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1 **“Making stillbirths visible: A systematic review of globally reported causes of stillbirth”**

2 **Short title:** Global reporting of causes of stillbirth

3 **Authors**

4 Hanna E Reinebrant<sup>a,b</sup>, Susannah Hopkins Leisher<sup>a,b</sup>, Michael Coory<sup>c,d</sup>, Sarah Henry<sup>a,b</sup>, Aleena M  
5 Wojcieszek<sup>a,b</sup>, Glenn Gardener<sup>a,b</sup>, Rohan Lourie<sup>a,e</sup>, David Ellwood<sup>f,g</sup>, Zheyi Teoh<sup>a,h</sup>, Emma  
6 Allanson<sup>i,j</sup>, Hannah Blencowe<sup>k</sup>, Elizabeth S Draper<sup>l</sup>, Jan Jaap Erwich<sup>b,m</sup>, J Frederik Frøen<sup>n,o</sup>, Jason  
7 Gardosi<sup>p</sup>, Katherine Gold<sup>b,q</sup>, Sanne Gordijn<sup>b,m</sup>, Adrienne Gordon<sup>r</sup>, Alexander EP Heazell<sup>s,t</sup>, Teck Yee  
8 Khong<sup>u</sup>, Fleurisca Korteweg<sup>v</sup>, Joy E Lawn<sup>k</sup>, Elizabeth M McClure<sup>b,w</sup>, Jeremy Oats<sup>x,y</sup>, Robert  
9 Pattinson<sup>z</sup>, Karin Pettersson<sup>1</sup>, Dimitrios Siassakos<sup>b,2</sup>, Robert M Silver<sup>3</sup>, Gordon Smith<sup>4</sup>, Özge  
10 Tunçalp<sup>i</sup>, Vicki Flenady<sup>a,b</sup>

11 **Affiliations**

12 <sup>a</sup> Centre of Research Excellence in Stillbirth, Mater Research Institute, The University of Queensland (MRI-UQ),  
13 Brisbane, Australia

14 <sup>b</sup> International Stillbirth Alliance, Bristol, UK

15 <sup>c</sup> Murdoch Childrens Research Institute, Melbourne, Victoria, Australia

16 <sup>d</sup> Department of Paediatrics, University of Melbourne, Melbourne, Victoria, Australia

17 <sup>e</sup> Translational Research Institute, Brisbane, Queensland, Australia

18 <sup>f</sup> Griffith University School of Medicine, Queensland, Australia

19 <sup>g</sup> Gold Coast University Hospital, Gold Coast, Queensland, Australia

20 <sup>h</sup> University of Louisville, Department of Medicine-Pediatrics, Louisville, KY, USA

21 <sup>i</sup> Department of Reproductive Health and Research including UNDP/UNFPA/UNICEF/WHO/World Bank Special  
22 Programme of Research, Development and Research Training in Human Reproduction (HRP), World Health  
23 Organization, Geneva, Switzerland

24 <sup>j</sup> School of Women's and Infants' Health, Faculty of Medicine, Dentistry and Health Sciences, University of Western  
25 Australia, Perth, Australia

26 <sup>k</sup> London School of Hygiene & Tropical Medicine, London, UK

27 <sup>l</sup> MBRRACE-UK, Department of Health Sciences, University of Leicester Centre for Medicine, Leicester, UK

28 <sup>m</sup> University of Groningen, University Medical Center Groningen, Groningen, The Netherlands  
29 <sup>n</sup> Norwegian Institute of Public Health, Oslo, Norway  
30 <sup>o</sup> Centre for Intervention Science in Maternal and Child Health (CISMAC), University of Bergen, Bergen, Norway  
31 <sup>p</sup> Perinatal Institute, Birmingham, UK  
32 <sup>q</sup> Department of Family Medicine and Department of Obstetrics and Gynecology, University of Michigan, Ann Arbor,  
33 MI, USA  
34 <sup>r</sup> University of Sydney, Sydney, Australia  
35 <sup>s</sup> Division of Developmental Biomedicine, Faculty of Medical and Human Sciences, University of Manchester,  
36 Manchester, UK  
37 <sup>t</sup> St Mary's Hospital, Central Manchester University Hospitals NHS Foundation Trust, Manchester Academic Health  
38 Science Centre, Manchester, UK  
39 <sup>u</sup> SA Pathology, Women's and Children's Hospital, North Adelaide, Australia  
40 <sup>v</sup> Department of Obstetrics and Gynecology, Martini Hospital, Groningen, The Netherlands  
41 <sup>w</sup> Department of Social, Statistical and Environmental Health Sciences, Research Triangle Institute, Research Triangle  
42 Park, NC, USA  
43 <sup>x</sup> Melbourne School of Population and Global Health, The University of Melbourne, Melbourne, Victoria, Australia  
44 <sup>y</sup> Consultative Council on Obstetrics and Paediatric Mortality and Morbidity (CCOPMM), Victoria, Australia  
45 <sup>z</sup> Department of Obstetrics and Gynaecology, University of Pretoria, Pretoria, South Africa  
46 <sup>1</sup> Department of Clinical Science, Intervention and Technology, Karolinska Institutet, Stockholm, Sweden  
47 <sup>2</sup> University of Bristol, School of Social and Community Medicine, Obstetrics and Gynaecology, Southmead Hospital,  
48 Bristol, UK  
49 <sup>3</sup> University of Utah School of Medicine, Salt Lake City, UT, USA  
50 <sup>4</sup> Department of Obstetrics and Gynaecology, University of Cambridge, NIHR Cambridge Comprehensive Biomedical  
51 Research Centre, Cambridge, UK

## 52 **Correspondence**

53 Hanna Reinebrant, Mater Research Institute - The University of Queensland (MRI-UQ), Level 3,  
54 Aubigny Place, South Brisbane, Qld, 4101, Australia. Email: hanna.reinebrant@mater.uq.edu.au,  
55 Phone: +61731632119

56 **Abstract**

57 ***Background***

58 Stillbirth is a global health problem. The World Health Organization (WHO) application of the  
59 International Classification of Diseases for perinatal mortality (ICD-PM) aims to improve data on  
60 stillbirth to enable prevention.

61 ***Objectives***

62 To identify globally reported causes of stillbirth, classification systems, and alignment with the ICD-  
63 PM.

64 ***Search strategy***

65 We searched CINAHL, EMBASE, Medline, Global Health and Pubmed from 2009-2016.

66 ***Selection criteria***

67 Reports of stillbirth causes in unselective cohorts.

68 ***Data collection and analysis***

69 Pooled estimates of causes were derived for country representative reports. Systems and causes were  
70 assessed for alignment with the ICD-PM. Data are presented by income setting (low, middle and high  
71 income; LIC, MIC, HIC).

72 ***Main results***

73 85 reports from 50 countries (489,089 stillbirths) were included. The most frequent categories were  
74 *Unexplained*, *Antepartum haemorrhage* and *Other* (all settings), *Infection* and *Hypoxic peripartum*  
75 (LIC), and *Placental* (MIC, HIC). Overall report quality was low. Only one classification system  
76 fully aligned with ICD-PM. All stillbirth causes mapped to ICD-PM. In a subset from HIC mapping  
77 obscured major causes.

78 ***Conclusion***

79 There is a paucity of quality information on causes of stillbirth globally. Improving investigation of  
80 stillbirths and standardisation of audit and classification is urgently needed and should be achievable

81 in all well-resourced settings. Implementation of the WHO Perinatal Mortality Audit and Review  
82 guide particularly across high burden settings is needed.

83 ***Funding***

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86 ***Keywords***

87 Stillbirth, classification, systems, cause of death, ICD

88 ***Tweetable Abstract***

89 Urgent need to improve data on causes of stillbirths across all settings to meet global targets.

90

## 91 **Introduction**

92 The global stillbirth rate ( $\geq 28$  completed weeks' gestation) is estimated to be 18.4 per 1000 births<sup>1</sup> or  
93 around 2.6 million stillbirths each year<sup>1</sup>. The World Health Organization's (WHO's) Every Newborn  
94 Action Plan aims to reduce the stillbirth rate to 12 or fewer per 1000 births by 2030 in every country,  
95 and for countries already meeting this target to reduce equity gaps<sup>2</sup>. However, with an estimated  
96 annual reduction rate of 2.0% between 2000 and 2015<sup>1</sup>, half that for neonatal deaths, progress has  
97 been slow. Identifying interventions to achieve such a target would be facilitated by cross-country  
98 and inter-country comparisons of the causes of stillbirth. Moreover, while national neonatal causes  
99 of death are regularly published through the United Nations<sup>1,3</sup>, there is currently no systematic global  
100 reporting of causes of stillbirth. The WHO recommends use of the International Statistical  
101 Classification of Diseases and Health Related Problems (ICD) for classification of perinatal deaths  
102 for international reporting<sup>4</sup>. However, limitations in ICD for classifying stillbirths<sup>5</sup> has resulted in  
103 numerous disparate systems currently in use<sup>6</sup>, thus limiting global comparisons. In 2016, WHO  
104 released ICD Perinatal Mortality (ICD-PM) as part of the WHO Perinatal Mortality Audit and Review  
105 guide<sup>7</sup>. The ICD-PM is an application of ICD and holds promise as an important step in improving  
106 global and local reporting of causes of stillbirths and neonatal deaths<sup>8</sup>. The ICD-PM aims to collect,  
107 at a minimum, timing of death and clinically defined causes and associated conditions.

## 108 **Objectives**

109 Following on the introduction of the ICD-PM, we aimed to identify globally reported causes of  
110 stillbirth in order to support progress toward the WHO Every Newborn Action Plan stillbirth rate  
111 target. The specific objectives were to:

- 112 1. Describe the current status of global reporting of stillbirth causes, including reported causes  
113 and classification systems used;
- 114 2. Pool results from country representative reports to identify commonly reported causes of  
115 stillbirth, stratified by income setting (high-, middle-, and low-income); and

116 3. Assess alignment of systems used and reported causes of stillbirths with the ICD-PM for  
117 country representative reports.

## 118 **Methods**

119 This systematic review was conducted and reported according to the PRISMA checklist<sup>9</sup>. The  
120 protocol has not been published. Two authors independently undertook screening of reports,  
121 selection, data extraction and quality assessment.

### 122 *Eligibility criteria*

123 All published and unpublished cohort and cross-sectional reports from 1 January 2009 to 31  
124 December 2016 which presented causes of stillbirth were eligible. Reports were excluded if they:  
125 included non-consecutive or selected subgroups, e.g. preterm; aimed only to identify risk factors or  
126 did not provide data on causes in an extractable format (for complete study selection see Figure S1).

### 127 *Information sources*

128 We searched PubMed, Global Health, Cinahl, Medline and Embase without language restrictions.  
129 We identified national reports through web-based systematic searches (Appendix S1) and cross-  
130 referenced included reports.

### 131 *Study selection*

132 Titles and abstracts of identified reports were screened for eligibility; full text papers were retrieved  
133 if potentially eligible or unsure. All reports presenting causes of stillbirth were included to address  
134 Objective 1. To address Objectives 2 and 3, the most recent national report for each country was  
135 selected. If a national report was unavailable, a report was selected on criteria (in descending order):  
136 1) population-based report with the largest number of stillbirths, 2) multi-centre health facility report  
137 covering the largest population.

### 138 *Data extraction*

139 A purpose built data extraction form was used. For details on data items and definitions used, see  
140 Additional Information S2.

### 141 *Grouping reported stillbirth causes*

142 The development of categories and mapping of reported causes of stillbirth to categories  
143 were undertaken by a panel including Maternal Fetal Medicine Specialists (GG, BS, DE), pathologist  
144 (RL) and epidemiologist (VF), with guidance from The Amsterdam Classification Workshop<sup>10</sup>  
145 members. Categories were created by “clustering” reported causes into 15 clinically meaningful  
146 groups for stillbirth prevention (“global categories”) (Table S1). With the addition of *Placental*  
147 *conditions*, these categories generally coincided with previously suggested major causal groupings  
148 by Lawn et al<sup>11</sup>. We did not attempt to differentiate causes from associated conditions (Table S1).

#### 149 ***Quality assessment***

150 Quality assessment of country representative reports included in the pooled analysis of reported  
151 causes was performed using an adapted version of the Joanna Briggs Institute Critical Appraisal  
152 Checklist for Studies Reporting Prevalence Data<sup>12</sup> (Appendix S3). An overall quality rating was  
153 derived for each report (low, medium, or high quality). For subgroup analyses of “good” quality  
154 reports, we combined data from reports assessed as high and medium quality.

#### 155 ***Data presentation and analysis***

156 Data were presented by income setting using World Bank groupings<sup>13</sup> of low and lower-middle (LIC;  
157 Gross National Income (GNI)  $\leq$ \$3,955), upper-middle (MIC; GNI \$3,956- \$12,235) and high (HIC;  
158 GNI  $\geq$ \$12,236). Categories of stillbirth causes were presented as proportions of the total number of  
159 stillbirths classified. Results from country representative reports were statistically pooled to identify  
160 commonly reported causes stratified by country groupings. Analyses were done in R using the meta  
161 package<sup>14</sup> with 95% prediction intervals (PI)<sup>15-17</sup> (Appendix S4). Subgroup analyses by report quality  
162 and type of system (ICD versus clinical classification systems) were planned *a priori*. See Appendix  
163 S2 for definition of clinical classification systems<sup>6</sup> and criteria for alignment of classification systems  
164 with ICD-PM.

165 Each reported cause was mapped to the relevant ICD-PM major category. The ICD-PM includes five  
166 major maternal condition categories (M1-5) and 13 fetal categories, six with antepartum timing (A1-  
167 6) and seven with intrapartum timing (I1-7)<sup>4</sup>. For the Unknown (U) timing category we included the



168 categories: U1: *Congenital malformations, deformations and chromosomal abnormalities*; U2:  
169 *Infection*; U3: *Other specified disorder*; U4: *Disorders related to fetal growth*; U5: *Death of*  
170 *unspecified cause*. We added one category, *Other*, to all timings to accommodate the causes without  
171 ICD-PM coding.

172 The proportions of stillbirths that could be mapped to a fetal cause and/or a maternal condition in  
173 ICD-PM were calculated. Mapping of data from good quality HIC reports to ICD-PM was compared  
174 descriptively with the 15 global categories.

## 175 **Results**

176 Of 7415 abstracts screened for eligibility, 909 full-text papers were reviewed for inclusion and 824  
177 records were excluded: did not discuss stillbirth (396), no extractable data (217), sub-populations  
178 only (145), risk factors only (12) (for complete study selection see Figure S1). Eighty-five reports  
179 (LIC 28, MIC 20, HIC 37) with a total of 489,089 stillbirths were included in the review (LIC 13,197,  
180 MIC 431,216, HIC 44,676). Thirty-three country representative reports classifying 454,533 stillbirths  
181 were included in the pooled analysis of causes and mapping to ICD-PM.

### 182 ***Global stillbirth reporting***

#### 183 *Description of included reports*

184 The 85 included reports originated from 50 countries. Reports were published in English (66) and  
185 non-English (19; Table S2). Eleven reports excluded terminations of pregnancy. Half of the reports  
186 (including 2.4% of all stillbirths) were from hospital settings (LIC: 19 reports/7419 stillbirths; MIC:  
187 8 reports/1134 stillbirths; HIC: 16 reports/3240 stillbirths) (Table 1, for full details see Table S2).

#### 188 *Definitions of stillbirth*

189 Stillbirth was defined in 71 reports (84%) using 34 discrete definitions (Figure S2). The majority of  
190 HIC reports (78%) used a lower gestational age limit of 20-24 weeks while the majority of LIC reports  
191 (68%) used 28 weeks (Table 1).

#### 192 *Data available to classifiers*

193 Systematic prospective perinatal mortality audits were used in 21 reports (LIC 2, MIC 4, HIC 15), of  
194 which 12 were hospital audits; seven used comprehensive investigation protocols (all from HIC)  
195 (Table S2). In 40 reports, retrospective audit data were used; 18 of these (LIC 2, MIC 6, HIC 10)  
196 sourced causes from Civil Registration and Vital Statistics (CRVS). Sixteen reports (LIC 13, MIC 3)  
197 were prospective studies; eight of these, all from LIC, used verbal autopsy. Reported autopsy rates in  
198 20 reports [MIC 3 (14%), HIC 17 (47%)] ranged from 2.7% to 100%. In over half of the reports  
199 (55%) it was unclear whether autopsy had been performed. Placental pathology examination rates  
200 were included in 15 reports (18%) (none in LIC) with rates ranging from 22% to 100%. For full  
201 details on data available see Table S2.

### 202 *Classification systems*

203 Twenty-one clinical classification systems<sup>18-38</sup> were used in 41 of the 85 reports (LIC 15 reports/30%  
204 of stillbirths, MIC 6 reports/5% of stillbirths, HIC 20 reports/27% of stillbirths). The ICD was used  
205 more frequently in HIC (14 reports/72% of stillbirths) and MIC (7 reports/94% of stillbirths) than  
206 LIC (3 reports/2% of stillbirths) (Table 1). The remaining 20 reports listed causes of death without  
207 reference to any classification system. Areas of origin for the 21 clinical systems is shown in Table  
208 S3. Three-quarters of the systems allow a single primary cause of death, and half the systems allow  
209 associated factors to be recorded (Table S4). Five systems provide comprehensive definitions of  
210 causes<sup>20,27,30-32</sup> and 13 systems provide rules for assigning cause of death (See Table S4 for full details  
211 on clinical classification systems).

### 212 *Globally reported categories of stillbirth*

213 The 85 included reports presented causes of stillbirth using 860 unique terms. These were grouped  
214 into 15 global categories and 46 minor categories, of which eight major categories were common to  
215 over half (53%) of the reports (Table S5).

216 *Congenital anomalies* was the most frequently reported category, included in 93% of all reports. The  
217 proportion of stillbirths assigned to this category ranged from 1.4% in Nigeria<sup>39</sup> to 64.4% in China<sup>40</sup>  
218 (Figure 1, Table S5). The second category was *Unexplained*, included in 82% of all reports, ranging

219 from 0.3% in Turkey<sup>25</sup> to 82.0% in Japan<sup>41</sup>. *Maternal conditions* were included in 64% of all reports,  
220 with frequency ranging from 0.6% in Ireland<sup>42</sup> to 36.5% in Italy<sup>28</sup> (Figure 1, Table S5).

221 The proportions of categories also differed across type of classification system. The most commonly  
222 reported categories for reports using the ICD included *Other unspecified condition* (68% of reports)  
223 and *Hypoxic peripartum death* (64%), whereas for clinical systems these included *Antepartum*  
224 *haemorrhage* (72%) and *Infection* (67%).

## 225 ***Country representative reports***

### 226 *Description of included reports*

227 Thirty-three reports classifying 454,533 stillbirths were included in the pooled analysis: seven LIC  
228 (5,629 stillbirths), 11 MIC (429,666 stillbirths), and 15 HIC (19,238 stillbirths). Twenty-one reports  
229 included  $\geq 95\%$  of total stillbirths in the country during the reporting period, one report included 72%,  
230 three included 6-49% and eight included  $\leq 5\%$  (Figure S3). In two reports (6%), terminations of  
231 pregnancy were excluded, and in 21 (64%), no reference was made to terminations. The ICD was  
232 used mainly in HIC and MIC reports (60% and 64%, respectively, versus 14% of LIC reports; Table  
233 1, Table S2).

234 Quality assessment identified 13 good quality reports (29% of all LIC reports, 36% of all MIC reports,  
235 47% of all HIC reports); only one of these was high-quality<sup>43</sup>. The remaining reports were assessed  
236 as low-quality (Table S6, Figure S4).

### 237 *Pooled estimates of commonly reported causes of stillbirths*

238 The top five categories by frequency for each country grouping are shown in Figure 2. *Unexplained*  
239 was the top category across all settings, with pooled estimated ranging from 31.2% to 43.7% (Tables  
240 S7, S8). Two additional categories were amongst the top five across all settings: *Other unspecified*  
241 *conditions* (9.3% to 11.6%) and *Antepartum haemorrhage* (8.4% to 9.3%; Tables S7, S9, S10). In  
242 LIC, *Infection* (15.8%) and *Hypoxic peripartum death* (11.6%; Tables S7, S11, S12) were also  
243 amongst the top five. In both HIC and MIC settings *Placental conditions* (14.4% and 13.7%,

244 respectively) ranked in the top five, with *Congenital anomalies* as the remaining category in HIC  
245 (14.0%) and *Specific fetal/pregnancy pathology* in MIC (11.0%) (Tables S7, S13, S14, S15).

246 Details of pooled analyses of *Umbilical cord complications*, *Maternal conditions*, *Spontaneous*  
247 *preterm*, *Hypertension*, *Fetal growth restriction* and *Terminations* are presented in Tables S16-S21.

#### 248 *Sub-group analysis*

249 Due to insufficient data subgroup analysis by report quality was only possible for HIC. The proportion  
250 of *Unexplained* (15.4% vs 31.6%) and *Other unspecified conditions* (1.6% vs 9.3%) was lower in  
251 good quality reports versus all reports (Tables S8, S9). Subgroup analyses by system type showed  
252 higher proportions of *Antepartum haemorrhage* using clinical systems (14.1%) than using ICD  
253 (4.4%) in MIC (Table S10). Use of clinical systems resulted in lower proportions of *Other unspecified*  
254 *conditions* (1.6%) and *Unexplained* (17.7%) than use of ICD (13.2% and 43.4%, respectively) in HIC  
255 (Tables S9, S8).

#### 256 *Alignment with the ICD-PM*

##### 257 *Alignment of clinical classification systems with the ICD-PM*

258 Of 21 classification systems used, only Codac<sup>19</sup> was fully aligned with the ICD-PM. Four systems  
259 met two of the three criteria used to assess alignment, and 14 systems scored 0.5-1.5 out of a  
260 maximum of 3 (Table S3, Figure S5).

##### 261 *Mapping of reported causes to ICD-PM*

262 Nearly all the 454,533 stillbirths reported in the 33 country representative reports were mapped to an  
263 ICD-PM fetal or maternal category, or both. Causes for 831 stillbirths (0.2%) mapped to ICD-PM  
264 neonatal rather than fetal codes (for example “neonatal aspiration syndrome”). 264,480 stillbirths  
265 (58%) were mapped to a fetal but not a maternal ICD-PM cause, and 140,319 (31%) to a maternal  
266 but not a fetal ICD-PM cause; 49,734 stillbirths (11%) were mapped to both (Tables S22, S23).

267 Of the 204,545 stillbirths in the global category *Unexplained*, 113,558 (56%) were mapped to the  
268 ICD-PM category *Unknown timing unspecified* (no maternal condition), 90,335 (44%) to *Antepartum*  
269 *hypoxia* (no maternal condition), 602 (0.3%) to *Antepartum unspecified* (no maternal condition), and

270 50 (0.02%) to maternal condition *Other complications of labour and delivery* (no fetal cause) (Tables  
271 S22, S23).

272 The global causes from best available data (good quality reports using clinical classification systems  
273 in HIC, five reports; 6,194 stillbirths) were mapped to ICD-PM. The global categories reflecting  
274 underlying placental causes of *Antepartum haemorrhage* and *Placental condition* (insufficiency)  
275 accounted for 20%, and *Intrauterine growth restriction* 7% of stillbirths (Figure 3). When mapped to  
276 the ICD-PM, these global categories are included within the major maternal category *Complications*  
277 *of placenta, cord and membranes* and the fetal category *Disorders related to fetal growth*, accounting  
278 for 30% and 17% of stillbirths, respectively (Figure 3).

## 279 **Discussion**

### 280 ***Main findings***

281 From 85 reports presenting causes of nearly half a million stillbirths from 50 countries and all income  
282 settings, we identified 15 major causal categories from nearly 900 causal terms; eight categories were  
283 common to the majority of reports. Despite this overarching commonality, we found wide variation  
284 in frequency of stillbirth categories and in the systems used to classify them with generally poor  
285 quality data. Underlining one of the key challenges of achieving the Every Newborn Action Plan  
286 stillbirth target, are the high proportions of stillbirths without information to guide prevention  
287 (*Unexplained* and *Other unspecified conditions*) in all income settings.

### 288 ***Strengths and limitations***

289 We sought to include the most detailed causes of stillbirth available to allow identification of common  
290 groupings, and ultimately to enable consistent reporting across settings. In line with WHO  
291 recommendations<sup>4,44</sup> and to maximize the utility of the data for prevention strategies, we excluded  
292 reports which assigned more than one cause of stillbirths and excluded all those reported as associated  
293 only. This may have resulted in a loss of information and limited our ability to assess the full value  
294 of the ICD-PM, which aim to record both a fetal and a maternal condition for every stillbirth. The  
295 need to assign multiple causes for some stillbirths has been highlighted. Further, the distinction

296 between causes and associated conditions is often poorly defined<sup>26</sup> and in this review many reported  
297 “causes” are not recognised as causal conditions. Further, although we imposed no language  
298 restriction, we may have missed some reports due to English-language search terms.

## 299 *Interpretation*

### 300 *Data quality*

301 Data quality was generally poor with only a small number of reports based on high quality perinatal  
302 mortality audit. Further, many reports did not provide sufficient detail to adequately assess quality.  
303 Similar to others<sup>1,5,45</sup>, we found global comparisons problematic due to differing definitions and  
304 systems. The inability to identify termination of pregnancies in reporting of stillbirth causes is  
305 problematic; many are terminated as a consequence of congenital anomalies<sup>46</sup>, some of which may  
306 not have resulted in stillbirth.

### 307 *Global causes of stillbirth*

308 Results of the pooled analysis enabled comparisons of stillbirth causes across settings, providing  
309 additional evidence for key areas for prevention. The relatively high proportion of stillbirths attributed  
310 to intrapartum hypoxia (*Hypoxic peripartum*) in LIC versus HIC and MIC is in line with recent  
311 evidence from low- and middle-income countries (LMIC)<sup>47,48</sup> and confirms the urgency of improving  
312 care during labour and birth, when half of all global stillbirths occur<sup>1,3,47,49</sup>. Further, similar to other  
313 reports<sup>47,48</sup> we identified infection as a top cause of stillbirths in LIC, confirming the importance of  
314 infection prevention and management<sup>3,49,50</sup>. Our findings clearly highlight the importance of placental  
315 conditions as a major contributor to stillbirths in all settings, consistent with other recent studies<sup>47,51</sup>.  
316 However, many placental conditions were ill-defined and the causal link unclear (for instance delayed  
317 villous maturation)<sup>52,53</sup>. Many conditions that lead to stillbirth are also linked to neonatal deaths and  
318 therefore both must be accommodated within a single system to ensure optimal pregnancy care and  
319 outcomes<sup>54</sup>.

### 320 *ICD-PM and progress towards global reporting*

321 We confirmed findings of other studies, showing numerous disparate systems for classification of  
322 stillbirths in use globally<sup>5,45,55</sup>, further highlighting the need for a globally effective classification  
323 system. A recent consensus described user-identified characteristics for such a system<sup>56</sup>, however no  
324 existing systems meet these characteristics<sup>57</sup>. Further, robust evaluation of system performance is  
325 limited<sup>6</sup>. The ICD-PM is the first system intended for global use in classification of perinatal  
326 deaths<sup>4,58-60</sup>, aiming to facilitate comparisons by improving perinatal mortality data, particularly in  
327 high burden settings. While evaluation of the performance of ICD-PM is currently limited,  
328 retrospective application to datasets in the UK and South Africa highlighted its values and provided  
329 insights to future improvements<sup>59</sup>. In our dataset, all causes of stillbirths reported globally could be  
330 accommodated within the ICD-PM. However, our mapping of causes from good quality reports in  
331 HIC using clinical classification systems highlights that classification system needs differ across  
332 settings. Meeting the needs of diverse settings is essential for global comparisons to identify important  
333 variation and inform programmatic change to reduce deaths.

334 The WHO Perinatal Mortality Audit and Review guide<sup>7</sup> provides a tool to initialize audits in low-  
335 income settings using the ICD-PM for classifying perinatal deaths. The ICD-PM maps ICD-10 codes  
336 to an underlying fetal cause of antepartum, intrapartum or unknown timing, and a maternal condition;  
337 thus, data collection must include timing as well as fetal and a maternal condition. While this approach  
338 aims to capture information on stillbirths from low resource settings (either cause and/or associated  
339 conditions) the ICD-PM faces challenges due to its ICD-10 provenance, including insufficient  
340 differentiation of causes from associated conditions, and insufficient detail on maternal conditions<sup>8</sup>.

341 Conditions noted as Maternal in the ICD-PM include not only fetal underlying causes (*Placenta, cord*  
342 *and membranes*), but also maternal causes (*Maternal complications of pregnancy*) and maternal  
343 associated conditions (*Maternal medical and surgical conditions*). Further, one-fifth of stillbirths in  
344 the global category *Unexplained* mapped to ICD-PM *Antepartum asphyxia*. Classifying associated  
345 conditions is important, particularly in data poor settings where assigning cause may be difficult.  
346 However confusing causes from associated conditions or mechanisms of deaths (antepartum

347 asphyxia) while reducing the number of *Unexplained*, may obscure key areas for prevention. WHO  
348 is currently working towards ICD-11 which provides an opportunity to alleviate some of these  
349 issues[World Health Organization, #269].

350 Differences in proportions of causal categories across countries, were likely due to different  
351 classification approaches. Codac<sup>19</sup> was the only non-ICD system fully aligned with the ICD-PM.  
352 Although Codac has previously been shown to be the best-performing system<sup>45</sup>, the majority of  
353 stillbirths classified using Codac were mapped to unknown timing and cause within the ICD-PM (data  
354 not shown). Codac also resulted in a high proportion of *Unexplained* stillbirths, potentially influenced  
355 by the categories included. Moreover, this system was only aligned with nine of the 17 user-identified  
356 characteristics for an effective global system. Future enhancements to global classification of  
357 stillbirths need to incorporate user-identified characteristics for an effective global system. Further,  
358 optimisation of information from data-rich settings to incorporate recent advances in stillbirth  
359 aetiology such as the consensus on placental pathology<sup>53</sup>, and other detailed laboratory investigations  
360 will serve to advance prevention of stillbirths globally. Implementation of any system must also be  
361 accompanied by appropriate training to ensure high-quality data.

## 362 **Conclusion**

363 To achieve the Every Newborn Action Plan global stillbirth rate target, improving care of women in  
364 labour and birth and preventing and treating infections and the quality of data on causes to drive  
365 change are priorities. Implementation of ICD-PM as part of the WHO Perinatal Mortality Audit and  
366 Review guide<sup>7</sup> would be a major step forward. While the ICD-PM captures data from high-burden  
367 settings by allowing for a minimum of timing and clinically defined causes and associated conditions,  
368 a global system must also accommodate needs of data-rich settings to enable global comparisons.  
369 Clearly ascertaining underlying causes separate from associated conditions and enabling capture of  
370 more detailed information in data-rich settings will fully harness the ICD-PM's potential for global  
371 reporting and prevention of stillbirths. Further research is needed to improve the classification of



372 placental causes of stillbirths. Enhancements to global classification of stillbirths and neonatal deaths  
373 must be based on comprehensive testing across diverse settings.

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#### 389 **Contribution to Authorship**

390 HR was responsible for the conduct of the study. VF conceptualized the study and developed methods  
391 and procedures with HR, MC and SHL. HR, VF, SHL, AW and ZT undertook searches, selection of  
392 studies, data extraction and quality assessment. GG, DE, RL and VF created the global stillbirth  
393 categories. MC oversaw all statistical aspects of the study and undertook the pooled analysis. VF and  
394 SHL undertook the assessment of ICD-PM alignment with advice from RP, JG, ÖT and EA. HR and  
395 VF were responsible for interpretation of findings and preparation of the first draft of the manuscript.

396 SH, AW, GG, RL, DE, ZT, EA, HB, ED, JJE, FF, JG, KG, SG, AG, AH, YK, FK, JL, EM, JO, RP,  
397 KP, DS, RS, GS and ÖT have been actively involved throughout planning and consultation stages of  
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400 approved the final version. All authors are part of The International Stillbirth Alliance Collaborative  
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#### 402 **Details of Ethics Approvals**

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