ORIGINAL ARTICLES

The Quality and Completeness of 2008 Perinatal and Under-five Mortality Data from Vital Registration, Jamaica

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ABSTRACT

Objective: *To evaluate the completeness and timeliness of registration of stillbirths and under-five deaths and the validity of the certification and coding process.*

Subjects and Methods: *Registered stillbirths and under-five deaths occurring in 2008 were compared to hospital, police, forensic pathologist and coroner's records. Missed cases and new information such as birthweight, gestation and date of birth were added to the database. A 10% random sample was evaluated to measure the quality of certification and coding.*

Results: *Of 646 stillbirths [≥ 1000 g] and 933 under-five deaths, 69% and 79%, respectively were registered by December 31, 2009, for inclusion in the 2008 final demographic returns. Non-reporting of stillbirths was associated with infant gender, region and place of death [seven of 21 public hospitals accounted for 96% of unregistered stillbirths). Among under-five deaths, age at death, region, place and cause of death were important. Injury and community deaths increased with age. Registration delays including non-registration were associated with coroner's inquests. Most (80%) stillbirth certificates lacked usable cause of death data. Neonatal deaths due to prematurity and perinatal asphyxia were often misclassified by coders. The stillbirth (≥ 1000 g), infant and under-five mortality rates were 15, 20 and 22/1000 births/live births, respectively.*

Conclusions: *While registration of stillbirths and under-five deaths improved between 1998 and 2008, persistent under-reporting reduced official rates by 20–31%. A new perinatal death certificate documenting maternal and fetal causes of death and risk factors such as birthweight, gestation and age at death would improve stillbirth and neonatal death (0–28 days) data quality.*

Keywords: Infant mortality, perinatal mortality, stillbirths, under-five mortality

Calidad y Exhaustividad de los Datos sobre Mortalidad Perinatal y Muerte de Menores de Cinco Años Según el Registro Civil de Jamaica en el Año 2008

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RESUMEN

Objetivo: *Evaluar la exhaustividad y puntualidad del registro de nacidos muertos y las muertes de menores de cinco años, así como la validez de la certificación y el proceso de codificación.*

Sujetos y método: *Los datos sobre los niños nacidos muertos y las muertes de menores de cinco años fueron comparados con los registros provenientes de hospitales, policía, patólogo forense, y servicio forense. Casos perdidos y nuevas informaciones, tales como fechas de nacimiento, gestación y peso al nacer, fueron añadidos a la base de datos. Una muestra aleatoria del 10% fue evaluada para medir la calidad de la certificación y la codificación.*

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Resultados: *De 646 mortinatos [≥ 1000 g] y 933 muertes de niños menores de cinco años, 69% y 79% respectivamente, estaban registrados ya el 31 de diciembre de 2009, para su inclusión en los informes demográficos finales de 2008. Ninguno de los reportes sobre mortinatos estuvo asociado con el género del infante, la región, y el lugar de la muerte (siete de los 21 hospitales públicos representaron el 96% de los mortinatos no registrados). Entre las muertes de menores de cinco años, la edad en el momento de la muerte, la región, el lugar y la causa de la muerte fueron importantes. Las lesiones y las muerte en la comunidad aumentaron con la edad. Las demoras en los registros incluyendo la falta de registro, estuvieron asociadas con investigaciones forenses. La mayor parte de los certificados de muerte fetal (80%) carecía de datos útiles sobre las causas de muerte. Las muertes neonatales por prematuridad y por asfixia perinatal fueron a menudo mal clasificadas por los codificadores. Las tasas de mortalidad de mortinatos (≥ 1000 g), lactantes, y menores de cinco años, fueron 15, 20 y 22 por cada 1000 nacimientos/ nacidos vivos, respectivamente.*

Conclusiones. *Si bien el registro de nacidos muertos y las muertes de niños menores de cinco años mejoró entre 1998 y 2008, el persistente subregistro redujo las tasas oficiales en un 20 – 31%. Un nuevo certificado de muerte perinatal que documente las causas maternas y fetales de muerte, así como los factores de riesgo, tales como el peso al nacer, gestación y edad al morir, mejoraría la calidad de los datos sobre las muertes de mortinatos y neonatos (0 – 28 días).*

Palabras claves: Mortalidad infantil, mortalidad perinatal, mortinatos, mortalidad de menores de cinco años

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INTRODUCTION

Stillbirth (SB) and under-five (U-5) mortality are sensitive indicators of social and economic development. Risks are highest in the perinatal period beginning at 22 weeks gestation (154 days) when the fetus is potentially viable and weighs around 500 g, up to seven completed days after birth. The World Health Organization (WHO) recommends registering at birth all fetuses and infants weighing ≥ 500 g. However, to ensure cross-country comparability, international indicators should be restricted to fetuses and infants ≥ 1000 g [28 completed weeks] (1). Certifiers nonetheless often decide if and how perinatal outcomes among marginal infants are reported, especially babies weighing < 1500 g who are stillborn or die soon after birth (2, 3). Variable certification and registering of perinatal, infant and U-5 deaths affect the validity and reliability of official data generated by vital registration systems (VRS).

While young child survival is a clear global initiative, SB reduction is not among the Millennium Development Goals despite an annual global incidence of 2.64 million SBs (4) which is similar to the 2.8 million neonatal deaths (NNDs). Stillbirths share many determinants common to neonatal and maternal deaths. In deriving global SB estimates, if a country's vital maternal mortality data were not acceptable, vital SB data were rejected by the United Nations (UN) Inter-Agency Group for Child Mortality Estimation (IGME). Their estimated global stillbirth rate (SBR) for 2008 was 19.1/1000 births and it was 9.4/1000 for Latin America and the Caribbean [LAC] (4, 5) [Table 2]. The prevalence of intrapartum SBs is a quality indicator. These averaged 45% worldwide, 23% in LAC but was < 14% in high-income countries (5). Among infant deaths, the relative distribution among early neonatal (0–6 days), late neonatal (7–28 days) and postneonatal (1–11 months) deaths can indicate where to target programme interventions. High prevalence of early NNDs (ENNDs) suggests focussing on antenatal and intrapartum services while late NNDs reflect on neonatal care quality. If post-NNDs predominate, control of infectious diseases, weaning disorders and unintentional injuries are required. The overall under-five mortality rate (U-5MR) summarizes a child's chances of surviving their first five years of life.

Vital registration: global practice

A well-functioning VRS with high coverage (> 90% of events registered on time) is the gold standard for generating reliable demographic data on fertility, mortality and causes of death. Such systems establish legal identity records, track changes in civil status and provide public health data for policy and planning (6). At the dawn of the 21st century, vital data were only available for one-third of global deaths (7), ranging from 96% and 80% of deaths in high and upper-middle income countries, respectively to only 9% and 2% in lower-middle and low income countries (8–10). In the Netherlands, perinatal deaths were more likely to not get registered than late NNDs (2). In Mexico, 23% of U-5 deaths were not registered (11), while in Thailand, 26% of infant and 61% of deaths among 1–4-year olds were not registered (12). Active surveillance in Kenya found that 51% of NNDs were not registered (13). The Child Health Epidemiology Reference Group (CHERG) has called for NND reviews due to under-reporting compared to deaths in older children (14).

Mortality data quality depends on timely submission, adequate coverage, completeness and validity, with a major qualitative determinant being the extent to which doctors understand International Classification of Diseases (ICD-10)

rules for completing medical certificates of cause of death (MCCD). At minimum, MCCDs should document the underlying cause of death (UCOD), that condition initiating the train of morbid events leading to death (1). *Timeliness* standards established by Jamaica's Vital Statistics Commission [VSC] (15) require that data are available for analysis and dissemination within three months of death, but not later than March 31 the following year to generate provisional estimates for the prior year. Jamaican estimates are updated only once, 12 months later. Thus a 2008 vital event, *eg* birth, stillbirth or death, registered after March 31, 2010, will not be reflected in national demographic statistics. *Completeness* measures the per cent of registered medically certified deaths while *coverage* speaks to what proportion of the population gets accounted for. Uncertified deaths and those without a valid ICD-10 COD are not complete registrations and registration delays affect a database's completeness. Certification and coding *validity* is measured by the proportion of deaths coded to ill-defined or improbable conditions or garbage codes. Garbage coded conditions include deaths coded to signs, symptoms or ill-defined conditions and intermediate or immediate causes but lacking a UCOD. In 2010, WHO reported high variability in Caribbean mortality data quality, with four databases rated as low quality, suggesting that either < 70% deaths were registered and/or > 20% of deaths were certified to garbage coded conditions [Table 1] (8, 9).

If countries lack complete vital data, international research groups such as the Institute for Health Metrics and Evaluation [IHME] (18), the UN IGME (19) and CHERG (20) use statistical models to predict indicators from social and economic data. They draw on population surveys such as the United Nations Children's Fund (UNICEF) Multiple Indicator Cluster Surveys (MICS), in which Jamaica has participated since 1995 (21). These estimates, however, may not provide the detail necessary to influence routine programmatic decision-making.

Global U-5MRs in 2010 were 57/1000 live births (LB) and 23/1000 LB in LAC. Leading causes of U-5 mortality worldwide included serious infections [pneumonia, sepsis, meningitis; 25%], diarrhoeal diseases (15%), preterm birth complications (12%) and birth asphyxia (9%). Regional and country level causes varied considerably, with serious infections (17%), preterm births (17%) and injuries (16%) important in the Americas region (20). Globally, 44% of U-5 deaths (51% in LAC) occur in the neonatal period (19), with around half of NNDs occurring in the first week of life (22). The leading causes of global NNDs were preterm birth (35%), birth asphyxia (23%), and neonatal infections [sepsis, pneumonia, meningitis; 27%] (23). As U-5MRs declined, NNDs constituted an increasing fraction of these deaths.

Stillbirth and death registration completeness: Jamaica

Jamaica is an upper middle income country (10) with well-developed public health services for mothers and children. These are managed by four regional health authorities, combining three to four administrative areas or parishes.[1] Of the 2.7 mil-

Table 1: Quality of international mortality database, and rating of Caribbean countries

Data quality rating	**Rating criteria**		**Countries reporting mortality data to WHO**		**Caribbean countries and their World Bank economic classification** (order by economic classification)
	Completeness	Ill-defined ICD codes	Countries (%) worldwide	Countries (%) in the Americas	
High	≥ 90%	< 10%	34 (18%)	13 (37%)	Bahamas[a] Barbados[a] Cuba[b] Dominica[b] St Vincent and the Grenadines[b] Trinidad and Tobago[a]
Medium	70–90%	10–20%	47 (24%)	13 (37%)	Antigua and Barbuda[a] Dominica[b] Grenada[b] St Lucia[b] St Kitts and Nevis[b] Suriname[b] Belize[c]
Low	< 70%	> 20%	38 (20%)	7 (20%)	Dominican Republic[b] Jamaica[b] Guyana[c] Haiti[d]
None	No data received by WHO		74 (38%)	2 (6%)	No Caribbean countries
Total			**193**	**35**	

Source: World Health Statistics, 2010 (8) and 2012 (9)

Source: World Bank, 2012: World Bank Classification, 2011 (10): [a]high income (per capita gross national income [GNI) > US$ 12615); [b]upper middle income (GNI US$4086–12615); [c]lower middle income (GNI US$1036–4085); [d]low income (GNI ≤ US$1035)

WHO – World Health Organization; ICD: International Classification of Diseases

[1]South East Regional Health Authority (SERHA) – Kingston, St Andrew, St Catherine, St Thomas; North East (NERHA) – Portland, St Mary, St Ann; Western (WRHA) – Trelawny, St James, Hanover, Westmoreland; Southern (SRHA) – St Elizabeth, Manchester, Clarendon.

lion population, 47% reside in the south east region, including the capital Kingston and 22% in the southern region. The least populous regions are the western (18%) and north east regions (13%). Over 90% of births occur in 18 public hospitals, while five private hospitals attend < 5% of deliveries (24).

Vital registration began in 1877 when the Registrar General's Department [RGD] (25) was established. Stillbirths may be certified by a physician or midwife; however, deaths must be certified by the attending physician for decedents under routine medical care, or a pathologist for coroner's cases (accidents, violence, and sudden deaths). In the latter instances, an investigating officer should compile and transfer a case file (police report, post mortem report) to court for coronal review after which a Form D is issued, replacing the MCCD. The family uses the MCCD or Form D to register the death. The records are then transferred to the central RGD where all listed conditions are coded using ICD-10 (1) and the UCOD identified. Despite this history, Jamaica is not among the 34 countries with a highly respected VRS. The mortality database was rated as low (9). The B rating for maternal mortality (26), a category for countries with incomplete vital registration but other sources of maternal mortality, precluded acceptance of vital SB data (4).

Delays in registering births in selected socio-economic groups (27–29) led to the introduction of bedside birth registration in 2007. By 2012, 99.8% of hospital births were registered on time, making birth registration complete (> 90% events registered). Persistent challenges with under-reporting of perinatal, infant and U-5 (27, 29, 30) deaths, especially hospital perinatal deaths, led to the implementation of strategies to improve the certification and registration of facility deaths. By 1998, completeness of SB registration increased from 13% (1986) to 46% and infant death registration moved from 22% (1993) to 65% (27, 30). Neither the SB nor LB certificate records birthweight or gestation, limiting the capacity to objectively decide which perinatal deaths should be included in national SBRs or birthweight specific SB and IMRs. Table 2 shows that for 2008, the internationally estimated SBR for Jamaica was 12.5/1000 births (4), while estimated neonatal, infant and U-5MRs were 9, 26 and 31/1000 LBs (19). Given high under-reporting rates, and data quality concerns, we aimed to evaluate the quality and completeness of registration of SBs and U-5 deaths occurring in 2008 in Jamaica and specifically determine:

- The number of SBs, neonatal, infant and U-5 deaths and their registration status
- Delays in registering SBs and U-5 deaths and factors associated with the delays
- The quality of certification of a 10% random sample of SBs and U-5 deaths
- The effect of under-reporting on official SB, neonatal, infant and U-5MRs

METHOD

The study was approved by the Ethics Committee of the University Hospital of the West Indies/University of the West Indies/Faculty of Medical Sciences, Mona. As a record review, no informed consent was required. Given the continuous nature of vital registration, the RGD was asked for an Excel file of registrations from January 1, 2008 to December 31, 2009 from which 2008 occurrences were extracted. Variables of interest included date of death and registration, age, gender, place and parish of occurrence, parish of residence, cause of death (COD), qualification of certifier, and for SBs, maternal age. The Jamaica constabulary and the Ministry of Health also provided Excel files of 2008 SBs and deaths. The files were merged and ordered by date and place of death for hospital deaths and parish of occurrence for community deaths.

Data collectors visited all public and private hospitals, forensic pathologists and coroner's courts from May to November 2011 to validate the listed deaths. At 19/25 public and 5/6 private hospitals that attended deliveries or care for children, listed SBs and deaths were compared to registers on labour wards, newborn and paediatric nurseries, and casualty departments. Birthweight, gestation and date of birth were extracted from clinical notes if available and added to the database as these variables were not recorded on the MCCD. Available details for missed cases and missing information for known cases were extracted onto a data collection form and added to the database. While we evaluated deaths across all age groups (31, 32) including maternal deaths (33), this paper is restricted to SBs and U-5 deaths.

We selected for in-depth analysis a 10% random sample, independent of registration status, stratified by age and gender. At the RGD, SB certificates/MCCDs/Form Ds used to register these events were reviewed by YH/AMB. To evaluate the certification process, we examined the sequencing of the COD (immediate, intermediate, underlying and contributory causes) and recorded duration of illness. The ICD-10 codes generated by the RGD were reviewed to assess whether, given the available information, the codes were correct and if the selected UCOD was consistent with ICD-10 rules. Where these differed, the COD in the sample database was revised (YH/AMB). Clinical records were not consulted to validate whether certificates reflected the true COD. Instead, we focussed on how well the data, as presented, were documented and coded. International Classification of Diseases-10 SB and perinatal mortality definitions were used as per Appendix 1.

Data were summarized using SPSS, version 16.0 into broad disease groups (34). Chi-squared/Fisher's exact tests were used to evaluate associations among categorical variables. Completeness was reported as the proportion of deaths registered by March 31, 2009 (first provisional estimate = timely registration) and December 31, 2009 (final estimate = any registration). Timeliness was measured as median days to registration due to data skew created by registration delays. Validity was assessed as the proportion of incorrectly coded

Table 2: Estimates of stillbirth and under-five mortality, 2008 – Caribbean countries

Caribbean country	Stillbirth (SB) rate	Neonatal mortality	Infant mortality	Under-five mortality	SB/mortality data quality[a]	Civil registration coverage	
						Births	deaths
High income							
Antigua and Barbuda	6.8	8	11	12	nr/M	…	75–89
Bahamas	8.0	6	9	13	A/H	…	90–100
Barbados	8.8	7	10	11	A/H	> 90	90–100
Trinidad and Tobago	8.5	24	31	35	A/H	96	90–100
Upper-middle income							
Cuba	7.7	3	5	6	A/H	> 90	90–100
Dominica	10.7	8	9	10	nr/M	> 90	> 75
Dominican Republic	11.9	19	27	33	B/L	78	50–74
Grenada	10.6	13	13	15	B/M	…	…
Jamaica	12.5	9	26	31	B/L	> 90	…
St Kitts and Nevis	9.5	11	14	15	nr/M	…	> 75
St Lucia	14.6	12	13	15	A/M	> 90	90–100
Suriname	15.0	12	25	27	A/M		
Lower-middle income							
Belize	12.3	8	17	19	A/M	94	90–100
Guyana	16.6	23	46	61	B/L	93	50–74
St Vincent/Grenadines	11.8	10	12	13	A/H	> 90	90-100
Low income							
Haiti	15.6	25	54	72	B/L	81	< 25
Region of the Americas	**9.4**	**9**	**15**	**18**	**…**	…	…
Global	**19.1**	**26**	**45**	**65**	**…**	…	…

Sources: stillbirths: Cousens *et al*, 2011 – web-appendix (4); WHO: mortality data quality: H–high; M–medium; L–low (8); and neonatal, infant, under-5 mortality, civil registration coverage (8, 9).
Stillbirth rate per 1000 live births and stillbirths; Other rates per 1000 live births
[a]SB data: based on maternal mortality data; nr – not reported due to small numbers; A – civil registration complete, good attribution of cause of death, B – civil registration not complete, but other data available

certificates and those certified to ill-defined conditions of no public health value (garbage coded), applying the quality standards in Table 1 (8, 15–17). Stata version 12, two-sample test of proportions for large sample statistics was used to calculate 95% confidence intervals (CIs) for rates and test the differences between mortality rates for registered and all identified deaths.

RESULTS

Case identification

We identified 797 SBs and 19 286 deaths as occurring in 2008, including 933 U-5 deaths. Of the 797 SBs, at least 646 (81%) were assessed as ≥ 1000 g. Stillbirth, perinatal, infant and U-5 mortality rates were significantly lower in the north east region compared to the national average (Table 3). Of the 933 U-5 deaths, 91% occurred in the first year. Of 850 infant deaths, 70% occurred in the first week and 81% in the first 28 days. The national SBR for fetuses ≥ 500 g/22 weeks was 17.9 [95% CI 16.7, 19.2]/1000 births and 15.0 [13.8, 16.1]/1000 for those ≥ 1000 g. The neonatal, infant and U-5 MRs were 16.1 (15.8, 16.5), 20.0 (18.7, 21.4) and 22.0 (20.6, 23.4)/1000 LBs, respectively. Most identified SBs (99.8%) and 88% of U-5 deaths occurred in hospital.

Timeliness of registration – stillbirths

Two-thirds (n = 523; 66%) of the 797 SBs were registered. Birthweight/gestational age data were only available for 464 (58%), including 22 (5%) who were < 22 weeks/< 500 g, seven of whom had been registered. All 22 were excluded from further analysis (Table 4). Of fetuses with known birthweight ≥ 500 g, no association between birthweight and registration was noted. Birthweight could not be determined for 333; however, 85% of these were registered. All 333 were therefore included in calculating SB and perinatal mortality rates. Variables associated with SB registration were region of death (SE: 55%; NE: 57%; West: 80%; South: 91%; $p < 0.001$), gender of fetus, with fewer females (66%) than males (73%) registered (Fisher's; $p = 0.045$) and place of death. Seven hospitals (ordered by total unregistered SBs: Spanish Town, Victoria Jubilee, Cornwall Regional, Princess Margaret, St Ann's Bay, Port Antonio, Black River) accounted for 95% (191/202) of unregistered but 66% (436/646) of SBs ≥ 1000 g ($p < 0.001$). The median interval to registration was one day (interquartile range [IQR] 1) for all regions except the north east where there were unexplained delays (median: 113 days; IQR: 172). Only four SBs were registered after March 31, 2009.

Table 3: Stillbirths and under-five deaths identified as occurring in 2008 and mortality rates[a] by region, place of occurrence and age of death, Jamaica

Place of death/ Age at death	Region of residence at death				Jamaica
	South East[b]	North East[c]	West[d]	South[e]	
Hospital	**n**	**n**	**n**	**n**	**n**
Stillbirths ≥ 500 g	377[f]	73	134	182	766
Stillbirths ≥ 1000 g	310[f]	53	118	164	645
Live births by age at death					
< 24 hours	89	14	14	16	133
1–6 days	187	44	99	117	447
7–28 days	38	5	22	17	82
1–11 months	55	7	24	24	110
1–4 years	33	3	8[g]	6	50
All under 5 years	**402**	**73**	**168**	**180**	**822**
Home/Other					
Stillbirths ≥ 500 g	7	0	0	2	9
Stillbirths ≥ 1000 g	0	0	0	1	1
Live births by age at death					
< 24 hours	2	2	1	2	7
1–6 days	4	0	1	3	8
7–28 days	3	1	1	4	8
1–11 months	29	4	8	13	54
1–4 years	19	1	6	7	33
All under 5 years	**57**	**8**	**17**	**28**	**110**
All locations					
Stillbirths ≥ 500 g	384	73	134	184	775
Stillbirths ≥ 1000 g	**310**	**53**	**118**	**165**	**646**
Live births by age at death					
< 24 hours	91	16	15	18	140
1–6 days	191	44	100	120	455
7–28 days	41	6	23	20	90
1–11 months	84	11	33	37	165
1–4 years	52	4	14	13	83
All under 5 years	**459**	**81**	**185**	**208**	**933**
Stillbirth rate[a] ≥ 1000 g	15.8	***9.0	14.0	#17.7	16.1
(95% CI)	(14.1, 17.7)	(6.8, 11.7)	(11.7, 16.7)	(15.2, 20.5)	(13.8, 16.1)
Perinatal mortality rate[a]	30.2	***19.2	27.7	#32.5	28.8
(95% CI)	(27.9. 32.7)	[16.0, 23.0]	(24.4, 31.4)	(29.0, 36.2)	(27.2, 30.4)
Infant mortality rate	21.1	***13.2	20.6	21.3	20.0
(95% CI)	(19.2, 23.2)	[10.5, 16.4]	(17.7, 23.9)	(18.5, 24.4)	(18.7, 21.4)
Under-5 mortality ratio	23.8	***13.9	22.3	22.7	22.0
(95% CI)	(21.7, 26.0)	(11.2, 17.2)	(19.3, 25.7)	(19.8, 25.9)	(20.6, 23.4)
Registered live births	**19 276**	**5818**	**8287**	**9171**	**42 437**

[a]See Appendix 1 for definitions and rates used in this table
[b]Kingston and St Andrew, St Catherine, St Thomas; [c]Portland, St Mary, St Ann; [d]Trelawny, St James, Hanover, Westmoreland; [e]St Elizabeth, Manchester, Clarendon
[f]Includes 5 at private hospitals; [g]Includes 1 at a private hospital
$0.05 < p < 0.07$; *** $p < 0.001$, otherwise, regional rates not statistically different from national rate

Timeliness of registration – under-five deaths

Three of four U-5 deaths (75%) were registered on time (by March 31, 2009). A further 35 (3.8%) were registered by December 31, 2009, for a total registration rate of 79% (Table 5). Timely registration decreased with age, from 83% and 79% of early and late NNDs, respectively to 54% among children one month to four years. Registration was highest for hospital deaths (83%) certified by the attending physician (91%);

Table 4: Stillbirths identified by birthweight and registration status: Jamaica, 2008

Birthweight (BW)	Registered[a] n	%	Not registered n	%	Total
Abortion (< 500 g)[b]	7	31.8	15	68.2	22
Extremely low BW (500–999 g)	72	55.8	57	44.2	129
Very low BW (1000–1499 g)	37	47.4	41	52.6	78
Low BW (1500–2499 g)	63	58.9	44	41.1	107
Normal BW (2500–3999 g)	55	47.4	61	52.6	116
Macrosomic (≥ 4000 g)	7	58.3	5	41.7	12
BW not recorded[c]	282	84.7	51	15.3	333
Total	**523**	**65.6**	**274**	**34.4**	**797**
Total ≥ 500 g[c]	**516**	**66.6**	**259**	**33.4**	**775**
Total ≥ 1000 g[c]	**444**	**68.7**	**202**	**31.3**	**646**

[a]All but four were registered before March 31, 2009; none later than June 30, 2009

[b]Spontaneous fetal loss before 22 weeks gestation or weighing < 500 g [if singleton gestation] (1)

[c]Birthweight was often not recorded for stillborn fetuses, especially if died antepartum. As most of these were registered (85%) they are included in the totals for both weight categories on the assumption that attendants were more likely to certify stillborn fetuses of birthweight/gestation ≥ 28 weeks/≥ 1000 g

however, only 26% of deaths undergoing post mortem were registered. The lowest registration rates were among community deaths (19%) and from accidents or violence (17%).

Unexplained delays were seen in the western region ($p < 0.001$), where only 55% of U-5 deaths were registered up to December 31, 2009. The median interval to registration was 41.5 days (IQR: 84.0). However, unlike overall registration, the interval decreased with age, with registration of childhood deaths more than a month old more efficient than for neonates. Table 5 shows that medians fell from 53.3 days (IQR: 80.6) among ENNDs to 6.3 days (IQR: 24.9) among 1–4 year olds. As expected, delays were greatest for deaths undergoing necropsy (all pathologist certified deaths: 272.1 days, IQR: 403.1[not in table]). The north east had the longest interval to registration (88.5 days; IQR: 107.5); the south (21.5; IQR: 87.4 days) was the most efficient and the widest spread was observed in the west (41.5; IQR: 270.8), compared to the SE (42.9; IQR: 66.5).

Quality of certification and coding – 10% sample of stillbirths and under-five deaths

The sample included 113 SBs and 1955 deaths across all age groups, 95 of which were under-five deaths. Of the SBs, only

Table 5: Characteristics associated with timeliness of registration of under-five deaths: Jamaica, 2008

Characteristic	Total identified n	Registered On time[a] %	Late[b] %	Not registered %	Days to registration Median (IQR)
Age at death* **					
0–6 days	595	83.0	6.1	10.9	53.3 (80.6)
7–28 days	90	78.9	4.4	16.7	25.5 (73.0)
1–11 months	165	53.9	1.8	44.2	16.5 (66.6)
1–4 years	83	55.4	4.8	39.8	6.3 (24.9)
Place of death* **					
Hospital	823	82.8	4.0	13.2	41.8 (83.0)
Home/other	110	17.3	1.8	80.9	16.5 (127.9)
Certifier* **					
Attending physician[c]	736	91.4	1.6	7.3	38.5 (77.5)
Pathologist – natural causes[d]	161	14.6	12.8	72.6	295 (409.5)
Pathologist – accident or violence[d]	30	10.0	6.7	83.3	246 (396.0)
Health region* **					
South East	459	81.9	1.7	16.3	42.9 (66.5)
North East	81	76.5	6.2	17.3	88.5 (107.5)
West	185	44.3	10.8	44.9	41.5 (270.8)
South	208	86.5	1.0	12.5	21.5 (87.4)
Total	**933**	**75.0**	**3.8**	**21.2**	**41.5 (84.0)**

[a]By March 31, 2009 = timely registration

[b]April to December 2009 – all events registered by December 31, 2009 considered a registered death as would be included in final count for year

[c]Deaths in hospital or at home among patients who were under medical care in the 3 months preceding death

[d]Coroner's cases – sudden deaths in previously healthy persons, including injury deaths requiring necropsy to determine cause of death

***$p < 0.001$ – for categorical variable

20 [18%] bore COD information, including 8/13 [62%] certified by doctors. With 88% of SBs certified by midwives, and 81% lacking COD information, the data were of limited utility (Table 6). Of the 20 with information, two were certified to ill-defined conditions and six were incorrectly coded. After editing, 35% (n = 7) were attributed to maternal conditions, 40% (n = 8) to placental conditions and 15% (n = 3) to other causes. No further detail was possible due to the small numbers.

Of the 95 U-5 deaths sampled, 9.5% (n = 9) were certified to conditions of no public health value, lacking UCOD. These included unspecified sepsis (three cases), metabolic derangement (an ENND), unspecified brain damage (age three years) and multiple unspecified injuries in a four-year old. Three classified to ill-defined conditions included two sudden unexplained deaths (seven and 10 months old) and a three-month old registered awaiting post mortem findings whose record was never updated. After editing, the most important classification changes were between the categories prematurity and birth asphyxia (Table 7) among NNDs. Excluding deaths in the neonatal period, infectious diseases were important among infants 1–11 months and congenital malformations and accidents among children 1–4 years.

Impact of non-registration on official stillbirth and under-five mortality rates

Table 8 summarizes SB, neonatal, infant and U-5MR for all identified deaths and registered cases only. Except for late NNDs, non-registration significantly reduced official rates by 20–31% ($p < 0.027$–< 0.001), requiring adjustment factors from 1.10 (NNDs) to 1.46 (SBs) to 1.79 (post NNDs) to use vital data to estimate these outcomes. Such variability in adjustment factors by age complicates any probable adjustment process.

Table 6: Completeness of 10% sample of stillbirth certificates before recoding, by profession of certifier

Qualification of certifier	Recording of cause of death information on the stillbirth certificate								% stillbirths certified by skill group
	Fetal or maternal cause recorded		Time of death only, no cause		No COD information recorded		Total		
	n	%	n	%	n	%	n	%	
Physician	8	61.5	1	7.7	4	30.8	20	100	11.5
RNM	4	25.0	1	6.3	11	68.8	16	100	14.2
RM	4	9.5	2	4.8	36	85.7	42	100	37.2
No qualification noted	4	9.5	2	4.8	36	85.7	42	100	37.2
Total	**20**	**17.7**	**6**	**5.3**	**87**	**76.1**	**113**	**100**	**100**

COD – cause of death; RNM – registered nurse midwife; RM – registered midwife (single trained)

Table 7: Causes of neonatal (n = 66), infant (n = 86) and under-five deaths (n = 95): before and after editing of sample database, Jamaica, 2008

Causes of death	Neonates (0–28 days)				Infants (< 1 year)				Under-fives (0–4 years)			
	Before editing		After editing		Before editing		After editing		Before editing		After editing	
	n	%	n	%	n	%	n	%	n	%	n	%
Prematurity	5	7.8	30	45.5	5	5.8	32	37.2	5	5.3	32	33.7
Birth asphyxia	32	48.5	15	22.7	32	37.2	15	17.4	32	33.7	15	15.8
Serious infections	9	13.6	5	7.8	9	10.5	5	5.8	9	9.5	5	5.3
Congenital malformations	3	4.5	2	3.0	5	5.8	5	5.8	7	7.3	8	8.4
Other perinatal causes	9	13.6	12	18.2	9	10.5	12	14.0	9	9.5	12	12.6
Diarrhoeal diseases	–	–	–	–	5	5.8	6	7.0	6	6.3	7	7.3
Accidents/violence	–	–	–	–	–	–	–	–	–	–	5	5.3
All other	–	–	–	–	1	1.2	4	4.7	1	1.1	2	2.1
Ill-defined conditions	8	12.1	2	3.0	20	23.3	7	8.1	26	27.4	9	9.5
Total	**66**	**100**	**66**	**100**	**86**	**100**	**86**	**100**	**95**	**100**	**95**	**100**

DISCUSSION

Between 1998 (30) and 2008 (31), Jamaica's capacity to process vital registration data had improved. While for the 1998 study we had to manually extract the data, 2008 data were available electronically. This progress in data retrieval

Table 8: Observed and effective stillbirth, perinatal, infant and under-five mortality rates per 1000 births or live births, based on vital registration, Jamaica, 2008

Stillbirth and young child age group category	Weight/ Age group	Total events	% 0–4 deaths	Identified events Mortality rate[a,b] (95% CI)/1000	Events registered to December 2009	Registered events Mortality rate[a,b] (95% CI)/1000	Adjustment factor
Stillbirths	≥ 500 g	755		17.5 (16.2, 18.7)	512	***11.8 (10.8, 12.9)	1.48
	≥ 1000 g	**646**		**15.0 (13.8, 16.1)**	**444**	***10.3 (9.4, 11.3)**	**1.46**
Perinatal deaths	Stillbirths ≥ 1000g +NNDs[c] 0–6 days	**1241**		**28.8 (27.2, 30.4)**	**965**	***21.8 (20.8, 23.1)**	**1.32**
Early	*< 24 hours*	*140*	*15.0*]	*13.8 (12.7, 15.0)*	*123*]	**12.1 (11.1,13.2)*	*1.14*
Neonates	*1–6 days*	*455*	*48.8*]		*398*]		
Late neonates	*7–28 days*	*90*	*9.6*	*2.1 (1.7, 2.6)*	*75*	*1.8 (1.4, 2.2)*	*1.20*
Neonatal deaths	0–28 days	685	73.4	16.1 (14.8, 17.3)	593	**14.0 (12.9, 15.2)	1.10
Post neonates	1–11 months	165	17.7	3.9 (3.3, 4.5)	92	***2.2 (1.7, 2.6)	1.79
Infants	0–364 days	**850**	**91.1**	**20.0 (18.7, 21.4)**	**685**	***16.2 (15.0, 17.5)**	**1.21**
Young children	1–4 years	83	8.9	2.0 (1.6, 2.4)	50	**1.2 (0.9, 1.5)	1.66
Under fives	0–4 years	**933**	**100.0**	**22.0 (20.6, 23.3)**	**735**	***17.3 (16.1, 18.6)**	**1.27**

[a]Denominators: live births: 42 437; total births ≥ 500 g (live births+stillbirths): 43 192; total births ≥ 1000 g: 43 083
[b]See Appendix 1 for definitions of the rates used in this table
Difference between identified rates and registered rates statistically significant at *$p < 0.05$, **$p < 0.01$; *** $p < 0.001$
[c]Neonatal deaths

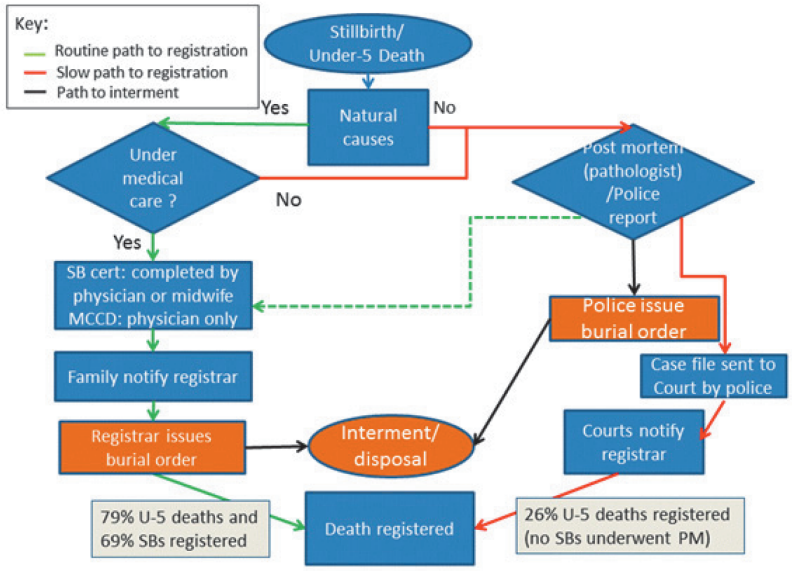

Figure: Registration process – stillbirths and under-five deaths, Jamaica, 2008.
SB – stillbirth; MCCD – medical certificate of cause of death; PM – post mortem

capacity should have enhanced our ability to identify registered deaths. The validation methods were similar. For SBs and U-5 deaths, registration rates improved over the decade but there was a decline in age groups 5–64 years, for an overall decline from 89% to 76% (31, 32). Stillbirth registration, however, increased from 46% to 69% and from 57% to 79% for U-5 deaths, suggesting that efforts to improve certification and registration of perinatal deaths had met with some success. A South African study reviewing 1996–2006 deaths recorded similar growth in completeness of U-5 death registration, which moved from 44% to 78% (35). Both changes could be associated with global efforts to monitor U-5MRs for the Millennium Development Goals. The remaining weaknesses in the data must be recognized, however, and efforts directed to

correcting the reporting challenges especially at the seven hospitals responsible for 96% of unregistered SBs.

Registration delays

The negative correlation between completeness and interval to registration may be due to how neonatal *versus* older deaths get registered. For SBs and ENNDs, hospitals often dispose of the remains. With no official funeral, staff may treat the certification and registration with less urgency, resulting in the observed delays but eventual registration of NNDs. If older children die in their parent's custody, the death is managed like an adult death and parents must notify the registrar to get permission for burial for childhood deaths from natural causes. If the death was injury related, it became a coroner's case with its attendant delays. Thus, unlike The Netherlands (2), Mexico (11), Thailand (12) and Kenya (13), where under-reporting of NNDs was a problem, in Jamaica it was deaths beyond the neonatal period which were often not getting registered. The Figure shows that while 79% of U-5 deaths certified by attending clinicians were registered, this was so for only 26% of coroner's cases, probably because the coroner's review process short-circuits the social inducement to register deaths. In these cases, the police issue the burial order after the autopsy to permit disposal of the remains, but before the coronal review and release of the Form D. Once the family has the burial order, their active participation in the registration process is halted unless the death certificate is needed to tie up a decedent's estate – rarely an issue for children. If, however, pathologists were to issue an MCCD after the post mortem (dotted line), as occurs elsewhere in the Caribbean, coroner's cases could get registered as usual (32).

Jamaica's failure to update the law to register SBs of ≥ 500 g/≥ 22 weeks and add birthweight on LB, SB and NND registration forms contravenes international guidelines, limiting the accuracy of SB and perinatal mortality rates (1). Efforts to extract this information from clinical records had limited success as we only located data for 58% of SBs. Some, especially antepartum SBs, were not weighed. We had to assume that SBs of unknown birthweight met WHO registration guidelines, especially as 85% were registered. If, however, they included fetuses < 1000 g, we may have over-estimated the SBRs and perinatal mortality rates.

While independent maternal mortality surveillance reports enabled validation of the certification of maternal deaths (33), this was not possible for all 1955 deaths or 113 SBs sampled. Introduction of perinatal mortality reviews might enable such an exercise in the future. No studies of the quality of SB and U-5 death registration were identified from other Caribbean countries; however, a New York City study (36) noted that, like Jamaica, SB registration varied widely by hospital. Their records also often lacked COD information, with 67% of SBs certified to ill-defined conditions. With those lacking COD being coded to ill-defined causes, 79% of our sampled SBs had ill-defined causes of death. Of NNDs in the New York city study, 5% were coded to ill-defined causes (36), compared to 12% of our sample before editing but only 3% after editing. This suggests that if RGD coders were better trained, the potential to generate high quality data from Jamaica exists. This would also indicate that the physicians were probably less to blame for the coding errors, as was found in the maternal mortality study (33). Caribbean countries with medium to low rating of their SB or mortality databases need to identify and correct the sources of these errors so the region can generate high quality, reliable data (4, 8, 26).

Physicians and midwives would benefit from training in certifying perinatal deaths. Midwives' failure to record COD on 88% of their SB certificates is an international problem observed by Lawn *et al* (5) and may reflect the limited attention traditionally paid to these pregnancy outcomes. The midwifery curriculum should be updated to ensure midwifery students acquire these skills, with remedial continuing education for practising midwives. Addition of practitioner registration numbers to certificates would facilitate the return of poorly completed certificates for correction and alert certifiers of the importance of providing high quality data.

The SBR of 15.0 (13.8, 16.1)/1000 exceeds the IGME 2008 estimate of 12.5 (11.5, 13.4)/1000 (4). The IMR was unchanged between 1998 and 2008, being 20.0/1000, with a small decrease in the U-5MR from 23.8 (30) to 22.0/1000. Inter-Agency Group for Child Mortality Estimation 2008 estimates for neonatal, infant and U-5 mortality were 9, 26 and 31/1000 (19), while IHME (37) U-5MR estimates reported in 2011 was 17.6 (12.7, 23.7), respectively compared to our findings of 15.0 (13.8, 16.1), 20.0 (18.7, 21.4) and 22 (20.6, 23.4). All IGME rates were much lower than ours, however, the confidence limits for the IHME U-5MR was within our range, as was their estimated total under-five deaths [~900] (37). Variance between the local reality and international estimates risks misdirecting the policy response, as managing preterm babies is different from efforts to prevent birth asphyxia. The IGME results would suggest that U-5 deaths were dominated by post neonatal and young-child deaths, requiring community-based responses to reduce infectious and nutritional disorders. The higher neonatal contribution evident in our data requires increasing access to specialized care for mother's antepartum and more intensive care for preterm babies soon after birth. A grant of €22 million to implement the *Programme for the Reduction of Maternal and Child Mortality* to provide critical care services for mothers and neonates in six referral hospitals might not have been funded if Jamaica were relying only on IGME/IHME evidence (38).

SUMMARY AND RECOMMENDATIONS

While the registration of SBs and U-5 deaths improved between 1998 and 2008, one-third of SBs and one-fifth of U-5 deaths were not registered in 2008. Regional health authorities need to address why selected hospitals were not certifying and registering SBs and U-5 deaths. The absence of COD information on 81% of SB certificates, including 88% of those cer-

tified by midwives needs urgent attention, as are coding errors introduced by the RGD.

Recommendations

1. Birthweight and gestation must be added to LB and SB certificates.
2. The Registrar should consider a separate perinatal death certificate to register SB ≥ 500 g and NNDs 0–28 days. The WHO prototype [Appendix 2] can be adapted by increasing the review period to 28 days of age.
3. Professional registration numbers should be added to SB certificates and MCCDs so that incorrectly completed certificates can be returned for correction.
4. The midwifery curriculum should be updated to ensure that midwives are taught to correctly certify SBs, and document fetal and maternal causes of death. While death certification was added to the medical curriculum at the University of the West Indies (UWI), Mona in 1996, it should be included at other UWI and non-UWI Caribbean medical schools.
5. Continuing education is needed to address skill deficiencies of practising midwives (and physicians) to improve certification of SBs in particular.
6. Labour ward physicians should collaborate with midwives to ensure COD information is recorded on the SB certificate as midwives attend > 80% of births and SBs.
7. Regional health authorities need to monitor the certification and registration of SBs and U-5 deaths, especially if they assume responsibility for the disposal of these remains.
8. Registrar General's Department coders and quality control officers need to be specifically trained in how to code SBs and U-5 deaths.

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Appendix 1: Definitions and indicators used in this paper, based on International Classification of Diseases 10 [ICD-10] (1)

DEFINITIONS

Perinatal period	Begins at 22 weeks gestation (154 days) when the fetus is potentially viable and weighs around 500 g and ends seven completed days after birth.
Early neonatal period	0–6 days after birth or 7 completed days. Day 0 is 0–23 hours 59 minutes after birth. An infant must pass through the first 24 hours to be considered 1 day old, hence the misclassification errors in recording deaths occurring in under 24 hours as some/many get reported as day 1 deaths because they occurred on the first day of life.
Late neonatal period	7–28 days after birth.
Post neonatal period	29–364 days after birth (up to but excluding the first birthday).
Live birth	The complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered live born. • For vital registration purposes, such products should be registered as a live birth, regardless of how long it survives after such separation. If it subsequently dies, the death must be certified as a separate event. • Misclassification or reporting dilemmas arise when there is no physician available to certify the neonatal death or it gets documented as a stillbirth for other psychosocial reasons.
Spontaneous abortion (miscarriage)	Spontaneous fetal loss [death] prior to viability (before 22 weeks gestation).
Fetal death [deadborn fetus]	Death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy; the death is indicated by the fact that after such separation, the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.
Stillbirth	Spontaneous fetal loss ≥ 22 weeks gestation (or ≥ 500 g birthweight if singleton fetus).
Registered event	Any death or stillbirth registered by December 31, 2009.
INDICATORS	• For vital registration purposes, fetuses and infants weighing 500 g or more (gestational age ≥ 22 weeks, crown-heel length ≥ 25 cm) should be registered. • For computing statistics for international comparison, countries should present statistics where the numerators and denominators are restricted to fetuses and infants weighing ≥ 1000 g [gestational age ≥ 28 completed weeks, body length ≥ 35 cm crown-heel] (1).
Completeness	Event registered within 3 months of occurrence but no later than March 31, 2009 (registered on time) and December 31, 2009 (any registration) as a proportion of all identified events.
Stillbirth rate, weight specific	$\frac{\text{Stillbirths weighing 1000 g or more}}{\text{Total births weighing 1000 g or more [live births+stillbirths]}} \times 1000$ • Rates may also be computed for stillbirths ≥ 500 g; then the numerator and denominator would be modified to reflect this.
Perinatal mortality rate	$\frac{\text{Stillbirths and early neonatal deaths weighing 1000 g or more}}{\text{Total births weighing 1000 g or more [live births+stillbirths]}} \times 1000$
Infant mortality rate	$\frac{\text{Deaths under one year of age}}{\text{Live births}} \times 1000$ • Neonatal, late neonatal or post neonatal mortality rates are calculated by restricting the numerator to the specified age group; the denominator will include all live births that year.
Under-5 mortality rate*	$\frac{\text{Deaths 0–4 years of age}}{\text{Live births (in the year of the deaths)}} \times 1000$ * This is a ratio which measures the likelihood that a child born in a given year will not survive to its 5th birthday at prevailing child mortality rates.

Appendix 2: World Health Organization prototype perinatal death certificate

CERTIFICATE OF CAUSE OF PERINATAL DEATH

To be completed for stillbirths and live born infants dying within 168 hours (1 week) from birth

(Identifying Particulars)

☐ This child was live born on ____ at ____ hours
and died on ____ at ____ hours

☐ This child was stillborn on ____ at ____ hours
and died Before labour ☐ During labour ☐ Not known ☐

Mother

Date of birth ☐☐☐☐☐☐
or, if unknown, age (years) ☐☐

Number of previous pregnancies:
Live births ☐☐
Stillbirths ☐☐
Abortions ☐☐

Outcome of last previous pregnancy:
Live birth ☐
Stillbirth ☐
Abortion ☐
Date ☐☐☐☐☐☐

1st day of last menstrual period ☐☐☐☐☐☐
or, if unknown, estimated duration of pregnancy (completed weeks) ☐☐

Antenatal care, two or more visits
Yes ☐
No ☐
Not known ☐

Delivery:
Normal spontaneous vertex ☐
Other (specify) .....

Child

Birthweight: ..... grams
Sex:
Boy ☐ Girl ☐ Indeterminate ☐
Single birth ☐ First twin ☐
Second twin ☐ Other multiple ☐

Attendant at birth

Physician ☐ Trained midwife ☐
Other trained person (specify) .....
Other (specify) .....

CAUSES OF DEATH

a. Main disease or condition in fetus or infant

b. Other diseases or conditions in fetus or infant

c. Main maternal disease or condition affecting fetus or infant

d. Other maternal diseases or conditions affecting fetus or infant

e. Other relevant circumstances

The certified cause of death has been confirmed by autopsy ☐
Autopsy information may be available later ☐
Autopsy not being held ☐

I certify .....
.....
.....
Signature and qualification

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