RESEARCH

Influence of definition based versus pragmatic birth registration on international comparisons of perinatal and infant mortality: population based retrospective study

OPEN ACCESS

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Abstract

Objectives To examine variations in the registration of extremely low birthweight and early gestation births and to assess their effect on perinatal and infant mortality rankings of industrialised countries.

Design Retrospective population based study.

Setting Australia, Canada, European countries, and the United States for 2004; Australia, Canada, and New Zealand for 2007.

Population National data on live births and on fetal, neonatal, and infant deaths.

Main outcome measures Reported proportions of live births with birth weight/gestational age of less than 500 g, less than 1000 g, less than 24 weeks, and less than 28 weeks; crude rates of fetal, neonatal, and infant mortality; mortality rates calculated after exclusion of births under 500 g, under 1000 g, less than 24 weeks, and less than 28 weeks.

Results The proportion of live births under 500 g varied widely from less than 1 per 10 000 live births in Belgium and Ireland to 10.8 per 10 000 live births in Canada and 16.9 in the United States. Neonatal deaths under 500 g, as a proportion of all neonatal deaths, also ranged from less than 1% in countries such as Luxembourg and Malta to 29.6% in Canada and 31.1% in the United States. Rankings of countries based on crude fetal, neonatal, and infant mortality rates differed substantially from rankings based on rates calculated after exclusion of births with a birth weight of less than 1000 g or a gestational age of less than 28 weeks.

Conclusions International differences in reported rates of extremely low birthweight and very early gestation births probably reflect variations in registration of births and compromise the validity of international rankings of perinatal and infant mortality.

Introduction

Several institutions, such as the United Nations Children's Fund and the Organisation for Economic Co-operation and Development (OECD), provide international rankings of countries based on perinatal, infant, or child mortality.¹⁻⁴ This annual updating of the health of children worldwide receives considerable attention in the lay press and medical journals, and frequently serves as the basis for political rhetoric, especially in industrialised countries.⁵⁻⁸ The subject is particularly pertinent in Canada and the United States; Canada placed 14th among about 35 OECD nations in 1960, ranked sixth in 1990, and began a steep descent to its current position of 25th place in 2008.² The United States ranked 13th in 1960 and 22nd in 1990 and is currently in 31st place among OECD countries.²

Although the intent of such international comparisons is to spur improvements in children's health globally, the validity of the rankings is questionable. Wide variations in birth registration procedures, even among industrialised countries, mean that comparisons of crude infant mortality may reward countries with a pragmatic approach to birth registration (that is, those

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which register only infants who survive or have a reasonable chance of survival). The medical literature documents wide variation in the registration of live births and stillbirths, especially with respect to births at the borderline of viability (for example, those with a birth weight of less than 500 g).⁹⁻¹² The World Health Organization recommends that international comparisons of infant mortality should be restricted to live births with a birth weight of at least 1000 g.¹³ The classification of deaths as neonatal deaths versus stillbirths and birth registration practices related to infants with lethal congenital anomalies (including the registration of live births that occasionally follow prenatal diagnosis and termination of pregnancy for congenital anomalies) are other potential sources of variation.^{11 14 15}

We carried out a study to assess the validity of ranking industrialised countries on the basis of perinatal and infant mortality rates. We focused on comparisons of neonatal mortality, as neonatal deaths constitute a substantial proportion of infant and child deaths and detailed information on neonatal deaths is widely available.

Methods

Our international comparisons used data for 2004, which were available from Australia, Canada, countries in Europe, and the United States. We also made comparisons using data for 2007 from Australia, Canada, and New Zealand.

Data for Canada came from the vital registration files of Statistics Canada and the hospital admission files of the Canadian Institute for Health Information. These data included information on all stillbirths, live births, neonatal deaths (0-27 days after birth), and infant deaths (0-364 days after birth) in Canada in 2004 from Statistics Canada files and all hospital live births, stillbirths, and infant deaths during the birth admission in the fiscal year 2007-8 from the discharge abstract database of the Canadian Institute for Health Information.¹⁵ For study purposes, we excluded births from the province of Ontario from Statistics Canada data because of concerns about quality,¹⁵ and hospital admission data did not include information from the province of Quebec.

Data for Australia (stillbirths in 2004 and neonatal deaths in 2007) and New Zealand (2007) came from published annual reports which provided the birth weight and gestational age of births and deaths.^{16 17} Data for countries in Europe for 2004 came from the European Perinatal Health Report and other publications.¹⁸⁻²⁰ The European Perinatal Health Report contained data on live births, stillbirths, neonatal deaths, and infant deaths for all European countries; in this study, we included only countries with complete birthweight specific (or gestational age specific) information on births and deaths.

Information on live births, stillbirths, neonatal deaths, and infant deaths in the United States came from the period infant mortality files of the National Center for Health Statistics for 2004. Information in these files was collated from birth and death certificates. For gestational age specific comparisons of neonatal mortality rates, we used the clinical estimate of gestation, as this is more reliable and corresponds more closely with estimates of gestational age from other countries.²¹⁻²³ Stillbirths were identified in accordance with the definition of the Centers for Disease Control and Prevention (as fetal deaths with a gestational age at birth of 20 weeks or greater).²⁴

We calculated the reported proportion of live births and the reported proportion of neonatal deaths at the lower end of the range of birth weight and gestational age in each country (that is, those with a birth weight under 500 g or under 1000 g or a gestational age of less than 24 weeks or less than 28 weeks).

We assessed the validity of using neonatal mortality rates for ranking countries' performance by examining ranks based on crude neonatal mortality rates and ranks based on neonatal mortality rates calculated after exclusion of live births with a known birth weight under 1000 g (or a known gestational age of less than 28 weeks). Our primary analysis focused on mortality rates calculated after exclusion of live births under 1000 g (rather than rates calculated after exclusion of live births at less than 28 weeks) because of international variations in the modalities used to measure gestational age (menstrual based dating, early ultrasound dating, first trimester ultrasound dating, paediatric examination, and so on).

We also assessed international variation in crude infant mortality and stillbirth rates and contrasted this with variation in infant mortality and stillbirth rates calculated after exclusion of births under 1000 g birth weight (or less than 28 weeks' gestation). Mortality calculations that excluded births under 1000 g birth weight (or less than 28 weeks' gestation) retained births with missing birth weight (or gestational age). Finally, we calculated mortality rate ratios, 95% confidence intervals, and P values to assess the magnitude and statistical significance of observed differences. For these comparisons, we used the United States as the reference category for neonatal mortality, Canada for infant mortality, and Australia for fetal mortality. We used EpiInfo and SAS version 9.2 for analyses.

Results

The reported proportion of live births with a birth weight of less than 500 g varied widely by country in 2004. Rates were less than 1 per 10 000 live births in countries such as Belgium, Ireland, Latvia, Poland, Portugal, and the Slovak Republic; 6.1 in England and Wales and Hungary; 10.8 in Canada; and 16.9 per 10 000 live births in the United States (table 1). The proportion of live births at less than 24 weeks' gestation also varied substantially by country: 0.0 per 10 000 live births in Hungary, Luxembourg, Malta, and Portugal; 7.1 in the Netherlands; 16.3 in Canada; and 26.2 per 10 000 live births in the United States (web appendix table A). Neonatal deaths under 500 g (expressed as a proportion of all neonatal deaths) ranged from less than 1% in Luxembourg and Malta to 16.7% in Northern Ireland, 29.6% in Canada, and 31.1% in the United States (table 1). We saw similar variations in live births under 1000 g and less than 28 weeks and in the proportion of neonatal deaths under 1000 g, at less than 24 weeks, and at less than 28 weeks (table 1 and web appendix table A). Figure 1 shows the relation between the reported proportion of live births under 500 g birth weight and crude neonatal mortality rates, and web appendix figure A shows the association between the reported proportion of live births at less than 24 weeks' gestation and crude neonatal mortality rates.

Table 2 contrasts crude neonatal mortality rates and neonatal mortality rates calculated after exclusion of live births under 1000 g in 25 countries in 2004. When crude neonatal mortality rates were used for ranking, Canada was placed 18th and the United States ranked 22nd. When neonatal mortality rates were calculated after exclusion of live births under 1000 g, Canadian and US ranks improved substantially to 12th and 11th place. Of the 10 countries that ranked ahead of the United States in neonatal mortality excluding live births under 1000 g, only two countries (the Czech Republic and Germany) had rates that were significantly lower ($P<0.05$). Similarly, only one of the 11 countries that ranked ahead of Canada (the Czech Republic) had a significantly lower rate of neonatal mortality after exclusion of live births 1000 g, and only six of the 16 countries

that ranked ahead of England and Wales had significantly lower rates (table 2). Figure 2 shows the contrast in the between country pattern in crude neonatal mortality and neonatal mortality excluding live births under 1000 g. Similar results were obtained in rankings of neonatal mortality rates calculated after exclusion of live births at less than 28 weeks' gestation (web appendix table B).

Canada ranked 12th and the United States ranked 16th in crude infant mortality rates among 18 countries, whereas the two countries ranked sixth and 12th according to infant mortality rates calculated after excluding live births under 1000 g. Of the five countries ranking ahead of Canada according to the second index, only the Czech Republic had a significantly lower rate ($P<0.05$, table 3).

Table 4 shows crude and birthweight specific stillbirth rates in 28 countries in 2004. Comparisons based on crude stillbirth rates placed the United States in 23rd position, Canada in 27th place, and Australia last (28th). Ranks were substantially altered in comparisons of stillbirth rates calculated after excluding those with a birth weight under 1000 g: Australia ranked 11th, Canada ranked 12th, and the United States was placed 17th. The corrected stillbirth rate in Australia was 58% lower than the crude rate, and only six countries had significantly lower fetal mortality rates than Australia ($P<0.05$). On the other hand, the crude stillbirth rate in Sweden declined by 5% after the correction and Sweden's rank fell from third to 10th (table 4).

Analyses comparing neonatal mortality rates in Australia, Canada, and New Zealand in 2007 showed similar patterns. The proportion of live births at very low birth weight or extremely preterm gestation varied significantly, and the ranks of the three countries depended on whether comparisons were made using crude neonatal mortality rates or neonatal mortality rates calculated after exclusion of very low birth weight or very early gestation live births.

Discussion

Our study shows substantial international variation in reported rates of live birth at the low end of the range of birth weight and gestational age. The proportion of neonatal deaths at these birth weights and gestational ages varied substantially as well. These differences led to substantial changes in the rankings of countries based on neonatal mortality, depending on whether the index for comparison was the crude neonatal mortality rate or a rate corrected for potential variations in birth registration at very low birth weight or very early gestation.

International differences in birth registration

The World Health Organization's International Statistical Classification of Diseases and Related Health Problems has long defined a live birth as any product of conception that shows signs of life at birth, with no consideration for birthweight or gestational age criteria.¹³ Although this definition remains unchallenged, countries have widely varying regulations for registration of birth that range from definition based to pragmatic. For instance, birth registration is required for all live births that satisfy the WHO's definition of live birth in Canada, England and Wales, and the United States,^{15 25} whereas countries such as the Czech Republic, France, and the Netherlands specify limits based on some combination of gestational age (for example, at least 22 weeks), birth weight (for example, at least 500 g), or survival (for example, any live birth irrespective of birth weight that survives the first 24 hours after birth) (web appendix table C).^{18 26 27} Procedural differences due to longstanding traditions, social attitudes, and local incentives

(including financial remuneration of healthcare providers) also probably dictate whether an infant at the borderline of viability is registered. Birth registration requirements for stillbirths also vary widely; countries such as the United States define stillbirths as fetal deaths delivered at or after 20 weeks' gestation,²⁴ whereas Canada (at least 20 weeks' gestation or at least 500 g birth weight),¹⁵ England and Wales (at least 24 weeks' gestation), and Sweden (at least 28 weeks' gestation) have different criteria.¹⁸ Although observed differences in the proportion of live births and stillbirths at extremely low birth weight and very early gestation may reflect true between country differences, our study suggests they are more likely to be the result of the variation in birth registration practices.

Implications for policy

Our study examined the effect of variation in birth registration on international rankings of fetal, neonatal, and infant mortality. Such studies cannot provide valid international rankings of countries in terms of health or healthcare services.²⁸ Although variation in the registration of extremely small babies and statistical variation may be corrected through appropriate analysis, other factors such as potential variation in true rates of extremely preterm birth and differences in the modality of ascertainment of gestational age cannot easily be resolved. Furthermore, any serious attempt at judging performance would have to account for potentially variable registration with regard to births affected by lethal congenital anomalies (including those born after prenatal diagnosis and termination of pregnancy)^{11 15} and differential labelling of stillbirths versus live births.¹³ The question of prenatal diagnosis is particularly relevant, as even in countries such as Canada with a definition based birth registration system, regional variations have been noted in the registration of such births.¹⁵ At the international level, little consensus exists on whether products of pregnancy termination require birth registration, even if they meet the definition of stillbirth or live birth. In short, birth registration policies have diverse effects (including, for instance, with regard to monitoring progress towards the millennium development goals²⁹), and forging a broad international consensus with regard to birth registration procedures may be worthwhile.

Study limitations

Our study has some limitations, including the use of data from national vital statistics or hospital admission databases that are not completely accurate. This problem is mitigated to some extent by our focus on birth weight (as opposed to gestational age). Other limitations of the study include use of published tabular data, which in some instances constrained the comparisons that could be made. Another limitation relates to the calculation of birthweight specific mortality rates, as some births and deaths had missing birth weights. We excluded only births and deaths with a birth weight known to be less than 1000 g and included births and deaths with missing birth weight in the mortality rates calculated. We chose this conservative approach to avoid "rewarding" countries with larger numbers of births with missing birth weight. Finally, our analysis involved multiple comparisons, as this is necessarily inherent in any ranking of countries. The direction of the bias introduced by multiple hypothesis testing should be noted, however. For instance, the spread of rank for the United States between crude neonatal mortality (22nd) and neonatal mortality excluding live births under 1000 g (only two countries had significantly lower rates) would have been even larger if we had adjusted our P values for multiple hypothesis testing. Similarly, adjusting for multiple hypothesis testing would have resulted in fewer than

six countries having a significantly lower neonatal mortality rate excluding live births under 1000 g than England and Wales and no country having a significantly lower rate than Canada.

Conclusions

In summary, we observed large international differences in the reported proportion of live births under 500 g and under 1000 g birth weight and in neonatal deaths in these birthweight categories. International comparisons based on crude fetal, neonatal, and infant mortality rates yielded results that differed from comparisons that excluded extremely low birthweight and early gestation births, especially those at the borderline of viability. Variations in the registration of births at the borderline of viability and related problems compromise the validity of international rankings of industrialised countries by perinatal and infant mortality.

We are grateful to the vital statistics registrars of the provinces and territories and to Statistics Canada for access to the Canadian vital statistics data, the Canadian Institute for Health Information for access to the hospital admission data for Canada, and the National Center for Health Statistics for access to the perinatal mortality files of the United States. Contributing members of the Fetal and Infant Health Study Group include Sharon Bartholomew (Public Health Agency of Canada), Juan Andrés Leon (Public Health Agency of Canada), Russell Kirby (University of South Florida), and Prakesh Shah (University of Toronto).

Contributors: Questions related to international comparisons of fetal and infant mortality have been previously discussed by the Fetal and Infant Health Study Group of the Canadian Perinatal Surveillance System. KSJ proposed the study. SLiu, JR, and SLisonkova did the data analysis. KSJ drafted the manuscript. KSJ, SLiu, JR, SLisonkova, JAH, RS, ACA, and MSK reviewed the preliminary analyses and initial draft of the manuscript and provided critical comments. All the authors and the study group reviewed the final version of the manuscript. KSJ is the guarantor.

Funding: The study received no funding. KSJ's work is supported by the Child and Family Research Institute and the Peter Lougheed Research Allowance of the Canadian Institutes of Health Research (PLS56343). SLisonkova is supported by a postdoctoral fellowship award from the Michael Smith Foundation for Health Research. JAH is supported by postdoctoral fellowship awards from the Michael Smith Foundation for Health Research and the Canadian Institutes of Health Research.

Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: Not required, as data are publicly available.

Data sharing: No additional data available.

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Accepted: 25 November 2011

Cite this as: *BMJ* 2012;344:e746

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What is already known on this topic

International rankings of countries based on perinatal, infant, or child mortality are a cause of debate and political rhetoric in industrialised countries

What this study adds

Substantial differences exist in reported rates of extremely low birth weight and very early gestation births in industrialised countries

Such differences probably reflect arbitrary differences in birth registration, which compromise the validity of international rankings based on perinatal, infant, or child mortality

Tables

Table 1 | Reported numbers of live births and neonatal deaths by country and rates of live birth under 500 g, live birth under 1000 g, neonatal death under 500 g, neonatal death under 1000 g, and crude neonatal mortality, 2004

Country	Live births			Neonatal deaths			Crude neonatal death rate (per 1000 live births)
	No	Rate*		No	Rate*		
		<500 g (per 10 000)	<1000 g (per 10 000)		<500 g (%)	<1000 g (%)	
Austria	78 934	2.8	37.8	215	8.4	47.4	2.72
Belgium	76 872	0.4	33.2	197	1.5	42.3	2.56
Canada	204 521	10.8	45.2	767	29.6	61.9	3.75
Czech Republic	97 664	1.4	37.9	224	3.1	38.8	2.29
Denmark	64 521	2.2	33.1	230	11.2	48.5	3.56
England and Wales	639 721	6.1	49.4	2185	15.1	50.0	3.42
Estonia	13 990	2.1	40.1	59	5.1	40.7	4.22
Finland	57 569	3.8	30.4	141	13.3	48.9	2.45
Germany	646 599	4.8	50.1	1892	16.0	54.6	2.93
Hungary	95 118	6.1	61.0	423	11.2	56.9	4.45
Ireland	62 066	0.0	32.6	167	0.0	39.8	2.69
Latvia	20 355	0.0	28.5	116	0.0	24.1	5.70
Lithuania	29 480	1.0	28.2	136	2.2	37.5	4.61
Luxembourg	5469	0.0	1.9	11	0.0	20.0	2.01
Malta	3887	0.0	25.7	17	0.0	23.5	4.37
Netherlands	181 006	2.7	36.8	631	6.8	43.8	3.49
Northern Ireland	22 362	1.8	40.7	66	16.7	48.5	2.95
Norway	57 111	1.9	33.4	118	3.4	34.2	2.07
Poland	356 697	0.0	38.9	1731	0.0	39.9	4.85
Portugal	109 356	0.6	35.7	280	2.6	39.7	2.56
Scotland	52 911	4.2	39.5	161	4.7	46.0	3.04
Slovak Republic	52 388	0.8	32.8	134	1.5	36.6	2.56
Slovenia	17 846	3.4	38.1	47	10.6	51.1	2.63
Sweden	100 158	1.5	27.4	210	5.1	27.7	2.10
United States	4 118 951	16.9	75.2	18 429	31.1	64.7	4.47

Rates of live birth <500 g and live birth <1000 g are expressed per 10 000 live births; neonatal death <500 g and neonatal death <1000 g are expressed as percentage of all neonatal deaths.

Table 2| Crude neonatal mortality rates, neonatal mortality rates excluding live births under 1000 g birth weight, ranks, and comparative rate ratios by country, 2004 (with United States as reference)

Country	Crude neonatal mortality			Neonatal mortality excluding live births <1000 g		
	Rate*	Rank	Country v USA: rate ratio (95% CI)	Rate*	Rank	Country v USA: rate ratio (95% CI)
Luxembourg	2.01	1	0.45 (0.25 to 0.81)	1.64	15	1.02 (0.53 to 1.96)
Norway	2.07	2	0.46 (0.39 to 0.55)	1.33	4	0.83 (0.66 to 1.04)
Sweden	2.10	3	0.47 (0.41 to 0.54)	1.56	9	0.97 (0.83 to 1.14)
Czech Republic	2.29	4	0.51 (0.45 to 0.58)	1.12	1	0.70 (0.58 to 0.84)
Finland	2.45	5	0.55 (0.46 to 0.65)	1.31	3	0.81 (0.65 to 1.02)
Slovak Republic	2.56	6	0.57 (0.48 to 0.68)	1.63	12	1.01 (0.82 to 1.25)
Portugal	2.56	6	0.57 (0.51 to 0.64)	1.58	10	0.98 (0.84 to 1.14)
Belgium	2.56	6	0.57 (0.50 to 0.66)	1.49	6	0.92 (0.77 to 1.11)
Slovenia	2.63	9	0.59 (0.44 to 0.78)	1.29	2	0.80 (0.53 to 1.21)
Ireland	2.69	10	0.60 (0.52 to 0.70)	1.63	12	1.01 (0.83 to 1.23)
Austria	2.72	11	0.61 (0.53 to 0.70)	1.43	5	0.89 (0.74 to 1.07)
Germany	2.93	12	0.65 (0.62 to 0.69)	1.49	6	0.92 (0.87 to 0.99)
Northern Ireland	2.95	13	0.66 (0.52 to 0.84)	1.52	8	0.95 (0.68 to 1.33)
Scotland	3.04	14	0.68 (0.58 to 0.79)	1.74	16	1.08 (0.88 to 1.33)
England and Wales	3.42	15	0.76 (0.73 to 0.80)	1.77	17	1.10 (1.03 to 1.17)
Netherlands	3.49	16	0.78 (0.72 to 0.84)	1.96	19	1.22 (1.10 to 1.36)
Denmark	3.56	17	0.80 (0.70 to 0.91)	2.09	20	1.30 (1.10 to 1.54)
Canada	3.75	18	0.84 (0.78 to 0.90)	1.63	12	1.01 (0.91 to 1.13)
Estonia	4.22	19	0.94 (0.73 to 1.22)	2.51	21	1.56 (1.12 to 2.17)
Malta	4.37	20	0.98 (0.61 to 1.57)	3.34	24	2.08 (1.21 to 3.58)
Hungary	4.45	21	0.99 (0.90 to 1.09)	1.95	18	1.21 (1.05 to 1.40)
United States	4.47	22	1.00	1.61	11	1.00
Lithuania	4.61	23	1.03 (0.87 to 1.22)	2.88	22	1.79 (1.45 to 2.22)
Poland	4.85	24	1.08 (1.03 to 1.14)	2.93	23	1.82 (1.70 to 1.94)
Latvia	5.70	25	1.27 (1.06 to 1.53)	4.32	25	2.68 (2.17 to 3.31)

*Neonatal mortality rates expressed per 1000 live births.

Table 3| Crude infant mortality rates, infant mortality rates excluding live births <1000 g birth weight, ranks, and comparative rate ratios by country, 2004 (with Canada as reference)

Country	Crude infant mortality			Infant mortality excluding live births <1000 g		
	Rate*	Rank	Canada v country: rate ratio (95% CI)	Rate*	Rank	Canada v country: rate ratio (95% CI)
Sweden	2.99	1	1.69 (1.49 to 1.92)	2.37	4	1.05 (0.90 to 1.22)
Norway	3.01	2	1.68 (1.43 to 1.97)	3.01	3	1.08 (0.89 to 1.31)
Finland	3.39	3	1.49 (1.28 to 1.74)	2.16	2	1.15 (0.95 to 1.40)
Czech Republic	3.75	4	1.35 (1.20 to 1.52)	2.12	1	1.18 (1.00 to 1.38)
Belgium	3.94	5	1.28 (1.13 to 1.46)	2.79	9	0.89 (0.76 to 1.05)
Northern Ireland	4.02	6	1.26 (1.01 to 1.56)	2.60	7	0.96 (0.73 to 1.25)
Austria	4.05	7	1.25 (1.10 to 1.41)	2.48	5	1.00 (0.85 to 1.18)
Germany	4.14	8	1.22 (1.14 to 1.31)	2.65	8	0.94 (0.85 to 1.04)
Denmark	4.43	9	1.14 (1.00 to 1.30)	2.88	10	0.87 (0.73 to 1.02)
Scotland	4.93	10	1.02 (0.89 to 1.17)	3.51	13	0.71 (0.60 to 0.84)
England and Wales	4.93	10	1.02 (0.95 to 1.10)	3.00	11	0.83 (0.75 to 0.91)
Canada	5.05	12	1.00	2.49	6	1.00
Malta	5.92	13	0.85 (0.57 to 1.29)	4.64	17	0.54 (0.34 to 0.86)
Estonia	6.29	14	0.80 (0.65 to 1.00)	4.38	15	0.57 (0.44 to 0.74)
Hungary	6.60	15	0.77 (0.69 to 0.84)	3.67	14	0.68 (0.59 to 0.78)
Poland	6.77	17	0.75 (0.69 to 0.80)	4.60	16	0.54 (0.49 to 0.60)
United States	6.70	16	0.75 (0.71 to 0.80)	3.50	12	0.71 (0.65 to 0.78)
Latvia	9.38	18	0.54 (0.46 to 0.63)	7.74	18	0.32 (0.27 to 0.39)

*Infant mortality rates expressed per 1000 live births.

Table 4| Crude fetal mortality rates, fetal mortality rates excluding births <1000 g birth weight, ranks, and comparative rate ratios by country, 2004 (with Australia as reference)

Country	Crude fetal mortality			Fetal mortality excluding births <1000 g		
	Rate*	Rank	Country v Australia: rate ratio (95% CI)	Rate*	Rank	Country v Australia: rate ratio (95% CI)
Slovak Republic	2.55	1	0.34 (0.29 to 0.41)	1.63	1	0.52 (0.42 to 0.65)
Luxembourg	3.10	2	0.42 (0.26 to 0.67)	2.64	6	0.85 (0.50 to 1.44)
Sweden	3.15	3	0.42 (0.37 to 0.47)	2.99	10	0.96 (0.84 to 1.10)
Spain	3.15	3	0.42 (0.39 to 0.45)	2.74	7	0.88 (0.80 to 0.96)
Finland	3.29	5	0.44 (0.38 to 0.51)	1.97	2	0.63 (0.52 to 0.77)
Germany	3.48	6	0.47 (0.44 to 0.50)	2.40	4	0.77 (0.71 to 0.84)
Austria	3.72	7	0.50 (0.44 to 0.56)	2.33	3	0.75 (0.64 to 0.88)
Portugal	3.84	8	0.52 (0.46 to 0.57)	2.89	8	0.93 (0.82 to 1.06)
Malta	3.84	8	0.52 (0.31 to 0.86)	3.86	24	1.24 (0.74 to 2.06)
Czech Republic	3.95	10	0.53 (0.47 to 0.59)	2.56	5	0.82 (0.71 to 0.95)
Belgium	4.36	11	0.59 (0.52 to 0.66)	2.91	9	0.93 (0.80 to 1.08)
Norway	4.48	12	0.60 (0.53 to 0.68)	3.76	19	1.21 (1.04 to 1.41)
Estonia	4.48	12	0.60 (0.47 to 0.77)	3.37	13	1.08 (0.81 to 1.45)
Poland	4.86	14	0.65 (0.61 to 0.70)	3.55	15	1.14 (1.05 to 1.25)
Hungary	4.98	15	0.67 (0.60 to 0.74)	3.58	16	1.15 (1.01 to 1.31)
Denmark	5.12	16	0.69 (0.61 to 0.77)	3.93	25	1.26 (1.10 to 1.45)
Lithuania	5.16	17	0.69 (0.59 to 0.82)	3.83	21	1.23 (1.01 to 1.50)
Ireland	5.35	18	0.72 (0.64 to 0.81)	3.85	23	1.24 (1.07 to 1.43)
Italy	5.42	19	0.73 (0.69 to 0.77)	4.97	28	1.60 (1.48 to 1.73)
Slovenia	5.57	20	0.75 (0.61 to 0.91)	3.48	14	1.12 (0.86 to 1.45)
England and Wales	5.73	21	0.77 (0.73 to 0.81)	3.84	22	1.23 (1.14 to 1.34)
Northern Ireland	6.31	22	0.85 (0.71 to 1.00)	3.62	17	1.16 (0.93 to 1.46)
United States	6.53	23	0.88 (0.84 to 0.92)	3.62	17	1.16 (1.08 to 1.25)
Latvia	6.69	24	0.90 (0.75 to 1.07)	4.71	27	1.51 (1.22 to 1.87)
Scotland	6.72	24	0.90 (0.80 to 1.01)	4.14	26	1.33 (1.15 to 1.54)
Netherlands	6.98	26	0.94 (0.87 to 1.00)	3.81	20	1.23 (1.11 to 1.36)
Canada	7.11	27	0.95 (0.88 to 1.03)	3.35	12	1.08 (0.96 to 1.21)
Australia	7.46	28	1.00	3.11	11	1.00

*Fetal mortality rates expressed per 1000 total births.

Figures

Fig 1 Association between reported proportion of live births under 500 g birth weight and crude neonatal mortality rates in 25 industrialised countries

Fig 2 Differences in pattern of crude neonatal mortality rates and neonatal mortality rates excluding live births under 1000 g in 25 industrialised countries