observed such that one in five 9 year olds and one in three 11 year old girls are overweight. We collected new data on measurements of the skinfold at the triceps. Given the increase in the extent of body mass index these measures were surprisingly not significantly greater than those expected from the 1975 standards. Anecdotal evidence suggests that the 1975 standards were based on overweight children (T Coles, personal communication), and this may prove to be the

Body mass index scores and triceps skinfold measures in Leeds primary school children. Values are numbers (percentages) unless stated otherwise

	Girls						Boys					
Age†	**7**	**8**	**9**	**10**	**11**	**Total**	**7**	**8**	**9**	**10**	**11**	**Total**
Body mass index	n=22	n=162	n=261	n=230	n=112	n=787	n=30	n=192	n=320	n=280	n=153	n=975
Overweight	3 (14)	24 (15)	56 (22*)	53 (23**)	36 (32**)	172 (22**)	3 (10)	25 (13)	71 (22**)	70 (25**)	41 (27**)	210 (22**)
Obese	1 (5)	10 (6)	27 (10**)	33 (14**)	15 (13**)	86 (11**)	1 (3)	10 (5)	33 (10**)	38 (14**)	30 (20**)	112 (12**)
Triceps	n=22	n=160	n=257	n=231	n=112	n=782	n=29	n=190	n=318	n=280	n=153	n=970
Overweight	3 (14)	26 (16)	39 (15)	26 (11)	17 (15)	111 (14)	4 (14)	19 (10)	47 (15)	44 (16)	28 (18)	142 (15)
Obese	1 (5)	5 (3)	11 (4)	8 (4)	4 (4)	29 (4)	1 (4)	9 (5)	22 (7)	13 (5)	5 (3)	50 (5)

Prevalence of overweight and obesity is shown using definition of greater than 85th centile for overweight and greater than 95th centile for obese.
Frequencies significantly different from expected values of 15% (overweight) and 5% (obesity) at *P<0.01, **P<0.001.
†Each year group was taken as year to next birthday ("seven" year olds included children aged 7 to less than 8 years).