Sociodemographic and obstetric characteristics of stillbirths in China: a census of nearly 4 million health facility births between 2012 and 2014

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Summary

Background Very little is known about the burden and determinants of stillbirths in China. We used data from a national surveillance system for health facility births to compute a stillbirth rate representative of all facility births in China and to explore sociodemographic and obstetric factors associated with variation in the stillbirth rate.

Methods We used data from China's National Maternal Near Miss Surveillance System between Jan 1, 2012, and Dec 31, 2014, which covers 441 hospitals in 326 urban districts and rural counties. The surveillance aimed to enumerate all maternal deaths and near misses in health facilities, and collected data prospectively for all pregnant or post-partum women admitted to the obstetric department. We restricted the analysis to births of 28 or more completed weeks of gestation or 1000 g or heavier birthweight. We examined the strength of association between sociodemographic characteristics, gestational age, and obstetric complications and stillbirths using logistic regression, taking account of the sampling strategy and clustering of births within hospitals and in cases of more than one birth per woman.

Findings There were 3 956 836 births and 37 855 stillbirths, giving a stillbirth rate of 8·8 per 1000 births (95% CI 8·8–8·9). The stillbirth rate was particularly high for women younger than 15 years of age (59·9 stillbirths per 1000 births), those who had not sought antenatal care (38·3 per 1000), the unmarried (32·5 per 1000), those with no education (26·9 per 1000), or those who had had four or more births (23·2 per 1000). A high proportion (29 319 [78·2%] of 37 514) of stillbirths occurred at gestational ages of younger than 37 weeks, and about two thirds (24 787 [66·1%] of 37 514) were in women without any maternal complication at the time of birth. Of babies born at normal gestations (37–41 weeks), maternal complications substantially increased the risk of stillbirth (odds ratio comparing antepartum or intrapartum complications with no complication 3·96 [95% CI 3·66–4·29]), but only a small proportion (1638 [4·4%] of 37 514) of stillbirths fell into this group.

Interpretation Our analysis of nearly 4 million births in 441 health facilities in China suggests a stillbirth rate of 8·8 per 1000 births between 2012 and 2014. Stillbirths do not feature in the Chinese Government's 5 year plans and most information systems do not include stillbirths. The Government need to start paying attention to stillbirths and invest strategically in antenatal care, particularly for the most disadvantaged women, including the very young, unmarried, and illiterate, and those at high parity.

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Introduction

The Millennium Development Goals have been instrumental in drawing attention to the high burden of maternal and child deaths in low-income and middle-income countries. During the past 25 years, substantial progress has been made in both child survival and safe motherhood, although regional inequalities persist.[1,2] Stillbirths, by contrast, have been largely ignored in public health debates and programmes, despite the obviously devastating effect that they have on parents. Stillbirths are often not counted in national and international statistics, and the worldwide focus remains on the survival of babies born alive.

Attention has been drawn to the importance of stillbirths, and systematic efforts have been made to ascertain levels and causes. Stanton and colleagues[3] reported 3·2 million stillbirths worldwide for 1989, but very few low-income and middle-income countries had usable data. In 2011, Lawn and colleagues[4] revised the estimates to 2·65 million stillbirths for 2008, with 98% thought to occur in low-income and middle-income countries. Many countries did not have valid data, however, and China, representing more than a fifth of the world's population, was identified as contributing to an important data gap. Nationally representative data for China were not available, and only a dearth of small

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Research in context

Evidence before this study

We searched both English (PubMed) and Chinese (China Biology Medicine, China National Knowledge Infrastructure, Wanfang, and VIP) databases for reports published in English or Chinese with the search terms "stillbirth", "China", "死胎", "死产", "发生率", "流行病学", and "围产儿死亡", with no date restrictions. The English literature search identified six population-based and four facility-based studies. Only one of the population-based studies reporting stillbirth rates relied on empirical data from a cohort of pregnant women in 20 townships in one rural county in eastern China; all other estimates were model-based. The Chinese literature search resulted in 223 reports mentioning stillbirths, only four of which captured population-based data in restricted geographical areas. Of the 220 studies reporting facility-based stillbirth estimates, 175 were from a single hospital, 18 collected data from two to 30 hospitals, and six reported estimates from more than 30 hospitals. None weighed the data by hospital. Very few population-based or facility-based data exist that can provide representative estimates of stillbirths in China. As a result, reported stillbirth rates are based on statistical models and vary substantially. For example, Stanton and colleagues reported a rate of 24 stillbirths per 1000 births for 1989, WHO estimated the stillbirth rate in 2000 to be 19 per 1000, and Lawn and colleagues reported a rate of nine per 1000 for 2008. The national birth defect surveillance system, which covers about 500 hospitals across the country, suggested unweighted estimates of 13·3 per 1000 between 1988 and 1992, and a decrease from 15·6 to 9·8 per 1000 between 1990 and 2001. Even less is known about the socioeconomic or obstetric determinants of stillbirths in China. Findings from two hospital-based studies published in Chinese suggest that the causes of stillbirth in China are similar to those found elsewhere, although many stillbirths remain unexplained. One large unpublished study from Zhejiang, a wealthy province in eastern China, suggested that socioeconomic disadvantage, migrant status, and absence of antenatal care were important contributing factors. The study was descriptive, however, and no crude or adjusted relative risks were provided.

Added value of this study

Our analysis presents, for the first time, an empirical estimate of the stillbirth rate in a large sample of county and provincial hospitals across China. By focusing our analysis on sociodemographic determinants and the role of gestational age and obstetric complications, we provide insights into the ways in which health interventions could contribute to further reduction of the number of stillbirths in China.

Implications of all the available evidence

Stillbirth rates are much lower than those in much of Asia, but remain higher than those in high-income countries, despite excessively high caesarean section rates in China. Strategic investments in strengthening of antenatal care for the most disadvantaged women, particularly the very young, unmarried, and illiterate, and those at high parity, are essential to further reduce stillbirth rates in China.

studies reporting population-based stillbirth rates were found.[3–5] As a result, the number of stillbirths for China was inferred from statistical models, with rates varying substantially depending on the data used to inform the models. For example, Stanton and colleagues[3] reported a rate of 24 stillbirths per 1000 births for 1989, WHO estimated the stillbirth rate in 2000 to be 19 per 1000,[6] and Lawn and colleagues[4] reported a rate of nine per 1000 for 2008.

Even less is known about the causes or determinants of stillbirths than about rates of stillbirths. Direct causes include congenital factors, maternal infection, fetal growth restriction, and placental insufficiency, but most stillbirths have no identified cause.[4,7] Obstetric complications, such as diabetes, hypertension, dystocia, or antepartum haemorrhage, increase the risk of stillbirth, but most occur in the absence of maternal disorders.[4] Authors of a systematic review[7] of risk factors for stillbirths in low-income countries showed that socioeconomic disadvantage and absence of antenatal care were important factors associated with stillbirth, but the number of studies was small and no Chinese studies were identified. Findings from hospital-based studies published in Chinese suggest that the causes of stillbirth in China are similar to those found elsewhere, although many remain unexplained.[8,9] Investigators of one large unpublished study[9] from Zhejiang province suggested that socioeconomic disadvantage, migrant status, and absence of antenatal care were important contributing factors.

In this study, we use data from nearly 4 million health facility births to calculate a stillbirth rate representative of all facility births in China and to explore sociodemographic and obstetric factors associated with variation in the stillbirth rate. Most Chinese women now give birth in health facilities, so a facility-based sample therefore captures most births in China.[10,11] By focusing our analysis on the role of gestational age and obstetric complications, we provide insights into the ways in which health interventions could contribute to a further reduction of the number of stillbirths in China.

Methods

Data sources

We used data from China's National Maternal Near Miss Surveillance System (NMNMSS) between Jan 1, 2012, and Dec 31, 2014. The NMNMSS was established in October, 2010,[12] in health facilities in the districts and counties included in the National Maternal and Child Mortality Surveillance System.[13] The National Maternal and Child Mortality Surveillance System was established

in 1996 in 116 cities and rural counties using stratified random sampling on the basis of 17 socioeconomic strata across China.[14] The National Maternal and Child Mortality Surveillance System covered 176 urban districts and rural counties in 1996. In 2006, 30 urban districts and 130 rural counties were added to increase the sample size for mortality surveillance. The National Maternal Near Miss Surveillance System covered a slightly smaller part of the National Maternal and Child Mortality Surveillance System: 326 urban districts and rural counties. Existing surveillance sites within provinces—sites selected by provincial authorities to monitor levels and causes of child and maternal mortality within the province—were stratified by region and urban or rural characteristics, and the additional districts or counties were sampled randomly within strata to ensure proportional representation of urban and rural populations across all three regions in China (eastern, central, and western). Within each of the sampled districts or counties, two health facilities with more than 1000 deliveries per year were randomly selected (or one facility if only one was available). Because some districts or counties did not have hospitals with the necessary number of births, large hospitals in urban districts were oversampled. As a result, urban populations were over-represented in the NMNMSS, particularly in central and western regions (appendix).

The NMNMSS aimed to enumerate all maternal deaths and near misses (women who nearly died from a severe complication of pregnancy or delivery) in health facilities using the same approach as that proposed by WHO's global survey on maternal and perinatal health in 2007.[15] In each of the 441 facilities sampled, data were collected for all pregnant or post-partum women admitted to obstetrics departments. Doctors responsible for patient care within each facility were trained to collect data prospectively from admission to discharge and to complete a specially designed data collection form for each woman. Data were collected for sociodemographic characteristics, obstetric history, place and method of delivery, pregnancy outcome, and complications during pregnancy or delivery, or post-partum. Definitions were those outlined in the surveillance manual,[12] and the definition of maternal near miss adhered to a standard protocol (see below).

Data were entered onto a web-based data management system, which was centralised at the National Office for Maternal and Child Health Surveillance of China. Quality assurance was ensured by county-level, municipal, and provincial Maternal and Child Health hospital staff who visited all of the selected facilities once or twice a year. The National Office for Maternal and Child Health Surveillance also visited a random sample of six to eight hospitals in each province once a year to verify the quality of the records. All quality control results are entered into the web-based system, and surveillance hospitals are asked to re-examine all of the data when errors exceed a predefined standard (eg, obstetric complications if under-reported by more than 5%, maternal deaths if under-reported by more than 1%, and maternal near misses if under-reported by more than 5%). In 2014, the provincial quality control suggested that the frequency of obstetric complications had been under-reported by 9% in surveillance hospitals in Beijing, 0·3% in those in Hubei, and 5% in those in Shaanxi. The number of maternal deaths were correct, whereas near misses were under-reported by 2% in Beijing, 6% in Hubei, and 4% in Shaanxi. The surveillance hospitals in Beijing and Hubei were asked to re-examine all of the data for 2014.

Definitions

We restricted our analysis to births of 28 completed weeks of gestation or longer or 1000 g birthweight or heavier to conform to the WHO definition of third trimester stillbirths.[4,16] We further classified stillbirths as occurring before or during labour. The gestational age in China is generally ascertained on the basis of the last menstrual period or of ultrasound when the date of the last menstrual period is not known. We selected exposure variables on the basis of factors for which the scientific literature has suggested a possible association with stillbirths, including sociodemographic characteristics (region, hospital level, place of birth, number of antenatal visits, mother's education, maternal age, and birth order), gestational age, and obstetric complications (more than one birth and maternal complications).[4,7] We used China's standard definitions for region (western, central, and eastern),[17] hospital level (level 1–3 based on the following criteria: number of beds, categories of clinical departments, numbers of medical personnel, type and quantity of equipment, and hospital funding),[18] and education (none, primary school, middle school, high school, and college or higher). We reported place of birth because some women were admitted to the study hospital after giving birth elsewhere.

See Online for appendix

We classified maternal complications hierarchically into mutually exclusive categories of maternal death, maternal near miss, antepartum or intrapartum complication, post-partum complication, medical disease, and none of the above. We based near miss on the organ failure criteria recommended by WHO.[19] Antepartum or intrapartum complications were ruptured uterus, placenta praevia, abruptio placentae, unspecified antepartum haemorrhage, chronic hypertension, gestational hypertension, pre-eclampsia, eclampsia, HELLP syndrome, or any fetal malpresentation (breech, shoulder, or other). Post-partum complications were lacerations, uterine atony, retained placenta, puerperal infection, and caesarean wound infection. Medical diseases were heart disease, embolism or thrombophlebitis, hepatic disease, severe anaemia (haemoglobin concentration of <700 g/L), renal disease (including urinary tract infection), lung disease (including upper respiratory tract infection), HIV/AIDS, connective tissue disorders, gestational diabetes mellitus, and cancer.

Statistical analysis

We first examined the strength of association between sociodemographic characteristics and stillbirths. We used logistic regression, taking account of the sampling strategy and clustering of births within hospitals and in cases of more than one birth per woman, using the PROC SURVEYLOGISTIC procedure in SAS. We investigated both multicollinearity and model goodness-of-fit to identify the most robust and stable model. We took sampling into account by weighting the data against the probability of each individual to be included in the sample in each region and rural or urban area (appendix). We did not weigh the data against the probability of each hospital to be included because we did not know the distribution of hospitals doing deliveries in each region and urban or rural area. We report crude odds ratios (ORs) with 95% CIs and ORs adjusting for sociodemographic characteristics.

We then examined the association between obstetric complications and stillbirths using the same approach. We did not adjust this analysis for gestational age or method of delivery because we deemed both to be on the causal pathway.

Last, we examined the strength of association between gestational age and stillbirths using two measures of gestational-age-specific stillbirth rates: stillbirths per 1000 births and stillbirths per 1000 fetuses at risk.[20,21] We compared stillbirths per 1000 births using logistic regression and stillbirths per 1000 fetuses at risk of stillbirth using the Woolf method. To understand the distribution of stillbirths by gestational age and maternal complications, we examined the proportion of livebirths and stillbirths in each gestational age and complication group. We tested for an interaction between gestational age and maternal complications, comparing the stillbirth rates at birth for each gestational age and complication group against that in babies born at 37–41 weeks' gestation without complications. We did statistical analyses with SAS 9.3 software and drew graphs with SPSS 16.0 software.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. JZ, JL, YM, and DM had full access to all the data in the study. CR had full access to a random sample of the data in the study and worked alongside YM for analysis of the full dataset. DM and CR had final responsibility for the decision to submit for publication.

Results

3 956 836 births and 37 855 stillbirths occurred at 28 completed weeks of gestation or longer or 1000 g birthweight or heavier in the 441 health facilities that were part of the National Maternal and Child Mortality Surveillance System in China between 2012 and 2014, giving a weighted stillbirth rate of 8·8 per 1000 births

	Number of births	Stillbirths per 1000 births*	Crude odds ratio*†	Adjusted odds ratio*†‡
Region				
East	1 153 754 (29·2%)	7·8 (8984)	1	1
Central	1 575 226 (39·8%)	8·5(14 969)	1·10 (0·90–1·36)	0·95 (0·77–1·17)
West	1 227 856 (31·0%)	10·5 (13 902)	1·36 (1·12–1·66)	1·17 (0·95–1·45)
Hospital level				
Level 1	287 641 (7·3%)	6·2 (1760)	0·81 (0·60–1·08)	0·76 (0·57–1·02)
Level 2	1 890 979 (47·8%)	7·6 (14257)	1	1
Level 3	1 582 053 (40·0%)	12·1 (20200)	1·59 (1·34–1·88)	1·54 (1·20–1·98)
Unknown	196 163 (5·0%)	7·7 (1638)	1·01 (0·73–1·41)	1·07 (0·79–1·43)
Place of birth				
Provincial hospital	1 938 973 (49·0%)	11·6 (23168)	1·60 (1·37–1·87)	1·86 (1·48–2·33)
County hospital	2 009 241 (50·8%)	7·3(14362)	1	1
Township hospital	1735 (<0·1%)	28·8 (55)	4·05 (2·87–5·71)	2·25 (1·61–3·15)
Home	6035 (0·2%)	34·9(235)	4·93 (4·10–5·92)	2·17 (1·72–2·72)
Other	641 (<0·1%)	46·8 (28)	6·71 (4·26–10·55)	3·54 (2·15–5·82)
Missing	211 (<0·1%)	28·9 (7)	4·06 (1·60–10·26)	3·44 (1·39–8·49)
Antenatal visits				
None	76 427 (1·9%)	38·3 (3165)	14·09 (9·52–20·86)	14·97 (11·54–19·40)
1–3	351 784 (8·9%)	26·7(10260)	9·72 (7·68–12·31)	11·32 (9·37–13·68)
4–6	1 340 309 (33·9%)	8·4(13496)	3·01 (2·42–3·75)	4·02 (3·38–4·78)
7–9	1 118 863 (28·3%)	4·8 (6056)	1·72 (1·48–2·00)	1·95 (1·71–2·22)
≥10	964 908 (24·4%)	2·8 (2956)	1	1
Missing	104 545 (2·6%)	15·7 (1922)	5·64 (4·07–7·83)	5·26 (4·05–6·83)

(Table 1 continues on next page)

	Number of births	Stillbirths per 1000 births*	Crude odds ratio*†	Adjusted odds ratio*†‡
(Continued from previous page)				
Mother's education				
None	23 522 (0·6%)	26·9 (702)	4·44 (3·57–5·51)	1·75 (1·45–2·12)
Completed primary school	153 122 (3·9%)	16·3 (2828)	2·65 (2·24–3·14)	1·44 (1·24–1·68)
Completed middle school	1 452 828 (36·7%)	9·1 (14788)	1·47 (1·26–1·71)	1·22 (1·08–1·39)
Completed high school	1 037 953 (26·2%)	9·1 (10596)	1·47 (1·30–1·67)	1·25 (1·09–1·43)
College or higher	1 199 494 (30·3%)	6·2 (7837)	1	1
Missing	89 917 (2·3%)	10·5 (1104)	1·69 (0·77–3·73)	1·35 (0·94–1·92)
Marital status				
Married	3 894 830 (98·4%)	8·5 (35716)	1	1
Single, widowed, or divorced	61 088 (1·5%)	32·5 (2122)	3·94 (2·93–5·30)	2·34 (1·82–3·03)
Missing	918 (<0·1%)	16·6 (17)	1·99 (0·93–4·25)	1·23 (0·60–2·52)
Mother's age (years)				
≤15	2308 (0·1%)	59·9 (164)	9·25 (7·24–11·82)	4·29 (3·45–5·34)
16–17	19 179 (0·5%)	33·6 (735)	5·04 (4·23–6·02)	2·63 (2·27–3·04)
18–19	72 615 (1·8%)	17·4 (1424)	2·58 (2·29–2·90)	1·59 (1·43–1·77)
20–24	856 651 (21·6%)	8·5 (8306)	1·24 (1·18–1·31)	1·12 (1·06–1·18)
25–29	1 617 262 (40·9%)	6·8 (12049)	1	1
30–34	872 953 (22·1%)	8·1 (7475)	1·19 (1·14–1·25)	1·10 (1·05–1·15)
35–39	291 237 (7·4%)	11·7 (3614)	1·72 (1·64–1·82)	1·33 (1·25–1·41)
40–44	68 068 (1·7%)	18·1 (1265)	2·68 (2·48–2·89)	1·72 (1·58–1·87)
45–49	4556 (0·1%)	24·1 (108)	3·59 (2·84–4·54)	2·01 (1·59–2·55)
Missing	152 007 (3·8%)	17·0 (2715)	2·51 (1·73–3·65)	1·78 (1·19–2·65)
Birth order				
1	2 519 133 (63·7%)	7·8 (21251)	1	1
2	1 220 082 (30·8%)	9·2 (12628)	1·18 (1·12–1·24)	1·01 (0·95–1·06)
3	181 668 (4·6%)	15·7 (3116)	2·01 (1·83–2·21)	1·34 (1·24–1·46)
≥4	33 970 (0·9%)	23·2 (828)	3·00 (2·64–3·40)	1·54 (1·35–1·75)
Missing	1983 (0·1%)	13·5 (32)	1·74 (0·97–3·12)	1·30 (0·95–1·78)
All	3 956 836 (100·0%)	8·8 (37855)	..	..

Data in parentheses are % of births, number of stillbirths, or 95% CIs. *Adjusted for sampling distribution of population. †Adjusted for clustering of births within hospitals and women with more than one birth. ‡Adjusted for all other factors in the table.

Table 1: **Association between sociodemographic characteristics and stillbirths in China (2012–14)**

	Number of births	Stillbirths per 1000 births*	Crude odds ratio*†	Adjusted odds ratio*†‡
More than one gestation				
Yes	133 454 (3·4%)	24·0 (3342)	2·91 (2·59–3·28)	1·64 (1·45–1·85)
No	3 823 000 (96·6%)	8·4 (34 486)	1	1
Missing	382 (0·1%)	84·4 (27)	11·00 (5·53–21·89)	6·69 (3·17–14·09)
Maternal complication				
Maternal death	343 (<0·1%)	182·1 (68)	31·62 (23·44–42·63)	14·98 (10·53–21·29)
Maternal near miss	26 949 (0·7%)	53·8 (1346)	8·06 (5·25–12·36)	5·04 (3·82–6·66)
Antepartum or intrapartum complication	335 462 (8·5%)	26·9 (9533)	3·91 (3·66–4·18)	3·13 (2·94–3·34)
Post-partum complication	74 352 (1·9%)	7·6 (599)	1·08 (0·90–1·31)	1·09 (0·91–1·30)
Medical disease	174 688 (4·4%)	7·2 (1289)	1·02 (0·91–1·14)	1·11 (1·01–1·23)
None of the above	3 345 042 (84·5%)	7·0 (25 020)	1	1
All	3 956 836 (100·0%)	8·8 (37 855)	..	..

Data in parentheses are % of births, number of births, or 95% CIs. *Adjusted for sampling distribution of population. †Adjusted for clustering of births within hospitals and women with more than one birth. ‡Adjusted for all factors in table 1.

Table 2: **Association between obstetric complications and stillbirths in China (2012–14)**

(95% CI 8·8–8·9). When we weighed the data by the national distribution of level 1, 2, and 3 hospitals irrespective of whether they offer obstetric care (data not shown), the stillbirth rate was 8·1 per 1000 births (8·0–8·2). 7761 stillbirths (20·5%) occurred during labour and 30 094 (79·5%) occurred before labour. Table 1 describes the sociodemographic characteristics of all births. Nearly all women gave birth in a provincial or county hospital, more than half of all women had received seven or more antenatal visits, very few women had not attended school or only attended primary school, and most women were married. About a third of women gave birth to a second-order or higher-order child.

The association between sociodemographic characteristics and stillbirths was strong. The few women who delivered in a township hospital or at home were more than twice as likely to have a stillbirth than were those giving birth in a county hospital. The association between the number of antenatal visits and stillbirths was particularly strong. For example, women with one to three antenatal visits were 11 times more likely to have a stillbirth than were those with ten or more visits, whereas women with four to six visits had a four times greater risk. Education and marital status were strongly associated with stillbirths in the crude analysis, but these effects were attenuated after adjustment for other sociodemographic factors. Very young mothers were at greatly increased risk of stillbirth compared with women aged 25–29 years. The risk of stillbirth increased by birth order.

The association between obstetric complications and stillbirths is shown in table 2. The maternal mortality ratio was 8·7 per 100 000 births of 28 weeks' gestational age or older or a birthweight of 1000 g or heavier (inclusion of the 45 maternal deaths in low-birthweight or low-gestational age groups increased the maternal mortality ratio to

	Number of births	Number of stillbirths	Birth-based analysis		Fetuses at risk-based analysis		
			Stillbirths per 1000 births *	Crude odds ratio*†	Number of fetuses at risk	Stillbirths per 1000 fetuses at risk*	Crude risk ratio*
Gestational age (weeks)							
<28‡	8407 (0·2%)	6179 (16·3%)	752·1	1400·51 (1152·94–1701·24)	3 942 300	1·6	0·73(0·71–0·75)
28–29	17 356 (0·4%)	6426 (17·0%)	380·7	283·67 (253·01–318·06)	3 933 893	1·4	0·67(0·65–0·70)
30–31	26 042 (0·7%)	5420 (14·3%)	218·8	129·27 (115·66–144·49)	3 916 537	1·2	0·58(0·56–0·60)
32–33	46 689 (1·2%)	4930 (13·0%)	111·3	57·80 (51·64–64·70)	3 890 495	1·1	0·52(0·51–0·54)
34–36	222 981 (5·6%)	6364 (16·8%)	28·6	13·59 (12·80–14·43)	3 843 806	1·5	0·69(0·67–0·72)
37–41	3 578 870 (90·4%)	7995 (21·1%)	2·2	1	3 620 825	2·1	1
≥42	41 955 (1·1%)	200 (0·5%)	4·2	1·96 (1·67–2·30)	41 955	4·2	1·98(1·73–2·28)
Missing	14 536 (0·4%)	341 (0·9%)	21·1	9·95 (5·21–19·00)	..	..	..
All	3 956 836 (100·0%)	37 855 (100·0%)	8·8	..	3 956 836	8·8	..

Data in parentheses are % or 95% CIs. *Adjusted for sampling distribution of population. †Adjusted for clustering of births within hospitals and women with more than one birth. ‡Because some babies born with a birthweight of 1000 g or heavier had a gestational age of younger than 28 weeks, a very small number of babies were born at gestations younger than 28 weeks.

Table 3: **Association between gestational age and stillbirths in China (2012–14)**

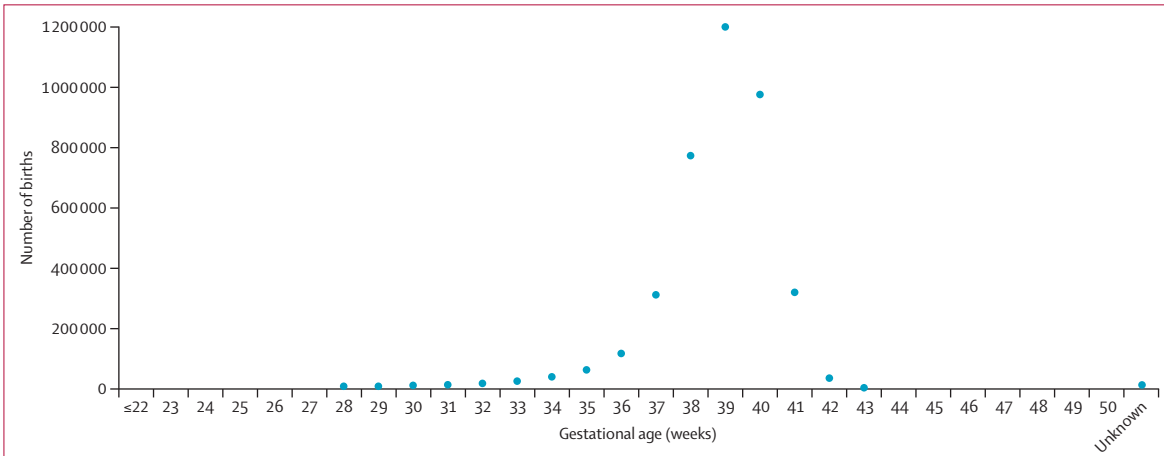

Figure 1: **Distribution of births by gestational age in China (2012–14)**

9·8 per 100 000). Nearly half (1 867 716 [47·2%] of 3 956 836) of all births were by caesarean section, and births by caesarean section had much lower stillbirth rates than did vaginal births (3·1 per 1000 births compared with 15·3 per 1000; OR 0·19 [95% CI 0·19–0·20]). Maternal deaths, near misses, and antepartum or intrapartum complications were associated with substantially increased risks of stillbirth.

The prevalence of preterm birth (less than 37 weeks' gestation) was 321 475 (8·1%) of 3 956 836 (table 3). The weighted prevalence of preterm birth was 276 800 (7·1%) of 3 872 390. More than two thirds (69·4%) of preterm births occurred at gestational ages of 34–36 weeks (figure 1, table 3). Gestational age at birth was strongly associated with stillbirths: nearly all babies born at less than 28 weeks' gestation were stillborn, and babies born at 34–36 completed weeks of gestation sustained substantially increased risks. With use of all fetuses at risk of stillbirth in the denominator, the risk of stillbirth was low at each gestational age, peaking at gestational ages of 42 weeks or older (table 3).

The proportion of livebirths and stillbirths and the stillbirth rates by maternal complications and gestational age at birth are shown in table 4 and figure 2. A

	<32 weeks' gestation	32–36 weeks' gestation	37–41 weeks' gestation	≥42 weeks' gestation
Number of livebirths				
Maternal death or near miss	1283 (<0·1%)	6532 (0·2%)	17 789 (0·5%)	119 (<0·1%)
Antepartum or intrapartum complication	11 055 (0·3%)	66 705 (1·7%)	245 309 (6·3%)	1690 (<0·1%)
Post-partum complication	613 (<0·1%)	4710 (0·1%)	67 317 (1·7%)	813 (<0·1%)
Medical disorder	1462 (<0·1%)	13 606 (0·3%)	157 121 (4·0%)	841 (<0·1%)
None of the above	19 367 (0·5%)	166 823 (4·3%)	3 083 339 (79·0%)	38 292 (1·0%)
Number of stillbirths				
Maternal death or near miss	534 (1·4%)	530 (1·4%)	330 (0·9%)	2 (<0·1%)
Antepartum or intrapartum complication	4784 (12·8%)	3002 (8·0%)	1638 (4·4%)	34 (<0·1%)
Post-partum complication	229 (0·6%)	203 (0·5%)	156 (0·4%)	10 (<0·1%)
Medical disorder	449 (1·2%)	444 (1·2%)	378 (1·0%)	4 (<0·1%)
None of the above	12 029 (32·1%)	7115 (19·0%)	5493 (14·6%)	150 (0·4%)
Stillbirths per 1000 births*				
Maternal death or near miss	300·9	80·7	21·3	16·8
Antepartum or intrapartum complication	316·6	44·0	6·6	18·3
Post-partum complication	289·6	41·9	2·3	10·9
Medical disorder	243·8	31·8	2·4	3·4
None of the above	404·9	41·0	1·7	3·5
Crude odds ratio*†				
Maternal death or near miss	249·23 (207·85–298·85)	50·85 (41·68–62·04)	12·63 (7·22–22·09)	9·92 (2·42–40·64)
Antepartum or intrapartum complication	268·23 (238·17–302·08)	26·65 (24·58–28·89)	3·88 (3·58–4·20)	10·78 (7·28–15·96)
Post-partum complication	236·02 (181·87–306·30)	25·30 (20·30–31·52)	1·33 (1·06–1·68)	6·39 (3·11–13·15)
Medical disorder	186·66 (156·63–222·46)	19·00 (16·49–21·88)	1·42 (1·24–1·64)	1·99 (0·68–5·81)
None of the above	393·95 (342·87–452·63)	24·75 (22·89–26·76)	1	2·01 (1·68–2·41)
Adjusted odds ratio*†‡				
Maternal death or near miss	194·71 (163·02–232·55)	46·16 (38·15–55·85)	13·13 (8·58–20·09)	6·45 (1·46–28·45)
Antepartum or intrapartum complication	221·31 (197·51–247·96)	25·70 (23·59–28·00)	3·96 (3·66–4·29)	7·84 (5·28–11·65)
Post-partum complication	198·45 (151·96–259·16)	24·46 (19·75–30·29)	1·45 (1·15–1·81)	5·07 (2·41–10·66)
Medical disorder	171·13 (144·92–202·07)	20·56 (17·91–23·59)	1·80 (1·57–2·06)	1·65 (0·57–4·83)
None of the above	306·57 (272·27–345·18)	22·52 (20·88–24·29)	1	1·63 (1·37–1·95)

Data in parentheses are % or 95% CIs. Births with missing gestational age are excluded. *Adjusted for sampling distribution of population. †Adjusted for clustering of births within hospitals and women with more than one birth. ‡Adjusted for all factors in table 1.

Table 4: **Association between gestational age at birth and maternal complications and stillbirths in China (2012–14)**

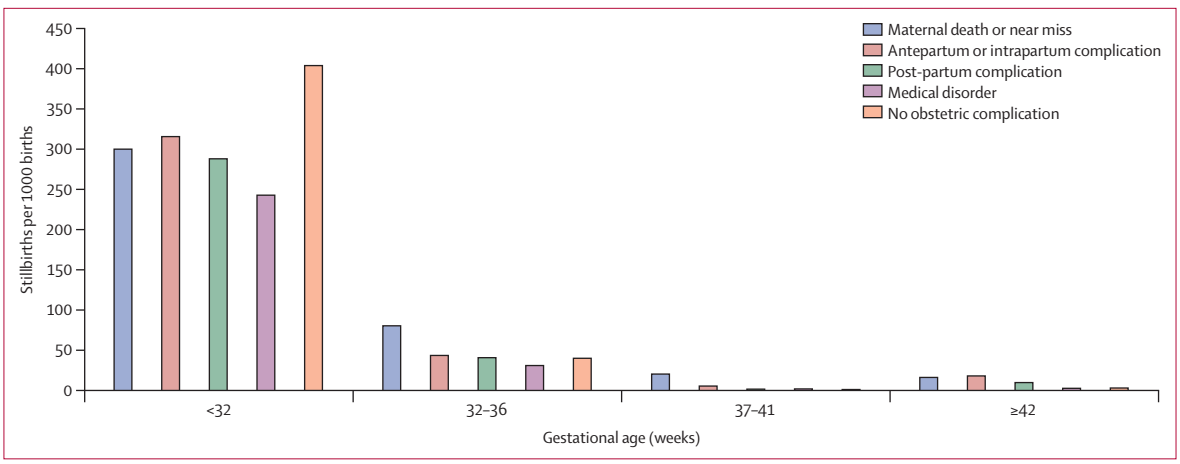

Figure 2: **Stillbirth rates by obstetric complication and gestational age at birth in China (2012–14)**

high proportion (3 083 339 [79·0%] of 3 904 786) of livebirths occurred at normal gestations of 37–41 weeks in women without maternal complications. A high proportion (29 319 [78·2%] of 37 514) of stillbirths occurred at gestational age of younger than 37 weeks, but about two thirds (24 787 [66·1%] of 37 514) of all stillbirths were in women without reported complications (table 4). The interaction between gestational age and maternal complications was significant (p<0·0001). The stillbirth rate was extremely high in babies born at younger than 32 weeks or 32–36 weeks' gestation, irrespective of whether the mother had experienced a maternal complication. Of babies born at 37–41 weeks' gestation, the risk of stillbirth was about 13 times higher in women who died or experienced a near miss and about four times higher in those with an antepartum or intrapartum complication than in those with no maternal complications. The prevalence of maternal complications was 611 794 (15·5%) of 3 956 836 births.

Discussion

Our finding of a stillbirth rate of 8·8 per 1000 births needs careful scrutiny, particularly because births in the selected hospitals may not represent all hospital births in China. Very few data sources exist for stillbirths in China, but the national birth defect surveillance system, which covers about 500 hospitals across the country, suggested unweighted estimates of 13·3 stillbirths per 1000 births between 1988 and 1992,[22] and a decline from 15·6 to 9·8 per 1000 between 1990 and 2001.[23] The NMNMSS oversampled large referral hospitals in urban districts, where stillbirth rates were higher than in smaller hospitals. Weighting of the data by the population distribution in urban districts and rural counties in each region accounted for the NMNMSS's oversampling of urban districts, but whether this weighting adjusted fully for the oversampling of large hospitals is not known. The stillbirth rate of 8·1 per 1000 births when we weighed the data by national distribution of level 1, 2, and 3 hospitals irrespective of whether they offer obstetric care would have biased the stillbirth rate downward because low-level hospitals would have been over-represented and Chinese women increasingly give birth in high-level county and provincial hospitals.[24]

The facility-based stillbirth rate reported in this study is very close to the rates of 9·0 per 1000 births estimated for China nationally in 2008[4] and 10·4 per 1000 in 2009.[25] Nearly all women in urban and rural China now give birth in hospital, but a small proportion still give birth at home, particularly in remote regions.[10,11] No estimates exist of stillbirth rates in home births, but these rates can be reasonably inferred to be higher than in hospital births from the higher neonatal mortality in babies born at home.[14] Assuming that the stillbirth rate in those giving birth at home is three times that reported in this study and that 4% of the population gives birth at home,[11] the adjusted stillbirth rate would be 9·5 per 1000 births, a slight increase from the 8·8 per 1000 estimated in this study. Annually, this result represents close to 150 000 stillbirths in China, similar to the yearly number of neonatal deaths.[14]

The stillbirth rate in China is higher than that in high-income countries—where rates typically range from two to four per 1000 births—but much lower than that in southeast (14·2 per 1000 in 2008) and south (26·7 per 1000 in 2008) Asia.[4] Stillbirth rates show the strength of the health system and are associated with neonatal and maternal mortality.[4,26] China has made remarkable progress in reduction of maternal and neonatal mortality, largely because of substantial investments in skilled health personnel and removal of financial barriers that made birth in health facilities accessible and safe.[10,14,27] As in high-income countries, intrapartum stillbirths have become less common and most stillbirths occur at earlier gestations in the absence of maternal complications. In such settings, further prevention of stillbirths needs high-quality antenatal care, with early detection and management of hypertension,

infection, fetal growth restriction, and twins and triplets.[28] The Chinese Government recommends five or more antenatal visits in rural areas and eight or more in urban areas. Antenatal care in primary care institutions is free of cost and uptake is high,[11] although some—particularly illiterate and ethnic minority women—might visit very late in pregnancy.[29] Abdominal ultrasound is common,[29] although its quality and the quality of antenatal care in general are not known. Detection and treatment of syphilis in pregnancy, for example, is substandard, and congenital syphilis is thought to be on the rise.[30]

As expected, obstetric complications were associated with an increased risk of stillbirth,[4,31] although about two thirds of all stillbirths were in women without reported maternal complications. The prevalence of maternal complications was similar to the estimates from the WHO global survey for China,[31] but was low compared with that reported in other studies.[32] The maternal mortality ratio is lower than the 21·7 stillbirths per 100 000 livebirths reported by the National Maternal and Child Mortality Surveillance System for 2014.[33] This discrepancy is due to various factors: the fact that we excluded deaths at home or in low-level facilities and that we only recorded deaths in women who were admitted to the obstetrics department of the surveillance facilities (eg, we did not include women dying in intensive care or other departments). WHO's definition of near miss is extremely stringent, and the prevalence of near miss falls within the range reported by WHO.[34] Unfortunately, WHO's near-miss definition does not capture obstructed or prolonged labour,[31] and even though we recorded fetal malpresentation, many cases of dystocia will have been missed. The very low stillbirth rate in babies born by caesarean section should not be interpreted as implying that caesareans prevent stillbirths because few women with an antepartum stillbirth would have had their baby delivered by caesarean section, thereby artificially lowering stillbirth rates in those born by caesarean section. The low stillbirth rates in high-income countries are achieved with substantially lower caesarean section rates than in China, supporting the view that caesarean section rates far exceeding 20% are not conducive to low stillbirth rates.[26]

The prevalence of preterm birth of 7·1% of all births in our sample is similar to rates reported elsewhere.[35] We were unable to separate spontaneous preterm births from those for which labour was induced, and the high stillbirth rates in preterm births will be, in part, due to labour being induced after a stillbirth has been diagnosed, rather than vice versa. More than two thirds of preterm births occurred at 34–36 weeks' gestation, but investigators of very few studies have examined the survival of newborns by gestational age.[36,37] As with stillbirths, a clear knowledge gap exists for preterm births in China, and research into its burden, determinants, and effects is urgently needed.

The NMNMSS was designed to enumerate maternal deaths and near misses rather than stillbirths, so data and analytical limitations need to be acknowledged. First, stillbirths in China are defined as the death of a fetus at or after 28 completed weeks of gestation. However, this gestational age cutoff is similar to the one suggested by WHO, and addition of the 1000 g or heavier birthweight criterion makes our definition conform to the WHO definition.[4,16] Second, women with missing information about sociodemographic or obstetric factors had substantially higher stillbirth rates than did those with data available, suggesting that they were a particularly susceptible group. Few data were missing, however, and we included those who did have missing data in the overall stillbirth rate to avoid bias. Third, we did not have data for ethnic composition or place of registration of the household, so we might therefore not have fully accounted for all sociodemographic factors in our analysis. Fourth, complications in pregnancy are prone to bias, particularly if no clear definitions are given,[32] and we might have underestimated the contribution of obstetric complications. The surveillance did not identify fetal contributions, which is a common problem in stillbirth studies.[4] Finally, the two measures of gestational age-specific stillbirth rates that we report convey distinct messages that need different interpretations.[20,21] If one considers a pregnant woman at a particular gestational age, the risk of stillbirth only increases at gestational ages of 42 weeks or older. Conversely, if one considers a woman who is giving birth at a particular gestational age, the odds of stillbirth decrease with gestational age and most stillbirths occur at early gestations, irrespective of whether the mother had a complication. Unfortunately, we were not able to stratify the fetus-at-risk analysis by maternal complications because maternal complications were only recorded around the time of labour or delivery, or post partum.

The Chinese Government's strategic investments in maternal and neonatal health has no doubt contributed to a substantial reduction in the number of stillbirths, and the low stillbirth rate adds further credence to the government's strategic choice in strengthening of facility-based antenatal and delivery care. Stillbirth rates are much lower than those in much of Asia, but remain higher than those in high-income countries, despite excessively high caesarean section rates in China. Much more can be done, particularly in strengthening of antenatal care for the most disadvantaged women, namely, the very young, unmarried, and illiterate, and those at high parity. The annual number of stillbirths equals the annual number of neonatal deaths in China,[14] yet stillbirths do not feature in the government's 5 year plan for development of health[38] or National Programme of Action for women and children.[39] Most information systems do not include stillbirths, and data, where available, are not used. The time has come for the government to start paying attention to stillbirths and invest strategically to reduce its burden.

Contributors

JZ, JL, YM, DM, and CR designed the study with contribution from all authors. YM did the statistical analysis with support from XL and CR. CR wrote the first draft of the paper and all authors contributed to

critical interpretation of the results and development of the report. All authors saw and approved the final version.

Declaration of interests

We declare no competing interests.

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