Cover page

Title

Neonatal intracranial pathologies on ultrasound imaging in sub-Saharan Africa: A systematic review and meta-analysis

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Category of study: Systematic Review

Impact:

- Newborn conditions, like prematurity and neonatal encephalopathy, are leading causes of under-5 child mortality, with the greatest burden in sub-Saharan Africa.
- Intracranial pathologies relating to newborn conditions, may have important long-term consequences, yet frequently go undetected in settings with limited access to imaging.
- We examined the spectrum and prevalence of different neonatal intracranial pathologies detectable on cranial ultrasound imaging from the sub-Saharan Africa region.
- A wide spectrum of intracranial pathology was reported, including a high prevalence of intraventricular haemorrhage and periventricular leukomalacia among small and preterm neonates, with potential important implications for childhood outcomes.

Abstract

Background: Annually, 30 million children are affected by newborn conditions, most in low-income countries, with long term implications for survivors. We aimed to evaluate neonatal intracranial pathologies identifiable on cranial ultrasound (CUS) in sub-Saharan Africa (SSA).

Methods: This systematic review and meta-analysis explored the spectrum of neonatal intracranial pathology, in nine databases, using the Joanna Briggs Institute Systematic Review Tools. The review was registered with PROSPERO (CRD42022309249).

Results: In total, 92 studies from 14 countries were identified, with South Africa (34%) and Nigeria (28%) most represented. Of these, 38 (42%) focused on intraventricular haemorrhage (IVH), 13 (14%) on congenital brain anomalies, 11 (12%) on intracranial infection, 9 (10%) on ventriculomegaly/hydrocephalus, and 7 (8%) on neonatal encephalopathy. IVH pooled prevalence was 29% (CI 23-35%), with a quarter high-grade (24%, CI 20-29%). Higher prevalence was seen at lower gestation (<32 weeks, 38% (CI 26%-50%)) and birthweight (<1500g, 32% (CI 24-40%)). Periventricular leukomalacia was less common than IVH (9% (CI 6-13%)).

Conclusion: A spectrum of intracranial pathology has been reported on neonatal CUS from SSA. IVH affected close to one third of at-risk neonates, and PVL one in eleven, with potentially important implications for longer term outcomes for affected children.

Body Text

INTRODUCTION

Globally, neonatal conditions such as prematurity, small-for-gestational-age, intrapartum-related neonatal encephalopathy (NE) and neonatal infections remain a major global health challenge, representing some of the leading causes of under five-year child mortality. [1] Importantly, each of these conditions can have substantial impacts on the developing brain with important lifelong consequences for survivors. Despite decreasing trends in both child and neonatal mortality over the past decade, no significant change in the incidence of the main neonatal conditions has been seen. [2] Sub-Saharan Africa (SSA) continues to shoulder a significant proportion, including nearly one third of the 13.4 million global preterm births, and an estimated 478,000 million incident cases of NE. [3,4]

Cranial ultrasound (CUS) imaging through the patent cranial fontanelles is a safe, easy to perform, non-invasive imaging modality that can be used to detect important intracranial pathologies including haemorrhagic, ischaemic, infective, metabolic and maturational changes, as well as major congenital abnormalities. [5] Modern machines, incorporating Doppler sonography and high-frequency transducers, provide increasingly detailed views of the neonatal brain and vasculature. Its combined diagnostic ability, comparatively low cost and portability make CUS a potentially important tool in improving neonatal care in resource limited settings. However, operators need to be skilled in image acquisition, and expertise in accurate interpretation of findings is required. Knowledge around the relative availability, and use, of CUS as part of routine neonatal care in SSA is currently lacking; in Nigeria, only 14% of reported ultrasound machines were dedicated to children in a recent survey of radiology doctors working in mostly tertiary health facilities. [6]

To date clinical research in the SSA setting has used CUS to examine the prevalence of intracranial pathology amongst term neonates with NE, amongst neonates born preterm, and as part of pre-operative imaging in endoscopic surgery trials for paediatric hydrocephalus. [7-9] Prematurity and intrauterine growth restriction are associated with an increased risk of intraventricular haemorrhage (IVH) and periventricular leukomalacia (PVL), which, in turn, significantly increase the risk of cerebral palsy and other neurodevelopmental impairments affecting cognition, language, hearing, and vision. [10,11] Although both conditions can be promptly diagnosed, and evolution and severity tracked, by serial CUS imaging, there is limited literature on the prevalence of these important conditions amongst neonates in SSA. [12]

To our knowledge, to date, there has been no previous systematic review of neonatal brain pathology, detectable on CUS imaging, in SSA. Hence, we aimed to synthesise the available published literature on the spectrum of common intracranial pathologies detected by CUS during the neonatal period in SSA, including the prevalence of IVH and PVL.

METHODS

This Systematic Review was conducted according to 2022 Joanna Briggs Institute (JBI) guidance for Systematic Reviews of Prevalence, registered with PROSPERO (CRD42022309249) and is reported here according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. [13,14, 15]

Search strategy

We conducted a systematic search of the bibliometric databases MEDLINE, Embase, Global Health, Global Index Medicus, Cochrane library, PsycInfo, Scopus, Web of Science as well as Google scholar using relevant keywords and medical subject headings related to: African countries, neonates, as well as CUS or intracranial pathologies (Supplementary Appendix

S1). The last search was conducted on 22 February 2023 with no restrictions to time or language of publication. Reference lists of included articles and relevant review articles were hand-searched; where data was missing corresponding authors of relevant publications were contacted.

Study selection

The review question was formulated according to the JBI Condition/Context/Population (CoCoPop) framework and included studies fulfilled the following criteria; (1) Condition: primary study reporting intracranial pathology detected on CUS imaging conducted in the neonatal period with the publication explicitly mentioning CUS as a method of diagnosis; (2) Context: conducted in the geographic region of sub-Saharan Africa (as defined by the World Bank); (3) Population: study presents primary data from neonates. Pragmatically we included data for infants <3 months of age to capture preterm and small for gestational age (SGA) neonates of uncertain gestational age.[14,16] We excluded review articles and studies presenting only aggregate data grouped by age ranges not exclusive to the neonatal period.

Abstracts of retrieved studies were screened independently by two review authors (two of: EL, GY, JE, ED) with a consistency check of inter-reviewer agreement demonstrating a Kappa value of 0.88. Disagreement between reviewers over eligibility of particular studies was resolved through discussion with a third reviewer. The full text of potentially eligible studies was similarly independently assessed for eligibility by two review team members (two of: EL, GY, JE, ED, RM).

Data extraction

Two review team members (EL, GY, JE, ED) independently extracted data from included full text articles using a purpose-built, pre-piloted Excel form with discrepancies resolved by discussion.

Study quality assessment

For included studies presenting counts of IVH events, number of individuals and/or prevalence, two review team members (EL, CT) independently appraised methodological validity using the nine question JBI appraisal tool for prevalence studies. [14,17,18] Differences were resolved by discussion and studies with scores of 0-4 assigned 'low', 5-7 assigned 'intermediate', 8-9 scores 'high' quality.

Data synthesis

Included studies are described in summary tables stratified by type of intracranial pathology. Counts of IVH events and their denominator were extracted from the studies according to IVH severity as low grade (grade I/II) or high grade (grade III/IV) consistent with Papile criteria. [19] We used random effects meta-analysis to estimate pooled prevalence of IVH according to grade of IVH, birthweight, gestation and, for studies reporting PVL, prevalence. Study-specific estimates are reported in forest plots as an overall pooled prevalence, using a two-sided 95% confidence intervals. Statistical heterogeneity was assessed using the I^2 statistic. To explore potential sources of between-study heterogeneity, we further performed meta-regression on known risk factors (prematurity and birthweight), study quality (intermediate or high), country income level (low-income, lower-middle-income, or upper-middle-income country) and publication year (before or after 2010). Publication bias was assessed visually using Doi plots and quantitatively using the Luis Furuya-Kanamori (LFK) index. All analyses were performed using Stata v17 (College Station, Texas).

RESULTS

Of 10,223 records screened; we identified 103 relevant publications (representing 92 studies) reporting primary neonatal CUS data, from 14 sub-Saharan Africa countries (Fig. 1). South Africa (33.7%, n=31) and Nigeria (28.2%, n=26) were most highly represented (Fig. 2a). Study types ranged from interventional (6.5%, n=6), prospective observational (39.1%, n=36), retrospective observational (23.9%, n=22), case series (4.3%, n=4) and case reports (26.1%, n=24) (Table 1, Supplementary Tables S1 and S2).

Spectrum of intracranial pathology

The majority of included studies focused on detection of IVH (+/- PVL) (41.8%, n=38). These are described in more detail including quantitative summary estimates of prevalence below. After IVH, congenital structural abnormalities (n=13), intracranial infection (n=11), ventriculomegaly/hydrocephalus (n=9) and CUS studies relating to neonatal encephalopathy (NE) (n=7) were most commonly represented (Fig. 2b). In total, 53 CUS studies, from 12 countries, examined non-IVH intracranial pathology (Fig. 1). These are summarised by pathology of focus below and described in detail in Supplementary Table S1. The country with the highest number of studies that were not focused on IVH was Nigeria (n=18), accounting for a third of such studies, followed by South Africa (n=13). Two interventional studies were included, the remaining were observational studies with case reports and case series accounting for 50% (n=26).

Congenital structural anomalies

Of the 13 studies reporting on congenital structural anomalies, 11 were case reports, from seven different countries. In these studies, CUS was performed in response to either abnormal antenatal imaging or clinical suspicion in the neonatal period. A variety of pathology was

reported including Arnold-Chiari malformation, Dandy-Walker malformation, lissencephaly, hydranencephaly, holoprosencephaly and periventricular nodular hypertrophy. [26-38]

Neonatal intracranial infection

Of 11 studies relating to intracranial infection, only four had a study population of >5 neonates. In those studies, CUS was performed in 40.9-100% of the total study population. [39-42] Missker et al performed the largest study looking at CUS findings in 83 newborns with intracranial infection during the first 18 postnatal days following a diagnosis of meningitis based on CSF white cell count or clinical suspicion if the newborn was too unwell to undergo lumbar puncture. [42] Abnormal findings were reported in 16.1% (14/83), with hydrocephalus being the most common finding (92.8%).[42]Adhikari et al reviewed CUS findings in infants with bacterial meningitis, diagnosed on CSF culture or positive Streptococcus agalactiae CSF antigen test. [39] Of 44 neonates, 18 underwent CUS, and 10 (55.5%) had abnormal findings including primarily grade I/II IVH (3 neonates) or ventricular dilatation +/- ventriculitis (7 neonates). [39]

Ventricular dilatation and hydrocephalus

There was variation in the parameters used in CUS diagnosis of hydrocephalus. One study defined hydrocephalus as mean diameter >2.5mm +/- 0.7mm of anterior horns of left and right lateral ventricles at the level of the foramen of Monro and another according to the diameters of the occipital horn and body of lateral ventricles in sagittal view as >16mm and >3mm, respectively. [43,44] Non-communicating hydrocephalus was seen most commonly in both studies. Marchie et al compared the mean diameter of the anterior horn of left and right lateral ventricles at the level of foramen of Monro in hydrocephalic newborns with healthy controls. The mean diameters in hydrocephalic infants were 18.4 mm ± 14.3 mm (left) and

20.1 mm ± 16.8 mm (right) compared to 2.5 mm ± 0.6 mm (left) and 2.5 mm ± 0.7 mm (right) in controls. [45]

Neonatal encephalopathy

Two interventional studies were identified, looking for CUS changes consistent with brain injury in NE cases, in the context of randomised controlled trials investigating effects of selective cerebral hypothermia and magnesium supplementation. [20,21] Where specified, scans were performed by neonatologists and/or radiologists, including five studies where internationally trained doctors/researchers trained local staff. Seven studies reported NE findings such as cerebral oedema, white matter changes and basal ganglia-thalami abnormalities. [7,20,21,46-49] Tann et al compared CUS findings in term newborns with NE to unaffected term newborns in a large cohort comparison study. [7] They reported 21.2% of NE infants with major evolving injury on early CUS performed at a median age of 11.5 hours, compared to 1% of the comparison cohort and major CUS abnormalities were associated with an increased risk of neonatal death (OR 3.34). [7]

Non-IVH intracranial haemorrhage

Non-IVH intracranial haemorrhage was infrequently reported with only three case reports identified. [50-52]

Screening for suspected pathology

Alongside two case reports, four cross-sectional studies reported on findings from CUS used as a screening tool for suspected pathology, three of the studies were from different teaching hospitals in Nigeria where findings specific to the neonatal period were not detailed and the fourth was from a rural hospital in Tanzania. [22,53-55]

Defining parameters in healthy newborns

Three CUS studies aimed to define baseline parameters, such as cerebral ventricular size, amongst healthy neonates, with study populations between 100 and 115. [56-58]

Prevalence estimates for intracranial pathologies

Overall, our review only yielded adequate data to estimate pooled prevalence for two intracranial pathologies: intraventricular haemorrhage and periventricular leukomalacia.

Prevalence of intraventricular haemorrhage

Overall, 38 studies reported primary data on IVH detected by neonatal CUS (Table 1 and Supplementary Table S2). These were predominantly observational studies (retrospective 36.8% n=14 [including one case report]; prospective 52.6%, n=20) with only four identified interventional studies reporting IVH prevalence (10.5%). Size of study populations that underwent neonatal CUS ranged from 1 to 981 with 21 study population including at least 100 scanned neonates. 15 of these studies were excluded from prevalence analysis most commonly due to lack of denominator data (5 studies), data limited to severe grade only (3 studies) or no disaggregated preterm-specific data presented (3 studies) (Fig. 1, Supplementary Table S2).

In total, 23 studies (16 prospective observational, 4 retrospective observational, 3 interventional) including a total of 4323 preterm and/or low birth weight neonates were included in the random effects meta-analysis (Table 1). [59-85] All included studies were of intermediate (11 studies) or high (12 studies) methodological quality (Table 2).

Studies were conducted in tertiary/quaternary hospitals (9 studies), teaching hospitals (8 studies), regional referral (4 studies) or national referral hospitals (2 studies); with a predominance in South Africa (9 studies) and Nigeria (5 studies). Eligibility criteria for CUS

scanning were most frequently based on birthweight, with 10 studies exclusive to very low birthweight (VLBW, <1500g), and/or gestation at birth with all included studies restricted to preterm neonates (<37 weeks), and six studies including only those of a gestation of <35 weeks or less (Table 1). [59-85]

Where detailed (21 studies, 3343 neonates), first reported CUS were performed within 72h after birth in 10 studies (1820 neonates) and within the first 7 days after birth in 6 studies (824 neonates). Screening scans continued up to day 7 in 10 studies (2169 neonates) and to day 14 or beyond in 9 studies (1502 neonates), suggesting that for the majority of studies it is unlikely IVH was missed due to not scanning late enough. [59-75,77,78,80,82-85]

Detection of post-haemorrhagic ventricular dilatation (PHVD) or post-haemorrhagic hydrocephalus (PHH) on CUS was mentioned in only eight studies, with often unclear denominators as to how many neonates underwent serial/later scans.[61,62,67,74-76,80,83,84]

In total, 11 studies detailed the CUS operator, with the majority performed by radiologists (5), paediatricians (4) or a combination of the two (2). [61-67,70,73,74,76-78,84,85] Two described CUS operator training and one utilisation of existing CUS guidelines. [70,80,84] The majority of studies used 3-7Mz probes but four only used 5MHz probes even though they were scanning preterm infants. However, in eight studies information on CUS machine and probes used was not available (Table 1). The majority of studies specified that they scanned in two planes (Table 2).

IVH by grade

The pooled prevalence of IVH of any grade was 29% (CI 23-35%) (Fig. 3a). Where Papile grading of IVH severity was applied (17 studies, 3542 neonates), low grade IVH was more common than high grade, with a pooled prevalence of 21% (CI 17-25%) and 7% (CI 5-8%)

respectively (Fig. 3b and 3c). High grade IVH constituted a quarter (24%, CI 20-29%) of all IVH (Fig. 3d). DOI plots and LFK index exhibited no asymmetry for any of these analyses suggesting no publication bias was present (Fig. 4)

IVH by gestation and birthweight

Subgroup analysis and meta-regression showed that IVH prevalence was increased in neonates of lower birthweight or lower gestational age; pooled prevalence of any grade IVH was 32% (CI 24-40%) in infants with a birthweight <1500g and 38% (CI 26%-50%) in those born at <32 weeks gestation (Table 3).

The meta-regression showed no evidence of a difference in prevalence based on study period (before/after 2010), country economic status (World Bank) and methodological quality score (Table 3 and Supplementary Fig. S1). No significant between group difference in prevalence was seen. DOI plots showed no (LFK index within ±1) or only minor asymmetry (LFK index within ±2) consistent with no indication of publication bias (Supplementary Fig. S2).

Prevalence of periventricular leukomalacia

Twelve of the 23 IVH studies (2938 neonates) also reported on the prevalence of periventricular leukomalacia (PVL). There was wide variation in terms of specification of PVL type, with only 4 of the 12 included studies referring specifically to cystic PVL (cPVL), 3 studies definitely including increased echogenicity PVL and the remainder simply referred to 'PVL' (Table 1). The majority of these study populations (11 studies, 2760 neonates) included only neonates with a birth weight <1500g. Gestational age for these study populations, where described, ranged more widely (Table 1). The pooled prevalence of PVL was 9% (CI 6-13%) (Fig. 5a). A DOI plot showed minor positive skew asymmetry (Fig. 5b).

DISCUSSION

This study is, to our knowledge, the most comprehensive review to date examining neonatal CUS findings from sub-Saharan Africa reporting on a spectrum of important intracranial pathology from a variety of neonatal conditions. Included studies reported on CUS findings associated with a variety of neonatal conditions, including prematurity, low birth weight, neonatal infection, neonatal encephalopathy and structural brain abnormalities. By far the greatest number of studies explored the prevalence of IVH and PVL in at-risk (preterm or low birthweight) populations. On meta-analysis, IVH affected close to one third of at-risk neonates, and PVL one in eleven, with potentially important implications for longer term outcomes for affected children.

A recent systematic review demonstrated that CUS use is increasing in LMICs across a wide range of healthcare settings, with paediatric use estimated to represent 6% of included studies in the review. [86] In our study, Nigeria and South Africa were the most highly represented countries, followed by those in the East African region. The predominance of these host countries for published neonatal CUS studies echoes previous analysis of African research production, with for example Nigeria, South Africa and Egypt accounting for 60% of publications of African-hosted research indexed by PubMed in 1996-2005. [87,88]

There is evidence of feasibility and benefit for routine use of newborn CUS in clinical practice in SSA settings. [6,22,25] Whilst the majority of studies meeting the eligibility criteria for our review examined the prevalence of IVH in at-risk populations, we found published studies reporting on a spectrum of neonatal conditions. For example, in Uganda, a CUS study amongst NE infants showed that abnormalities on early CUS (day 1) were associated with neonatal death. [7] In the same study, later scans (day 4/5) correlated with neurodevelopmental impairment at two years of age suggesting that in settings without access to neonatal brain MRI, CUS may have a role in stratifying NE survivors for targeted follow-up of those most at

risk to provide access to early child intervention programmes.[89] Expanding the use of CUS in resource limited, majority world settings might improve diagnosis of neonatal intracranial pathology and support prognostication, as well as optimise care by, for example, initiation of timely and targeted referral and follow-up.

In high-income country settings, CUS is routinely used to screen asymptomatic, at-risk neonatal populations for intracranial pathology, in particular for IVH and PVL amongst a preterm population. Similarly, in this review, most included studies relating to IVH prevalence reported CUS findings in at-risk populations, often asymptomatic of intracranial pathology. Of the studies utilising CUS to report on non-IVH pathology, only three non-case studies utilised CUS on healthy newborns, in all others signs and symptoms of neonatal conditions related to the intracranial pathology were present.[56-58].

Prevalence of IVH and PVL

We found that IVH was reported in more than a quarter of preterm neonates and increased in frequency with reducing gestation and birth weight. Lower gestation had a more significant impact on IVH incidence than lower birth weight, consistent with recent other studies, including a 2023 cohort study from Sudan.[90] A recent meta-analysis of IVH in studies published from 2010-20 did not include any African studies, but estimated a global incidence rates of any grade IVH of 17.4% (CI 13.8- 21.6%) for those born at a gestational age of 28–31 weeks, and 34.3% (CI 31.2-37.6%) for gestational age of <28 weeks.[91] By comparison we estimated a pooled prevalence of any grade IVH in 38% (CI 26-50%) in those SSA neonates born before 32 weeks gestation, suggesting that IVH rates may be higher than the global average for very premature newborns in SSA.

For high grade IVH we found a pooled prevalence of 7% (CI 5-8%) for preterm neonates in SSA; whilst we were unable to analyse rates of high grade IVH in subgroups by gestational age, this compares to global estimates of 1.8% (CI 1.2-2.8%) for those born at a gestational age of 34-36 weeks, 3.3% (CI 2.1-5.1%) for 32-33 weeks, 4.6% (CI 3.5-6.1%) for 28–31 weeks and 15.0% (CI 13.1-17.2%) for those born at a gestational age of <28 weeks. [91] Again, this suggests that the burden of severe IVH may be higher in SSA than globally. Furthermore, in our study 24% (CI 20-29%) of detected IVH were high-grade and, given high early mortality rates meaning that infants may die prior to imaging, this is likely to be an underestimate of the true prevalence. As known consequences of IVH include developmental delay and disability, this common pathology has potentially far-reaching implications for affected children and families. [10,11,92] Of note, the important potential IVH sequelae of PHVD or PHH was rarely reported, possibly related to the fact that only a minority of studies reported on serial CUS scanning beyond 14 days of age.

Regarding PVL prevalence, we estimated this to affect 1 in 11 infants in the CUS studies reported here, nearly all of which were conducted on very low birthweight (<1500g) newborns. It is likely that PVL rates reported here are an underestimation given that a significant proportion of studies reported on CUS findings only in the first 7-14 days from birth, when cystic changes might well not yet have manifested and/or utilised 5MHz probes which might not detect smaller more focal cystic change. The challenge of detecting non-cystic PVL on ultrasound scan, variable study populations as well as potential for variation in image interpretation and PVL classification are likely to further contribute to discrepancies in prevalence estimates. Variability in the definition of PVL might be underlying some of the variation in prevalence reported in individual studies. Four out of five studies reporting PVL prevalence estimates of 3% or less specifically reported cystic PVL only, whilst the two studies with highest PVL estimates specified inclusion of increased echogenicity PVL.

Contextual global estimates of PVL prevalence in preterm neonates vary widely according to imaging modality, gestation and other risk factors. A meta-analysis of 39 studies describing PVL prevalence, that did not included any studies from Africa, reported an overall 14.7% prevalence of PVL (of any type) detected by CUS in preterm newborns, with gestation stratified data showing a 7.3% prevalence in those less than 37 weeks and 27.4% in those less than 32 weeks gestation, and rates of PVL detected on MRI scanning higher yet at an overall 32.8%.[93] A recent systematic review of risk factors for all grades of PVL included only a single study from SSA, and our study therefore presents the to date most comprehensive estimate of PVL pooled prevalence in SSA.[66,94]

Whilst our meta-analysis focussed on the use of CUS in SSA we were only able to estimate prevalence of IVH and PVL - pathologies affecting preterms who are at highest risk of brain injury. CUS has also been shown to be useful in detecting other intracranial pathologies in late preterms and term neonates and this appears to be, by comparison, an underexamined or underreported group.

Strengths and limitations

Our research represents the first comprehensive systematic review of neonatal CUS findings from SSA. Limitations of the presented data include heterogeneity of the study populations, early mortality in scanned populations leading to underestimation of the prevalence of intracranial pathology, lack of clear definitions of risk factors (such as method of gestational age assessment) and the frequency of missing data in included studies. To capture the spectrum of neonatal intracranial pathology reported on through the utilisation of CUS, we included original data from studies of any design and thus included a significant number of case reports. Notably non-IVH focussed studies only underwent narrative synthesis and we were not able to estimate prevalence for other pathologies, but in the absence of larger studies

we felt it important to include these to illustrate that CUS is utilised for a broad spectrum of neonatal diagnosis in SSA.

Whilst we included only preterm infants in meta-analysis of IVH prevalence, there was incomplete information as to detailed gestation in a significant proportion of included studies, and only about a quarter of included neonates were definitely born very prematurely (gestation of <32 weeks). Nevertheless we were able to show by subgroup analysis and meta-regression evidence that a higher prevalence of any IVH was associated with shorter gestation. Birthweight data was more readily available and over three-quarters of included preterm infants were known to be in the very low birthweight category. In addition, where this could be estimated, mortality rates in study cohorts eligible for CUS were commonly >10% leading to missed scans and a likely underestimation of rates of (severe) IVH. We were also unable to investigate the effect of other risk factors for IVH such as antenatal steroid use or mode and location of delivery due to a lack of data.

Conclusion

In summary, our study has documented the utility of CUS in a broad spectrum of important neonatal intracranial pathologies, associated with a variety of neonatal conditions, reported from studies across SSA. By far the greatest number of studies explored the prevalence of IVH in at-risk populations. There was limited data on the diagnostic use of CUS in important non-IVH conditions. We saw a high prevalence of IVH, and PVL, with increasing prevalence at lower gestational age and birthweight, with far reaching implications for longer term neurodevelopmental outcomes for those most at risk. Whilst it was not within the remit of this review to examine the use of CUS in routine practice, we have shown here that training in undertaking CUS can be successfully implemented in broad SSA geographies. The amount and breadth of the use of point-of-care CUS in SSA is steadily growing, and our

findings suggest a role in diagnosis, prognosis, and targeted intervention for affected children. More research is urgently needed on the incidence and impact of neonatal intracranial pathologies on longer term outcomes and our review has provided evidence of the potentially substantial human impact of newborn conditions on the developing brain in the SSA region. Promoting timely, high-quality perinatal care, including prioritisation of evidence-based neuroprotective strategies as part of small and sick newborn care is crucial, in addition to targeted follow-up of those at the highest risk of developmental delay and disability, to ensure that we leave no child behind in our "Survive and Thrive" agenda. [95]

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Author contributions

E.L. and C.J.T. conceptualized and designed the study. E.L. coordinated and supervised data acquisition, created the data collection sheet, coordinated qualitive analysis of included studies, drafted the initial manuscript and revised it according to feedback. G.Y. contributed to study design, data acquisition and qualitative analysis of included studies and drafted parts of the initial manuscript. J.E. and E.D. contributed to study design and data acquisition. R.M., F.M., W.O., and R.S. all contributed to data acquisition. C.O. conducted statistical analysis and C.J.T. contributed to qualitative analysis of included studies and contributed to the writing and review of the manuscript. C.H. and F.M.C. provided expertise on perinatal neurology and inclusion criteria. All authors reviewed the final version of the manuscript as submitted and agree to be accountable for all aspects of the work.

Competing interests

The authors declare no competing interests.

Consent statement

No patient consent was required for this study.

Figure legends

Fig. 1 PRISMA flow of included publications.

IVH – intra-ventricular haemorrhage; GIM – Global index medicus; SSA – sub-Saharan Africa; CUS – cranial ultrasound scan; * 2 publication records related equally to IVH as well as non-IVH pathology. 11 studies presented in 2 records, 1 study presented in 4 records

Fig. 2 Geographic location and pathology of focus for included CUS studies.

a Number of included neonatal CUS studies by country. Multi-country studies counted for each participating country **b** Neonatal intracranial pathology of interest in included studies. IVH – intraventricular haemorrhage; CUS - cranial ultrasound scan

Fig. 3 Forest plots.

Pooled proportion of **a** IVH of any grade, **b** low grade IVH (Papile grade I/II), **c** high grade IVH (Papile grade III/IV), **d** high grade IVH as proportion of all IVH. ES – estimate; CI - confidence interval

Fig. 4 DOI plots and Luis Furukya-Kanamori indices.

a IVH of any grade, **b** low grade IVH (Papile grade I/II), **c** high grade IVH (Papile grade III/IV), **d** high grade IVH as proportion of all IVH. ES – estimate

Fig. 5 PVL

a Forest plot of pooled proportion, **b** DOI plot and Luis Furukya-Kanamori (LFK) index

ES – estimate; CI - confidence interval

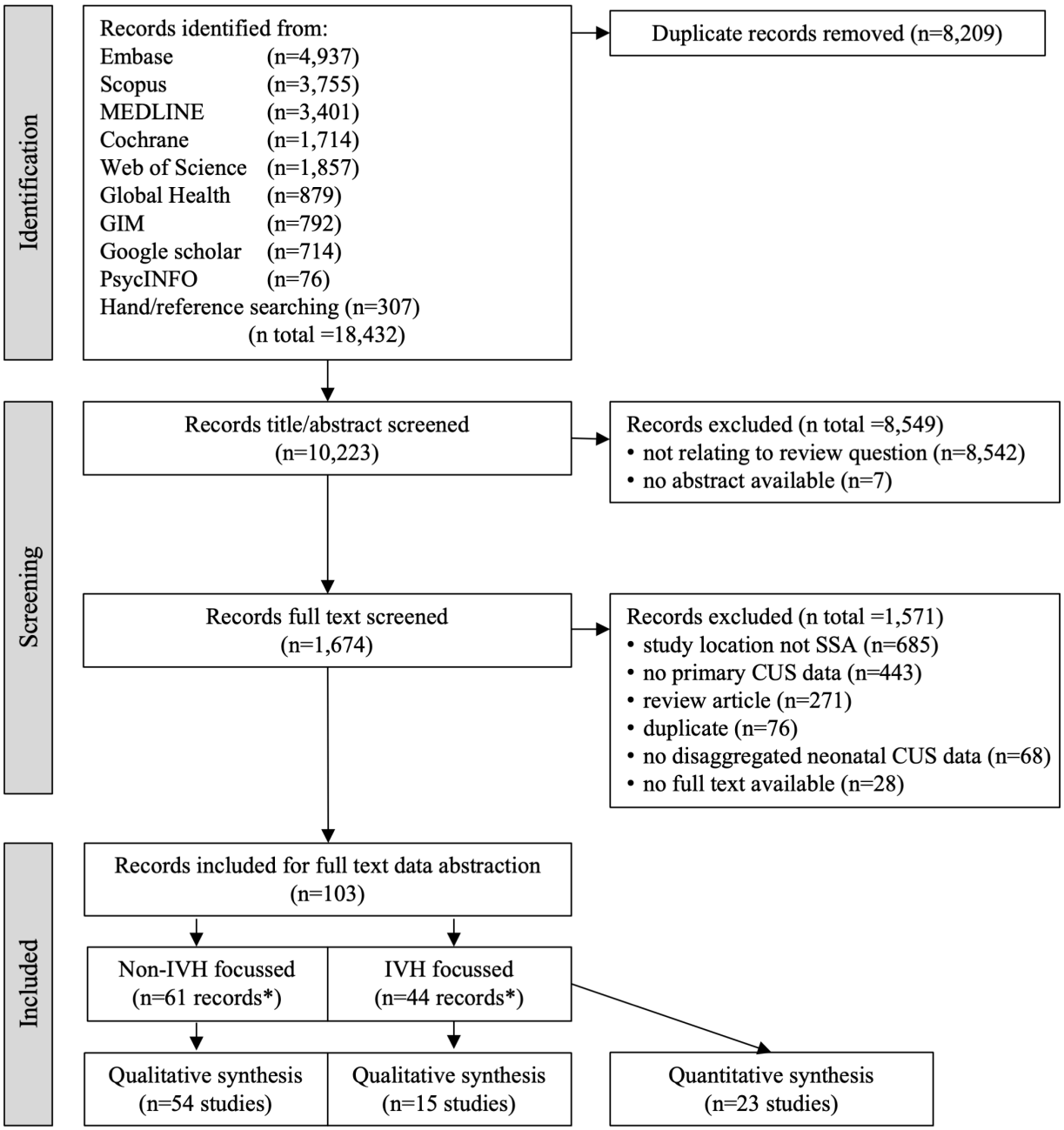


Fig. 1 PRISMA flow of included publications.

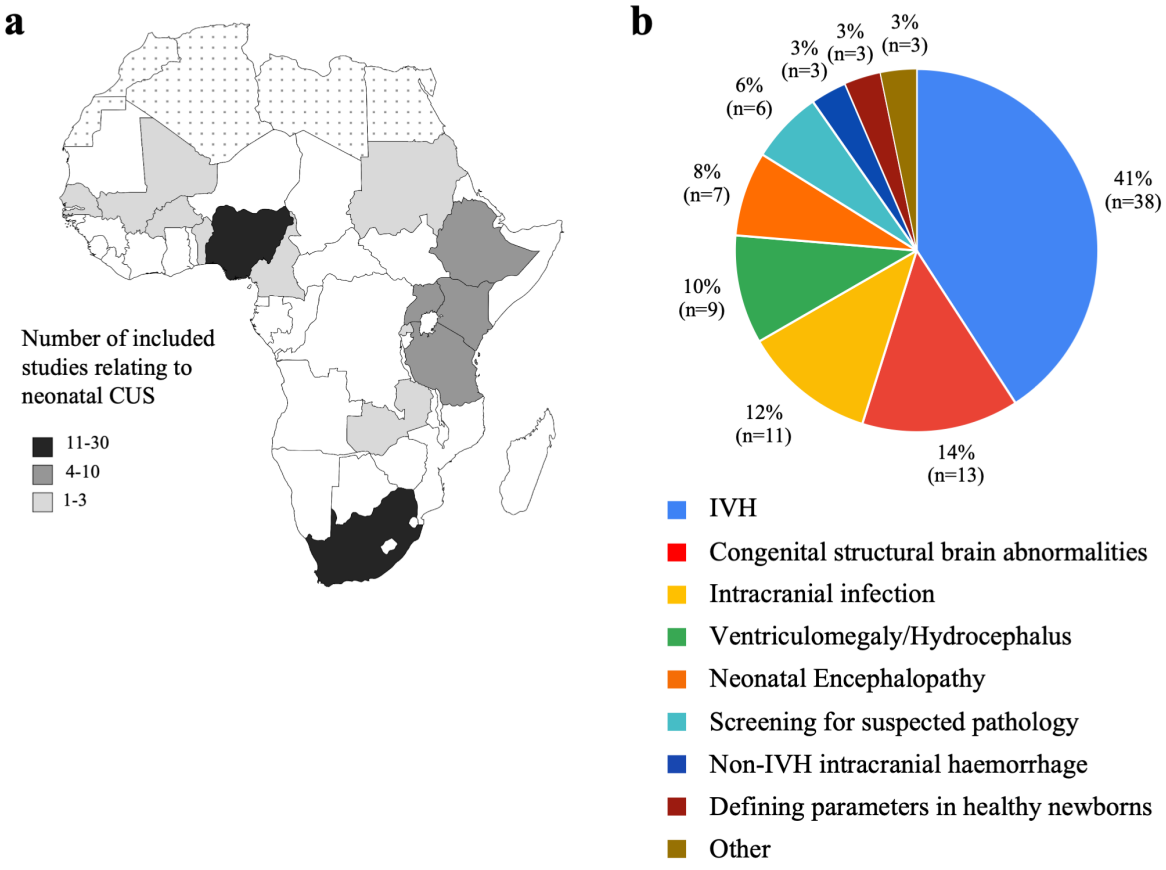
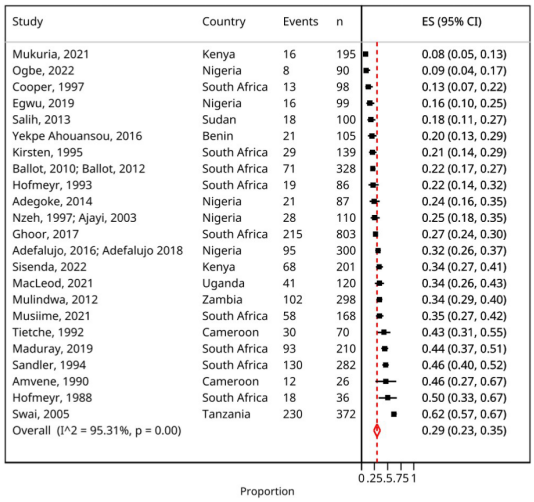


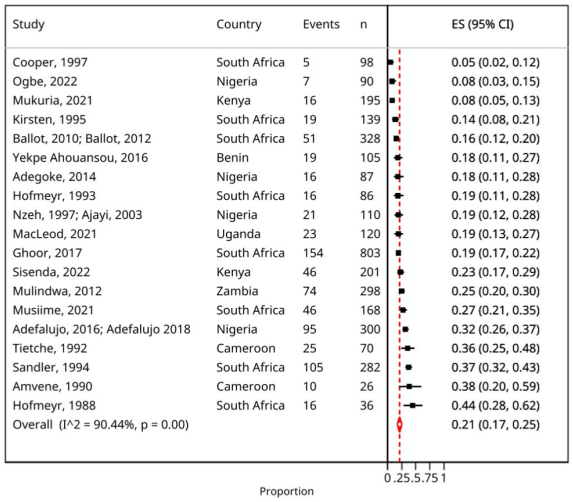
Fig. 2 Geographic location and pathology of focus for included CUS studies.

a IVH of any grade



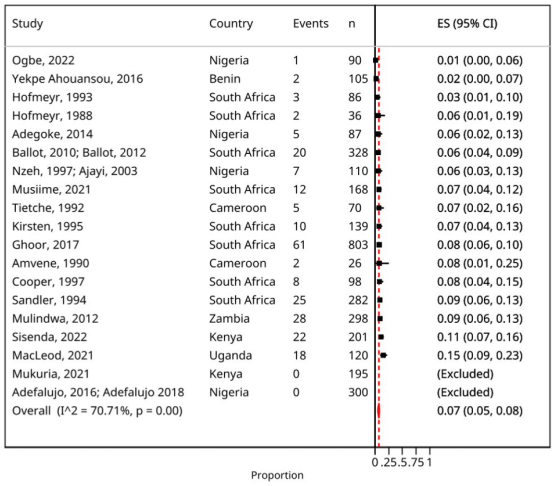
Study	Country	Events	n	ES (95% CI)
Mukuria, 2021	Kenya	16	195	0.08 (0.05, 0.13)
Ogbe, 2022	Nigeria	8	90	0.09 (0.04, 0.17)
Cooper, 1997	South Africa	13	98	0.13 (0.07, 0.22)
Egwu, 2019	Nigeria	16	99	0.16 (0.10, 0.25)
Salih, 2013	Sudan	18	100	0.18 (0.11, 0.27)
Yekpe Ahouansou, 2016	Benin	21	105	0.20 (0.13, 0.29)
Kirsten, 1995	South Africa	29	139	0.21 (0.14, 0.29)
Ballot, 2010; Ballot, 2012	South Africa	71	328	0.22 (0.17, 0.27)
Hofmeyr, 1993	South Africa	19	86	0.22 (0.14, 0.32)
Adegoke, 2014	Nigeria	21	87	0.24 (0.16, 0.35)
Nzeh, 1997; Ajayi, 2003	Nigeria	28	110	0.25 (0.18, 0.35)
Ghoor, 2017	South Africa	215	803	0.27 (0.24, 0.30)
Adefalujo, 2016; Adefalujo 2018	Nigeria	95	300	0.32 (0.26, 0.37)
Sisenda, 2022	Kenya	68	201	0.34 (0.27, 0.41)
MacLeod, 2021	Uganda	41	120	0.34 (0.26, 0.43)
Mulindwa, 2012	Zambia	102	298	0.34 (0.29, 0.40)
Musiime, 2021	South Africa	58	168	0.35 (0.27, 0.42)
Tietche, 1992	Cameroon	30	70	0.43 (0.31, 0.55)
Maduray, 2019	South Africa	93	210	0.44 (0.37, 0.51)
Sandler, 1994	South Africa	130	282	0.46 (0.40, 0.52)
Amvene, 1990	Cameroon	12	26	0.46 (0.27, 0.67)
Hofmeyr, 1988	South Africa	18	36	0.50 (0.33, 0.67)
Swai, 2005	Tanzania	230	372	0.62 (0.57, 0.67)
Overall (I^2 = 95.31%, p = 0.00)				0.29 (0.23, 0.35)

b Low grade IVH



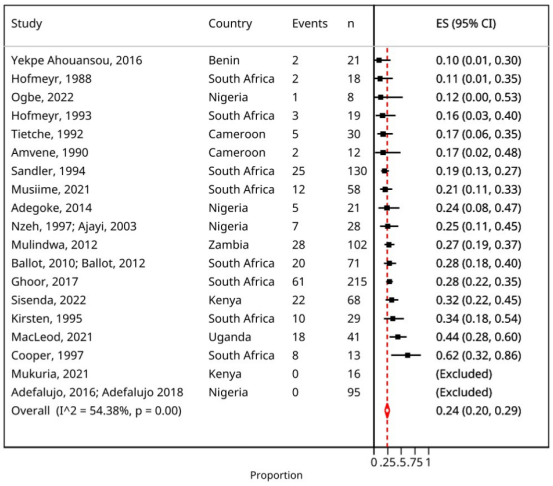
Study	Country	Events	n	ES (95% CI)
Cooper, 1997	South Africa	5	98	0.05 (0.02, 0.12)
Ogbe, 2022	Nigeria	7	90	0.08 (0.03, 0.15)
Mukuria, 2021	Kenya	16	195	0.08 (0.05, 0.13)
Kirsten, 1995	South Africa	19	139	0.14 (0.08, 0.21)
Ballot, 2010; Ballot, 2012	South Africa	51	328	0.16 (0.12, 0.20)
Yekpe Ahouansou, 2016	Benin	19	105	0.18 (0.11, 0.27)
Adegoke, 2014	Nigeria	16	87	0.18 (0.11, 0.28)
Hofmeyr, 1993	South Africa	16	86	0.19 (0.11, 0.28)
Nzeh, 1997; Ajayi, 2003	Nigeria	21	110	0.19 (0.12, 0.28)
MacLeod, 2021	Uganda	23	120	0.19 (0.13, 0.27)
Ghoor, 2017	South Africa	154	803	0.19 (0.17, 0.22)
Sisenda, 2022	Kenya	46	201	0.23 (0.17, 0.29)
Mulindwa, 2012	Zambia	74	298	0.25 (0.20, 0.30)
Musiime, 2021	South Africa	46	168	0.27 (0.21, 0.35)
Adefalujo, 2016; Adefalujo 2018	Nigeria	95	300	0.32 (0.26, 0.37)
Tietche, 1992	Cameroon	25	70	0.36 (0.25, 0.48)
Sandler, 1994	South Africa	105	282	0.37 (0.32, 0.43)
Amvene, 1990	Cameroon	10	26	0.38 (0.20, 0.59)
Hofmeyr, 1988	South Africa	16	36	0.44 (0.28, 0.62)
Overall (I^2 = 90.44%, p = 0.00)				0.21 (0.17, 0.25)

c High grade IVH



Study	Country	Events	n	ES (95% CI)
Ogbe, 2022	Nigeria	1	90	0.01 (0.00, 0.06)
Yekpe Ahouansou, 2016	Benin	2	105	0.02 (0.00, 0.07)
Hofmeyr, 1993	South Africa	3	86	0.03 (0.01, 0.10)
Hofmeyr, 1988	South Africa	2	36	0.06 (0.01, 0.19)
Adegoke, 2014	Nigeria	5	87	0.06 (0.02, 0.13)
Ballot, 2010; Ballot, 2012	South Africa	20	328	0.06 (0.04, 0.09)
Nzeh, 1997; Ajayi, 2003	Nigeria	7	110	0.06 (0.03, 0.13)
Musiime, 2021	South Africa	12	168	0.07 (0.04, 0.12)
Tietche, 1992	Cameroon	5	70	0.07 (0.02, 0.16)
Kirsten, 1995	South Africa	10	139	0.07 (0.04, 0.13)
Ghoor, 2017	South Africa	61	803	0.08 (0.06, 0.10)
Amvene, 1990	Cameroon	2	26	0.08 (0.01, 0.25)
Cooper, 1997	South Africa	8	98	0.08 (0.04, 0.15)
Sandler, 1994	South Africa	25	282	0.09 (0.06, 0.13)
Mulindwa, 2012	Zambia	28	298	0.09 (0.06, 0.13)
Sisenda, 2022	Kenya	22	201	0.11 (0.07, 0.16)
MacLeod, 2021	Uganda	18	120	0.15 (0.09, 0.23)
Mukuria, 2021	Kenya	0	195	(Excluded)
Adefalujo, 2016; Adefalujo 2018	Nigeria	0	300	(Excluded)
Overall (I^2 = 70.71%, p = 0.00)				0.07 (0.05, 0.08)

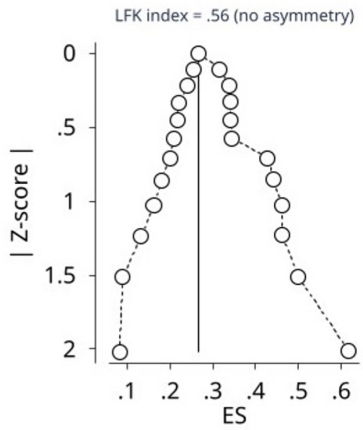
d High grade IVH as a proportion of all IVH



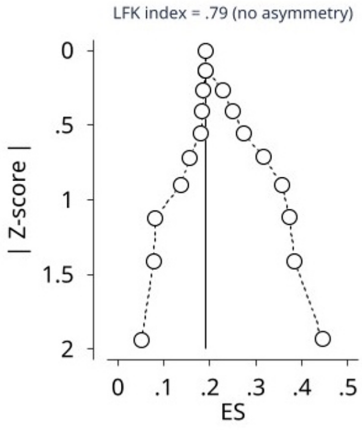
Study	Country	Events	n	ES (95% CI)
Yekpe Ahouansou, 2016	Benin	2	21	0.10 (0.01, 0.30)
Hofmeyr, 1988	South Africa	2	18	0.11 (0.01, 0.35)
Ogbe, 2022	Nigeria	1	8	0.12 (0.00, 0.53)
Hofmeyr, 1993	South Africa	3	19	0.16 (0.03, 0.40)
Tietche, 1992	Cameroon	5	30	0.17 (0.06, 0.35)
Amvene, 1990	Cameroon	2	12	0.17 (0.02, 0.48)
Sandler, 1994	South Africa	25	130	0.19 (0.13, 0.27)
Musiime, 2021	South Africa	12	58	0.21 (0.11, 0.33)
Adegoke, 2014	Nigeria	5	21	0.24 (0.08, 0.47)
Nzeh, 1997; Ajayi, 2003	Nigeria	7	28	0.25 (0.11, 0.45)
Mulindwa, 2012	Zambia	28	102	0.27 (0.19, 0.37)
Ballot, 2010; Ballot, 2012	South Africa	20	71	0.28 (0.18, 0.40)
Ghoor, 2017	South Africa	61	215	0.28 (0.22, 0.35)
Sisenda, 2022	Kenya	22	68	0.32 (0.22, 0.45)
Kirsten, 1995	South Africa	10	29	0.34 (0.18, 0.54)
MacLeod, 2021	Uganda	18	41	0.44 (0.28, 0.60)
Cooper, 1997	South Africa	8	13	0.62 (0.32, 0.86)
Mukuria, 2021	Kenya	0	16	(Excluded)
Adefalujo, 2016; Adefalujo 2018	Nigeria	0	95	(Excluded)
Overall (I^2 = 54.38%, p = 0.00)				0.24 (0.20, 0.29)

Fig. 3 Forest plots.

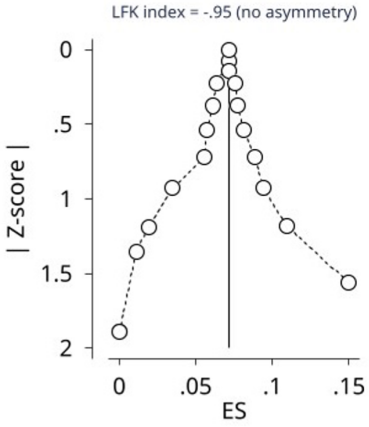
a IVH of any grade



b Low grade IVH



c High grade IVH



d High grade IVH as a proportion of all IVH

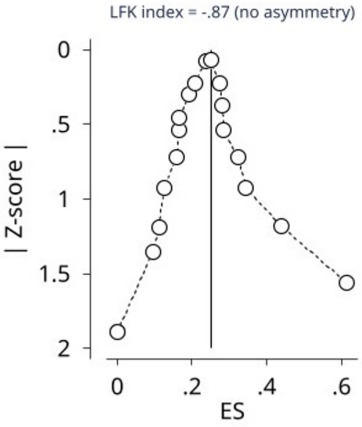
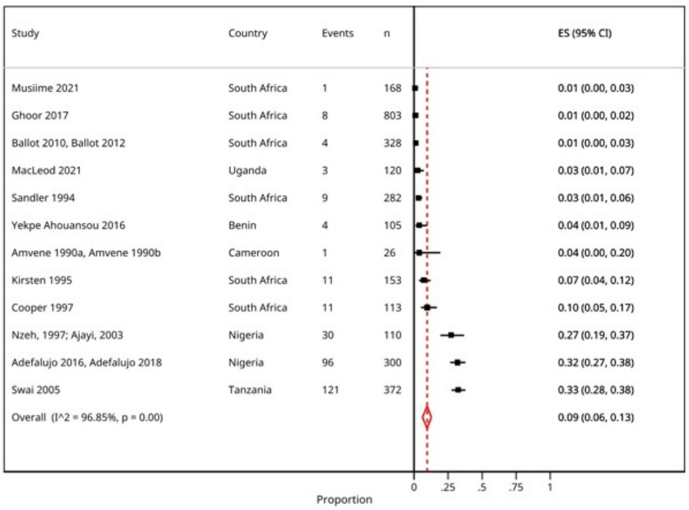


Fig. 4 DOI plots and Luis Furukya-Kanamori indices.

a


Study
Country
Events
n
ES (95% CI)
Musiime 2021 South Africa 1 168 0.01 (0.00, 0.03)
Ghoor 2017 South Africa 8 803 0.01 (0.00, 0.02)
Ballot 2010, Ballot 2012 South Africa 4 328 0.01 (0.00, 0.03)
MacLeod 2021 Uganda 3 120 0.03 (0.01, 0.07)
Sandler 1994 South Africa 9 282 0.03 (0.01, 0.06)
Yekpe Ahouansou 2016 Benin 4 105 0.04 (0.01, 0.09)
Amvene 1990a, Amvene 1990b Cameroon 1 26 0.04 (0.00, 0.20)
Kirsten 1995 South Africa 11 153 0.07 (0.04, 0.12)
Cooper 1997 South Africa 11 113 0.10 (0.05, 0.17)
Nzeh, 1997; Ajayi, 2003 Nigeria 30 110 0.27 (0.19, 0.37)
Adefalujo 2016, Adefalujo 2018 Nigeria 96 300 0.32 (0.27, 0.38)
Swai 2005 Tanzania 121 372 0.33 (0.28, 0.38)
Overall (I^2 = 96.85%, p = 0.00) 0.09 (0.06, 0.13)
0
.25
.5
.75
1
Proportion

b

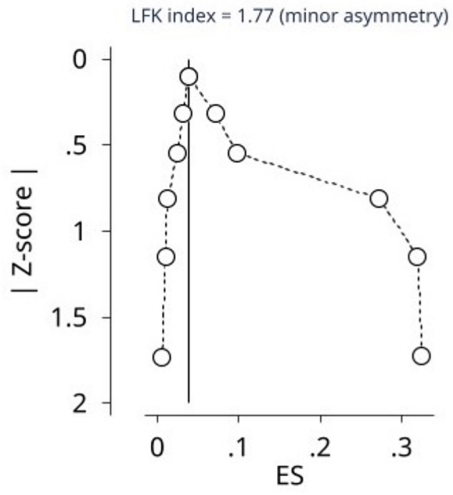

LFK index = 1.77 (minor asymmetry)
0
.5
1
1.5
2
| Z-score |
0
.1
.2
.3
ES

Fig. 5 PVL

Table 1. Characteristics of CUS studies included in meta-analysis of pooled proportion of IVH.

	Setting		Study Size	Eligibility Criteria	Population				IVH Prevalence Estimate(s)			PVL Estimate;	CUS Machine (M); Operator (O)	Study Design	Quality
	Country (WB economic status)	Facility	N (x)		Gestation (weeks)	Birthweight (g)	Male sex (%)	Mortality estimate (%)	Any	Grade I/II	Grade III/IV	Inclusive of increased echogenicity PVL			
Yekpe Ahouansou, 2016 [59]	Benin (LMI)	Teaching hospital	105	<37 weeks Excluded CNS infection	Mean: 33.5 (SD 1.9) Range: 28-36	21% <1500 73% 1500-2499 6% ≥2500	ND	ND	20% (21/105)	18.1% (19/105)	1.9% (2/105)	3.8% (4/105); Yes	M: X150 Siemens Acuson, 2-5MHz convex + 5-10MHz linear probes; O: ND	O - P	intermediate
Tietche, 1992 [60]	Cameroon (LMI)	Referral hospital	70	<35 weeks	Mean: 31+5 Range: 28-34	Mean: 1637 Range: 1200-2375	37.1	17.0	42.9% (30/70)	35.7% (25/70)	7.1% (5/70)	ND	M: Sonoline S1000, 5MHz probe; O: ND	O - P	high
Amvene, 1990a [61] 1990b [62]	Cameroon (LMI)	Teaching hospital	26 (84)	1. Preterm: ≥27-34 weeks (2. > 35 weeks at risk [a])	Median preterm group: 33	Median: 1904 in preterm	(56.0)	ND	46.2% (12/26)	38.5% (10/26)	7.7% (2/26)	3.8% (1/26); Unclear, 'PVL'	M: Sonel 400 CGR, 3&7MHz probes; O: radiologist	O - P	high
Mukaria, 2021 [63]	Kenya (LMI)	National hospital	195	<32 weeks	All <32 IQR 29-32 Median by Ballard score 31 Median by EDD 32	Median: 1440 65% <1500 13% <1000	50.8	26.2	8.2% (16/195)	8.2% (16/195)	0% (0/195)	ND	M: 5-7MHz curvilinear probe; O: neonatal staff/ radiologist	I	high
Sisenda, 2022 [64]	Kenya (LMI)	Referral hospital	201	<34 weeks and BW <1500g	98.5% 28-34 1.5% <28	Mean: 1251.9 (SD 185.4) 90.6% 1000-1500	52.2	ND	33.8% (68/201)	22.9% (46/201)	10.9% (22/201)	ND	M: 6.5MHz probe; O: radiologist	O - P	high
Nzeh, 1997 [65] Ajayi 2003 [66]	Nigeria (LMI)	Teaching hospital	110	<37 weeks	Mean: 31 (SD 1.66) Range: 26-36	Mean: 1260 (SD 252) Range: 650-2200	43.6	37.2	25.5% (28/110)	19.1% (21/110)	6.4% (7/110)	27.3% (30/110); Unclear, 'PVL'	M: Siemens Sonoline SX, 5MHz probe; O: radiologist	O - P	intermediate

	Setting		Study Size	Eligibility Criteria	Population				IVH Prevalence Estimate(s)			PVL Estimate;	CUS Machine (M); Operator (O)	Study Design	Quality
	Country (WB economic status)	Facility	N (x)		Gestation (weeks)	Birthweight (g)	Male sex (%)	Mortality estimate (%)	Any	Grade I/II	Grade III/IV	Inclusive of increased echogenicity PVL			
Adegoke, 2014 [67]	Nigeria (LMI)	Teaching hospital	87	<37 weeks and BW <1500 Excluded CA	17.2% <28 40.2% 28-32 42.5% 32-36	Mean 1193 (SD 344) Range: 750-1500	44.8	5.2	24.1% (21/87)	18.4& (16/87)	5.7% (5/87)	ND	M: real-time sector scanner DP 8500, 7.5MHz linear probe; O: radiologist	O - P	high
Adefalujo, 2016 [68] 2018 [69]	Nigeria (LMI)	Teaching hospital	300	<37 weeks Excluded at risk [b]	Median: 31 55% <32 Range: 24-36	36.7% <1500 60.3% ≥1500-2499 3% ≥2500	45.3	ND	31.7% (95/300)	31.7% (95/300)	0% (0/300)	32% (96/300) Yes	M: portable PCO90 system, 7.5MHz curvilinear probe; O: ND	O - P	high
Egwu, 2019 [70]	Nigeria (LMI)	Teaching hospital	99	<37 weeks Excluded CNS CA	Mean: 32 (SD 2 weeks) Range: 28-36	Mean: 1473 (SD 422)	41.4	ND	16.2% (16/99)	ND	ND	ND	M: MindrayR model DP8500, 3.5-5MHz curvilinear & 7.5MHz linear probes; O: radiologist /paediatrician	O - P	high
Ogbe, 2022 [71]	Nigeria (LMI)	Teaching hospital	90	<37 weeks Excluded at risk [c]	Median: 32 6.7% <28 68.9% 28-34 24.4% 35-36	Median: 1580 8.9% <1000 33.3% 1000-1499 47.8% 1500-2499 10% ≥2500	55.6	ND	8.9% (8/90)	7.8% (7/90)	1.1% (1/90)	ND	M: Philips HD5 O: ND	O - P	intermediate
Hofmeyr, 1988 [72]	South Africa (UMI)	Tertiary hospital	36	Women in 'advanced labour' at <35 weeks	All <35	23.7% <2500	ND	2.6	50% (18/36)	44.4% (16/36)	5.6% (2.36)	ND	M: ND O: paediatrician	I	intermediate

	Setting		Study Size	Eligibility Criteria	Population				IVH Prevalence Estimate(s)			PVL Estimate;	CUS Machine (M); Operator (O)	Study Design	Quality
	Country (WB economic status)	Facility	N (x)		Gestation (weeks)	Birthweight (g)	Male sex (%)	Mortality estimate (%)	Any	Grade I/II	Grade III/IV	Inclusive of increased echogenicity PVL			
Hofmeyr, 1993 [73]	South Africa (UMI)	Tertiary Multicentre (3)	86	BW <2000g	Mean in DCC group: 31.9 (SEM 0.33) Mean in ECC group: 32.1 (SEM 0.33)	Mean in DCC group: 1761 (SEM 65) Mean in ECC group: 1734 (SEM 75)	ND	0.0	22.1% (19/86)	18.6% (16/86)	2.3% (2/86)	ND	M: ND O: ND	I	high
Sandler, 1994 [74]	South Africa (UMI)	Tertiary	282	BW 1000-1749g	76.2% <35	Range: 1000-1749	50.4	4.9	46.1% (130/282)	37.2% (105/282)	8.9% (25/282)	3.2% (9/282); Unclear, 'PVL'	M: portable Kretztechnic Combison 310 sector scanner, 7.5MHz probe; O: paediatrician	O - P	high
Kirsten, 1995 [75]	South Africa (UMI)	Tertiary	139 (153)	BW <1500g and discharged within the study period	Mean: 29.9 Upper limit 36	Mean 1184.8 16.3% <1000 83.7% 1000-1500	41.2	27.1	20.9% (29/139)	13.7% (19/139)	7.2% (10/139)	0.6% (11/153); Unclear, 'PVL'	M: ND O: ND	O - P	intermediate
Cooper, 1997 [76]	South Africa (UMI)	Tertiary	113	BW <1500g and followed up to 18 months post discharge	Mean G1: 30.2 (SD 1.4) Mean G2: 31.3 (SD 1.7) Mean G3: 28.6 (SD 1.5)	Mean G1: 1255 (SD 153) Mean G2: 1285 (SD 147) Mean G3: 872 (SD 90)	ND	0.0	13.3% (13/98)	5.1% (5/98)	8.2% (8/98)	9.7% (11/113); Unclear, 'PVL'	M: portable Kretztechnic Combison 310 sector scanner, 7.5MHz probe; O: ND	O - P	intermediate
Ballot, 2010 [77] 2012 [78]	South Africa (UMI)	Tertiary	328 (474)	BW <1500g admitted within 24 hours of age	Mean: 29.6 (95% CI 29.6 - 30.1)	Mean: 1133.5 (95% CI 1111.9 - 1155)	46.2	ND	21.6% (71/328)	15.6% (51/328)	6.0% (20/328)	1.2% (4/328); No, cPVL specified	M: ND O: paediatric neurologist	O - R	high
Ghoor, 2017 [79]	South Africa (UMI)	Tertiary	803 (1562)	BW <1500g Excluded major CA and USS [d]	Mean: 29	Median: 1150 Mean cases: 1097 Mean controls:1065	46.7	0.0	26.8% (215/803)	19.2% (154/803)	7.6% (61/803)	0.9% (8/803) No, cPVL specified	M: ND O: ND	O - R	high

	Setting		Study Size	Eligibility Criteria	Population				IVH Prevalence Estimate(s)			PVL Estimate;	CUS Machine (M); Operator (O)	Study Design	Quality
	Country (WB economic status)	Facility	N (x)		Gestation (weeks)	Birthweight (g)	Male sex (%)	Mortality estimate (%)	Any	Grade I/II	Grade III/IV	Inclusive of increased echogenicity PVL			
Maduray, 2019 [80]	South Africa (UMI)	Quaternary hospital	210	BW <2500g Excluded [e]	41.9% <32	43.3% <1500 Range: 750-2500	60	ND	44.3% (93/210)	ND	ND	ND	M: Siemens Acuson X300, 8.5MHz curvilinear probe; O: not detailed	O - R	intermediate
Musiime, 2021 [81]	South Africa (UMI)	Tertiary	168 (256)	BW <1000g Excluded admission after day 28 of life	32.8% 23-26 60.2% 27-30 Range: 23-34	Mean: 850 (median IQR 750-928) Upper limit 1000	46.1	0.0	34.5% (58/168)	27.4% (46/168)	7.1% (12/168)	0.6% (1/168); No, cPVL specified	M: ND O: ND	O - R	high
Salih, 2013 [82]	Sudan (LI)	Referral hospital	100	<37 weeks	Median 34 Range: 28-36	10% 750-999 24% 1000-1499 55% 1500-2499	ND	ND	18% (18/100)	ND	ND	ND	M: ND O: ND	O - P	intermediate
Swai, 2005 [83]	Tanzania (LMI)	National hospital	372	BW <1500g Excluded major CA particularly CNS CA	Mean Female: 30 (SD 3 weeks) Mean Male: 30 (SD 2 weeks) Range: 6-37 weeks	Mean Female: 1170 (SD 240) Mean Male: 1190 (SD 210) Range: 500-1490	45.4	15.6	61.8% (230/372)	ND	ND	32.5% (121/372) Yes	M: Toshiba, 5MHz probe; O: ND	O - P	high
MacLeod, 2021 [84]	Uganda (LI)	Referral hospital	120	BW <2000g Excluded major CA	2.5% <28 31.6% 28-31 58.3% 32-36 2.5% 37-42	Mean: 1463 (SD 310) Upper limit: 2000	50	10.8	34.2% (41/120)	19.2% (23/120)	15.0% (18/120)	2.5% (3/120), No, cPVL specified	M: portable Sonosite M-Turbo, 5-8MHz curved & 5-13MHz linear probes O: paediatrician / researcher	O - P	high

	Setting		Study Size	Eligibility Criteria	Population				IVH Prevalence Estimate(s)			PVL Estimate;	CUS Machine (M); Operator (O)	Study Design	Quality
	Country (WB economic status)	Facility	N (x)		Gestation (weeks)	Birthweight (g)	Male sex (%)	Mortality estimate (%)	Any	Grade I/II	Grade III/IV	Inclusive of increased echogenicity PVL			
Mulindwa, 2012 [85]	Zambia (LMI)	Teaching hospital	298	<32 weeks and BW <1500g Excluded death before 1st CUS	Mean: 29.3 (SD 1.93) All <32	Mean: 1200 (SD 220) Upper limit: 1500	47.7	0.0	34.2% (102/298)	24.8% (74/298)	9.4% (28/298)	ND	M: Aloka SSD 900, 7.5MHz curved probe; O: paediatrician / radiologist	O - P	high

WB: World Bank with economic status: LI – low income, LMI – low middle income, UMI – upper middle income
ND: not detailed
SD: standard deviation
Facility: based on description within paper
Study size: N who underwent cranial ultrasound, (x) if N different to total study population x. Where x is different to N, population characteristics describe x.
Eligibility criteria

- CA: congenital anomalies
- CNS: central nervous system
- Excluded [a] Caesarean-section, requiring resuscitation, facial or neurological malformation, neurological signs
- Excluded [b] Congenital malformations, metabolic disorders, central nervous system infections, and unknown perinatal data
- Excluded [c] Congenital malformations, CNS disorders, APGAR <7 at 5 mins, SpO2 <90%, vigorous resuscitation
- Excluded [d] Cranial ultrasound revealing abnormalities such as absent corpus callosum, schizencephaly or findings with questionable significance, such as periventricular echodensities
- Excluded [e] If no cranial ultrasound scan had been performed or if the scan showed abnormalities other than IVH (e.g. congenital hydrocephalus, periventricular flaring, echogenic posterior horns, intracerebral haemorrhage other than grade IV IVH, an echogenic cerebellum, basal ganglia enhancement, and caudothalamic and choroid plexus cysts not associated with IVH)

Gest.: Mean, standard deviation (SD) and range of gestation where detailed. Other parameters detailed as available.
BW: Mean, standard deviation (SD) and range of birth weight where detailed. Other parameters detailed as available.
DCC: delayed cord clamping
ECC: early cord clamping
G1: Infants 1000 to 1499 g at birth who required mechanical ventilation
G2: Infants 1000 to 1499 g at birth who did not require mechanical ventilation

G3: Infants 1000 g at birth who were not ventilated
Mortality est: % mortality estimate in potentially eligible cohort leading to missed scans (not mortality rate overall in study cohort)
IVH: intraventricular haemorrhage
PVL: periventricular leukomalacia, cPVL: cystic periventricular leukomalacia
Study Design: O = observational, P = prospective, R = retrospective, I = interventional
Quality: Studies were scored using the Joanna Briggs Institute critical appraisal tool for prevalence studies[14] 0-3 scores=low quality, 4-6 scores=intermediate quality, 7-9 scores=high quality.

Table 2. Methodological quality assessment of CUS studies included in meta-analysis of pooled proportion of IVH.

Study	Country	Q1: Sample frame	Q2: Sampling methodology	Q3: Sample size	Q4: Study population details	Q5: Sample coverage in analysis	Q6: Identification methodology	Q7: Standardised methodology	Q8: Statistical analysis	Q9: Response rate	Score	Quality
Yekpe Ahouansou 2016[59]	Benin	Yes	Unclear	No	No	Yes	Yes	Yes	Yes	Unclear	5	intermediate
Tietche 1992[60]	Cameroon	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8	high
Amvene 1990a[61],1990b[62]	Cameroon	Yes	Unsure	No	Yes	Yes	Yes	Yes	Yes	Yes	7	intermediate
Mukuria 2021[63]	Kenya	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	high
Sisenda 2022[64]	Kenya	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Unclear	7	intermediate
Nzeh 1997[65], Ajayi 2003[66]	Nigeria	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Unclear	7	intermediate
Adegoke 2014[67]	Nigeria	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8	high
Adefalujo 2016[68], 2018[69]	Nigeria	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	8	high
Egwu 2019[70]	Nigeria	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	8	high
Ogbe 2022[71]	Nigeria	Yes	Yes	No	Yes	Yes	Yes	Unclear	Yes	Unclear	6	intermediate
Hofmeyr 1988[72]	South Africa	Yes	Unclear	No	No	Yes	Yes	Yes	Yes	Yes	6	intermediate
Hofmeyr 1993[73]	South Africa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	high
Sandler 1994[74]	South Africa	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8	high
Kirsten 1995[75]	South Africa	Yes	Yes	No	Yes	Yes	Yes	Unclear	Unclear	Yes	6	intermediate
Cooper 1997[76]	South Africa	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8	high
Ballot 2010[77], 2012[78]	South Africa	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Unclear	7	intermediate
Ghoor 2017[79]	South Africa	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	No	7	intermediate
Maduray 2019[80]	South Africa	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	7	intermediate
Musiime 2021[81]	South Africa	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	No	7	intermediate
Salih 2013[82]	Sudan	Yes	Yes	No	Yes	Yes	Yes	Unclear	Yes	Yes	7	intermediate
Swai 2005[83]	Tanzania	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	high
MacLeod 2021[84]	Uganda	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8	high
Mulindwa 2012[85]	Zambia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	high

Quality appraisal according to checklist for prevalence studies from the Joanna Briggs Institute[14] Only "Yes" gives a score. 0-4 scores=low quality, 5-7 scores=intermediate quality, and 8-9 scores=high quality.
Observational – P = prospective observational study; Observational – R = retrospective observational study.
Data quality from a single study presented in two publications was assessed taking into consideration information presented on both publications.
Q1: Was the sample frame appropriate to address the target population?
Q2: Were study participants sampled in an appropriate way?
Q3: Was the sample size adequate? [Yes assigned if a sample size calculation was reported and calculated sample size reached, where no sample size calculation reported, we conducted a sample size calculation utilising study reported sample size and prevalence, and assuming a 5% loss rate and 5% precision[18] and assigned Yes if calculated study population reached]
Q4: Were the study subjects and the setting described in detail? [Yes if at least birthweight and gestation data given]
Q5: Was the data analysis conducted with sufficient coverage of the identified sample?
Q6: Were valid methods used for the identification of the condition? [Valid method: cranial ultrasound (CUS)]
Q7: Was the condition measured in a standard, reliable way for all participants? [Yes if CUS operator described or description of scanning methodology details that scanned in at least two planes]
Q8: Was there appropriate statistical analysis? [all denominators and numerators reported in sufficient detail]
Q9: Was the response rate adequate, and if not, was the low response rate managed appropriately? [How many of those eligible underwent CUS? i.e. how many were lost due to death before scanning, no consent or unknown reason, Unclear if not reported, Yes if losses <1/3 of eligible population]

Table 3. Subgroup analysis and meta-regression for IVH of any grade.

	Number of studies	N	Pooled proportion (95% CI)	I^2 (%)	Between-group difference (95% CI), p-value
Overall	23	4323	0.29 (0.23 to 0.35)	95.3	N/A
Birthweight					
<1500g	16	3196	0.32 (0.24 to 0.40)	96.7	Ref.
≥1500g	7	570	0.21 (0.13 to 0.29)	80.6	-0.11 (-0.26 to 0.03), p = 0.125
Gestation					
<32 weeks	11	1208	0.38 (0.26 to 0.50)	95.3	Ref.
≥32 weeks	9[b]	665	0.21 (0.14 to 0.29)	82.2	-0.16 (-0.29 to -0.03), p = 0.017
Study period					
<2010	11	1647	0.33 (0.22 to 0.44)	96.1	Ref.
≥2010	12	2676	0.26 (0.20 to 0.33)	93.8	-0.07 (-0.19 to 0.05), p = 0.233
Country economic status[a]					
High middle income	9	2150	0.30 (0.23 to 0.38)	92.2	Ref.[c]
Low middle income	12	1953	0.29 (0.18 to 0.40)	96.9	-0.02 (-0.15 to 0.12), p = 0.805
Low income	2	220	0.25 (0.19 to 0.31)	N/A	-0.05 (-0.29 to 0.19), p = 0.667
Quality score					
Intermediate	12	2316	0.28 (0.22 to 0.33)	88.7	Ref.
High	11	2007	0.30 (0.19 to 0.42)	97.2	0.01 (-0.11 to 0.14), p = 0.839

[a] Country economic status as per World Bank
[b] excluding two studies with zero observations in subgroup
[c] p-value for heterogeneity = 0.903

Supplementary Material

Spectrum and prevalence of neonatal intracranial pathologies on ultrasound imaging in sub-Saharan Africa: A systematic review and meta-analysis

Eva M Loucaides, Georgina Yan, Jonathan Elliott, Eleanor Duckworth, Rachael MacLeod, Frederick Katongole, Wilson Okot, Raymond Senyonga, Cornelia Hagman, Frances M Cowan, Charles Opondo, Cally J Tann

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Supplementary Appendix S1. Search Strategy

8 bibliometric databases as well as Google scholar were searched for this systematic review. No time limits were applied and for each database, the search was completed from the start of the databases records up until the date of the search being completed. Search terms for each database are detailed below.

The search strategy utilised three groups of search terms linked by the Boolean operator AND, related to 1) Newborn infants, 2) Ultrasound or intracranial pathology, 3) Sub Saharan African nations. The search terms were adapted, including all identified keywords and index terms, for each database. The searches were carried out between 20-22 February 2023.

1. SCOPUS

<1788 to 20 February 2023> searched on 20 February 2023

Search terms:

NEWBORN

Keywords

Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*

ULTRASOUND/PATHOLOGY

Keywords Ultrasound

ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*

OR

Keywords Specific Pathology

(Hypoxic-Ischaemic Encephalopath*) or (Hypoxic ischaemic encephalopath*) or (hypoxic ischemic encephalopath*) or (hypoxic-ischemic encephalopath*) or HIE or (hypoxic encephalopath*) or (Ischaemia encephalopath*) or (ischaemic encephalopath*) or (ischemia encephalopath*) or (ischemic encephalopath*) or (neonatal encephalopath*) or (infant encephalopath*) or (newborn encephalopath*) or (epileptic encephalopath*) or (Neonatal hydrocephal*) or (newborn hydrocephal*) or (infant hydrocephal*) or (post haemorrhagic hydrocephal*) or (post-haemorrhagic hydrocephal*) or (posthaemorrhagic hydrocephal*) or (post hemorrhagic hydrocephal*) or (post-hemorrhagic hydrocephal*) or (posthemorrhagic hydrocephal*) or (congenital hydrocephal*) or IVH or (intraventricular haemorrhag*) or (intraventricular hemorrhag*) or (intra-ventricular haemorrhag*) or (intra-ventricular hemorrhag*) or (intraventricular bleed*) or (intra-ventricular bleed*) or (germinal matrix-intraventricular haemorrhage) or (germinal matrix-intraventricular hemorrhage) or (germinal matrix haemorrhage) or (germinal matrix hemorrhage) or (GMH-IVH) or PVI or (periventricular haemorrhagic infarct*) or (periventricular hemorrhagic infarct*) or HPI or (haemorrhagic parenchymal infarct*) or (hemorrhagic parenchymal infarct*) or (cerebellar haemorrhag*) or (cerebellar hemorrhag*) or (cerebral ventriculomegal*) or (hypoxic-ischaemic injur*) or (hypoxic ischaemic injur*) or (cerebral hypoxia ischemia) or (cerebral hypoxia-ischemia) or (cerebral hypoxia ischaemia) or (cerebral hypoxia-ischaemia) or (cerebral anoxia ischemia) or (cerebral anoxia-ischemia) or (cerebral anoxia ischaemia) or (cerebral anoxia-ischaemia) or (cerebral ischemia hypoxia) or (cerebral ischemia-hypoxia) or (cerebral ischaemia hypoxia) or (cerebral ischaemia-hypoxia) or (cerebral ischemia anoxia) or (cerebral ischemia-anoxia) or (cerebral ischaemia anoxia) or (cerebral ischaemia-anoxia) or (brain hypoxia ischemia) or (brain hypoxia-ischemia) or (brain hypoxia ischaemia) or (brain hypoxia-ischaemia) or (brain anoxia ischemia) or (brain anoxia-ischemia) or (brain anoxia ischaemia) or (brain anoxia-ischaemia) or (brain ischemia hypoxia) or (brain ischemia-hypoxia) or (brain ischaemia hypoxia) or (brain ischaemia-hypoxia) or (brain ischemia anoxia) or (brain ischemia-anoxia) or (brain ischaemia anoxia) or (brain ischaemia-anoxia) or PVL or (periventricular leukomalacia*) or (periventricular encephalomalacia*) or (neonatal cerebral leukomalacia*) or (lenticulostriate vasculopath*) or (lenticulostriate

vascular disease*) or (thalamostriate vasculopath*) or (absent corpus callosum) or (agenesis of the corpus callosum) or (agenesis of corpus callosum) or (corpus callosum absent) or (cerebellar hypoplasia) or (hypoplasia of the cerebellum) or (hypoplasia of cerebellum) or (central nervous system cyst*) or (cns cyst*) or (midline cyst*) or (subependymal cyst*) or (connatal cyst*) or (choroid plexus cyst*) or (arachnoid cyst*) or (porencephalic cyst*) or (periventricular flare*) or (periventricular bright*) or (parenchymal flare*) or (parenchymal echodensit*) or (cerebral echogenicit*) or (vein of galen aneurysm*) or (aneurysm* of vein of galen) or (vein of galen malformation*) or (malformation* of the vein of galen) or (germinolytic cyst*) or (congenital cytomegalovirus) or (congenital CMV) or (perinatal cytomegalovirus) or (perinatal CMV) or (congenital toxoplasmosis) or (congenital toxoplasma infection*) or (post-infectious hydroceph*) or (postinfectious hydroceph*) or (post-infective hydroceph*) or (postinfective hydroceph*)

OR

Keywords General Pathology (with adjacency to neonatal terms)

Encephalopath* or hydrocephal* or stroke* or calcification* or cytomegalovirus or CMV or toxoplasm* or meningitis

W/5

Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*

AFRICA

Keywords

Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or (Burkina Faso) or (Burkina Fasso) or (Upper Volta) or burkinabe or burkinese or Burundi* or Urundi* or (Ruanda-Urundi*) or Cameroon* or Kamerun* or Cameroun* or (Capo Verde*) or (Cape Verde*) or (Central African Republic) or (central african*) or (Ubangi-Shari*) or Chad* or Comoros or (Comoro Islands) or (Glorioso Islands) or (iles comores) or Mayotte or Congo* or congolese or (Cote d'Ivoire) or (Cote d' Ivoire) or (Cote dIvoire) or (Cote d Ivoire) or (Ivory Coast) or ivorian* or (Democratic Republic of Congo) or (Democratic Republic of the Congo) or (DR Congo) or (DR of the Congo) or (Congo-Kinshasa) or (Belgian Congo) or Zaire or (Congo Free State) or Djibouti* or (french somaliland) or Egypt* or (united arab republic) or (Equatorial Guinea*) or equatoguinean* or (Spanish Guinea) or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or (Gabonese Republic) or Gambia* or Ghana* or (Gold Coast) or Guinea* or (Guinea-Bissau) or (bissau guinean) or (Portuguese Guinea*) or Kenya* or (East Africa Protectorate) or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or (libyan arab jamahiriya*) or Madagascar or (Malagasy Republic) or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or (Agalega Islands) or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or (Portuguese East Africa) or mozambican* or Namibia* or (German South West Africa) or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or (Saint Helena) or (Sao Tome) or (sao tomean*) or orsantomean* or Senegal* or Seychelles or seychellois or

seychelloise or (Sierra Leone*) or Salone* or Somalia* or somali* or Somaliland* or (South Africa*) or (Cape Colony) or (British Bechuanaland) or (Boer Republics) or Zululand or Transvaal or (Natalia Republic) or (Orange Free State) or (South Sudan*) or Sudan* or Tanzania* or Tanganyika* or Zanzibar* or Togo* or (Togolese Republic) or Togoland* or Tunisia* or Uganda* or (Western Sahara) or Zambia* or (Northern Rhodesia*) or Zimbabwe*

2. Global Index Medicus

<1879 to 20 February 2023> searched on 20 February 2023

Search terms:

tw:(tw:((tw:(africa* OR algeria* OR angola* OR benin* OR dahomey OR botswana* OR batswana* OR bechuanaland* OR kalahari*)) OR (tw:(burkina faso OR burkina fasso OR upper volta OR burkinabe OR burkinese)) OR (tw:(burundi* OR urundi* OR ruanda-urundi* OR cameroon* OR kamerun* OR cameroun*)) OR (tw:(capo verde* OR cape verde* OR central african republic OR central african* OR ubangi-shari*)) OR (tw:(chad* OR comoros OR comoro islands OR glorioso islands OR iles comores)) OR (tw:(mayotte OR congo* OR congolese OR cote d'ivoire OR cote d' ivoire OR cote divoire)) OR (tw:(cote d ivoire OR ivory coast OR ivorian* OR democratic republic of congo)) OR (tw:(democratic republic of the congo OR dr congo OR dr of the congo OR congo-kinshasa)) OR (tw:(belgian congo OR zaire OR congo free state OR djibouti* OR french somaliland OR egypt*)) OR (tw:(united arab republic OR equatorial guinea* OR equatoguinean* OR spanish guinea)) OR (tw:(eritrea* OR abyssinia* OR eswatini* OR eswatini* OR swaziland* OR swazi* OR swati*)) OR (tw:(ethiopia* OR gabon* OR gabonese republic OR gambia* OR ghana* OR gold coast)) OR (tw:(guinea* OR guinea-bissau OR bissau guinean OR portuguese guinea* OR kenya*)) OR (tw:(east africa protectorate OR lesotho* OR basutoland OR mosotho OR basotho)) OR (tw:(liberia* OR libya* OR libyan arab jamahiriya* OR madagascar OR malagasy republic)) OR (tw:(malagasy OR madagascan OR malawi* OR malior OR mali*)) OR (tw:(mauritania* OR mauritanian* OR mauritius OR mauritian* OR agalega islands OR mayotte)) OR (tw:(morocco OR moroccan* OR mozambique OR nyasaland OR mocambique OR portuguese east africa)) OR (tw:(mozambican* OR namibia* OR german south west africa OR niger OR nigeria OR nigerien*)) OR (tw:(nigerian* OR rwanda* OR ruanda* OR rwandese OR ruandese OR saint helena)) OR (tw:(sao tome OR sao tomean* OR sao tome AND principe OR santomean* OR senegal*)) OR (tw:(seychelles OR seychellois OR seychelloise OR sierra leone* OR salone* OR somalia*)) OR (tw:(somali* OR somaliland* OR south africa* OR cape colony OR british bechuanaland)) OR (tw:(boer republics OR zululand OR transvaal OR natalia republic OR orange free state)) OR (tw:(south sudan* OR sudan* OR tanzania* OR tanganyika* OR zanzibar* OR togo*)) OR (tw:(togolese republic OR togoland* OR tunisia* OR uganda* OR western sahara OR zambia*)) OR (tw:(northern rhodesia*)) OR (tw:(zimbabwe*)))) AND (tw:(infant* OR newborn* OR neonat* OR baby OR babies OR preterm* OR pre-term*)) AND ((tw:(ultrasound* OR ultrasonograph* OR sonograph* OR ultrasonic* OR echoencephalograph*)) OR tw:((tw:(ivh OR intraventricular haemorrhag* OR intraventricular hemorrhag* OR intra-ventricular haemorrhag* OR intra-ventricular hemorrhag*)) OR (tw:(intraventricular bleed* OR intra-ventricular bleed* OR germinal matrix-intraventricular haemorrhage)) OR (tw:(or germinal matrix-intraventricular hemorrhage OR germinal matrix haemorrhage OR gmh-ivh OR brain haemorrhage*)) OR (tw:(pvi OR periventricular haemorrhagic infarct* OR periventricular hemorrhagic infarct*)) OR (tw:(hpi OR haemorrhagic parenchymal infarct* OR hemorrhagic parenchymal infarct* OR cerebellar haemorrhag*)) OR (tw:(cerebellar hemorrhag)) OR (tw:(cerebral ventriculomegal*)) OR (tw:(hypoxic-ischaemic injur* OR hypoxic ischaemic injur* OR cerebral hypoxia ischemia OR cerebral hypoxia-ischemia)) OR (tw:(or cerebral hypoxia ischaemia OR cerebral hypoxia-ischaemia OR cerebral anoxia ischemia)) OR (tw:(cerebral anoxia-ischemia OR cerebral anoxia ischaemia OR cerebral anoxia-ischaemia)) OR

(tw:(cerebral ischemia hypoxia OR cerebral ischemia-hypoxia OR cerebral ischaemia hypoxia OR cerebral ischaemia-hypoxia)) OR (tw:(cerebral ischemia anoxia OR cerebral ischemia-anoxia OR cerebral ischaemia anoxia OR cerebral ischaemia-anoxia)) OR (tw:(brain hypoxia ischemia OR brain hypoxia-ischemia OR brain hypoxia ischaemia OR brain hypoxia-ischaemia brain anoxia ischemia)) OR (tw:(or brain anoxia-ischemia OR brain anoxia ischaemia OR brain anoxia-ischaemia OR brain ischemia hypoxia OR brain ischemia-hypoxia)) OR (tw:(brain ischaemia hypoxia OR brain ischaemia-hypoxia OR brain ischemia anoxia OR brain ischemia-anoxia)) OR (tw:(brain ischaemia anoxia OR brain ischaemia-anoxia OR pvl OR periventricular leukomalacia* OR periventricular encephalomalacia*)) OR (tw:(neonatal cerebral leukomalacia* OR lenticulostriate vasculopath* OR lenticulostriate vascular disease*)) OR (tw:(or thalamostriate vasculopath)) OR (tw:(absent corpus callosum OR agenesis of the corpus callosum)) OR (tw:(agenesis of corpus callosum OR corpus callosum absent OR cerebellar hypoplasia OR hypoplasia of the cerebellum OR hypoplasia of cerebellum)) OR (tw:(central nervous system cyst* OR cns cyst* OR midline cyst* OR subependymal cyst* OR connatal cyst*)) OR (tw:(choroid plexus cyst* OR arachnoid cyst* OR porencephalic cyst*)) OR (tw:(periventricular flare* OR periventricular bright*)) OR (tw:(or parenchymal flare* OR parenchymal echodensit* OR cerebral echogenicit* OR vein of galen aneurysm*)) OR (tw:(aneurysm* of vein of galen OR vein of galen malformation* OR malformation* of the vein of galen)) OR (tw:(congenital cytomegalovirus OR congenital CMV OR perinatal cytomegalovirus)) OR (tw:(perinatal CMV OR congenital toxoplasmosis OR congenital toxoplasma infection*)) OR (tw:(post-infectious hydroceph* OR postinfectious hydroceph* OR post-infective hydroceph*)) OR (tw:(postinfective hydroceph* OR meningitis))))

3. Cochrane Library

<1908 to 20 February 2023> searched on 20 February 2023

Search terms:

NEWBORN

Keywords

Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*

Mesh terms

Infant (exp)

ULTRASOUND/PATHOLOGY

Keywords Ultrasound

ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*

OR

Keywords Specific Pathology

"Hypoxic-Ischaemic Encephalopath*" or "Hypoxic ischaemic encephalopath*" or "hypoxic ischemic encephalopath*" or "hypoxic-ischemic encephalopath*" or HIE or "hypoxic encephalopath*" or "Ischaemia encephalopath*" or "ischaemic encephalopath*" or "ischemia encephalopath*" or "ischemic encephalopath*" or "neonatal encephalopath*" or "infant encephalopath*" or "newborn encephalopath*" or "epileptic encephalopath*" or "Neonatal hydrocephal*" or "newborn hydrocephal*" or "infant hydrocephal*" or "post haemorrhagic hydrocephal*" or "post-haemorrhagic hydrocephal*" or "posthaemorrhagic hydrocephal*" or "post hemorrhagic hydrocephal*" or "post-hemorrhagic hydrocephal*" or "posthemorrhagic hydrocephal*" or "congenital hydrocephal*" or IVH or "intraventricular haemorrhag*" or "intraventricular hemorrhag*" or "intra-ventricular haemorrhag*" or "intra-ventricular hemorrhag*" or "intraventricular bleed*" or "intra-ventricular bleed*" or "germinal matrix-intraventricular haemorrhage" or "germinal matrix-intraventricular hemorrhage" or "germinal matrix haemorrhage" or "germinal matrix hemorrhage" or "GMH-IVH" or PVI or "periventricular haemorrhagic infarct*" or "periventricular hemorrhagic infarct*" or HPI or "haemorrhagic parenchymal infarct*" or "hemorrhagic parenchymal infarct*" or "cerebellar haemorrhag*" or "cerebellar hemorrhag*" or "cerebral ventriculomegal*" or "hypoxic-ischaemic injur*" or "hypoxic ischaemic injur*" or "cerebral hypoxia ischemia" or "cerebral hypoxia-ischemia" or "cerebral hypoxia ischaemia" or "cerebral hypoxia-ischaemia" or "cerebral anoxia ischemia" or "cerebral anoxia-ischemia" or "cerebral anoxia ischaemia" or "cerebral anoxia-ischaemia" or "cerebral ischemia hypoxia" or "cerebral ischemia-hypoxia" or "cerebral ischaemia hypoxia" or "cerebral ischaemia-hypoxia" or "cerebral ischemia anoxia" or "cerebral ischemia-anoxia" or "cerebral ischaemia anoxia" or "cerebral ischaemia-anoxia" or "brain hypoxia ischemia" or "brain hypoxia-ischemia" or "brain hypoxia ischaemia" or "brain hypoxia-ischaemia" or "brain anoxia ischemia" or "brain anoxia-ischemia" or "brain anoxia ischaemia" or "brain anoxia-

ischaemia" or "brain ischemia hypoxia" or "brain ischemia-hypoxia" or "brain ischaemia hypoxia" or "brain ischaemia-hypoxia" or "brain ischemia anoxia" or "brain ischemia-anoxia" or "brain ischaemia anoxia" or "brain ischaemia-anoxia" or PVL or "periventricular leukomalacia*" or "periventricular encephalomalacia*" or "neonatal cerebral leukomalacia*" or "lenticulostriate vasculopath*" or "lenticulostriate vascular disease*" or "thalamostriate vasculopath*" or "absent corpus callosum" or "agenesis of the corpus callosum" or "agenesis of corpus callosum" or "corpus callosum absent" or "cerebellar hypoplasia" or "hypoplasia of the cerebellum" or "hypoplasia of cerebellum" or "central nervous system cyst*" or "cns cyst*" or "midline cyst*" or "subependymal cyst*" or "connatal cyst*" or "choroid plexus cyst*" or "arachnoid cyst*" or "porencephalic cyst*" or "periventricular flare*" or "periventricular bright*" or "parenchymal flare*" or "parenchymal echodensit*" or "cerebral echogenicit*" or "vein of galen aneurysm*" or "aneurysm* of vein of galen" or "vein of galen malformation*" or "malformation* of the vein of galen" or "germinolytic cyst*" or "congenital cytomegalovirus" or "congenital CMV" or "perinatal cytomegalovirus" or "perinatal CMV" or "congenital toxoplasmosis" or "congenital toxoplasma infection*" or "postinfectious hydroceph*" or "postinfective hydroceph*"

OR

Keywords General Pathology (with adjacency to neonatal terms)

Encephalopath* or hydrocephal* or "brain hemorrhage*" or "intracranial haemorrhage*" or "intracranial hemorrhage*" or "cerebral haemorrhage*" or "cerebral hemorrhage*" or "cerebral parenchymal haemorrhage*" or "posterior fossa haemorrhage*" or "haemorrhagic brain lesion*" or "hemorrhagic brain lesion*" or "ischaemic brain lesion*" or "ischemic brain lesion*" or "haemorrhagic brain injur*" or "hemorrhagic brain injur*" or "ischaemic brain injur*" or "ischemic brain injur*" or "brain ischaemi*" or "brain ischemi*" or "haemorrhagic infarct*" or "hemorrhagic infarct*" or stroke* or "cerebrovascular accident*" or "cerebral infarct*" or "brain infarct*" or "cerebral calcification*" or "intracranial calcification*" or "brain calcification*" or "ventricular calcification*" or "thalamic calcification*" or cytomegalovirus or CMV or toxoplasm* or "cerebral abscess" or "intracranial abscess" or "brain abscess" or meningitis

NEAR/5

Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*

Mesh terms

Ultrasonography (exp); Toxoplasmosis, congenital

AFRICA

Keywords

Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or "Burkina Faso" or "Burkina Fasso" or "Upper Volta" or burkinabe or burkinese or Burundi* or Urundi* or Ruanda-Urundi* or Cameroon* or Kamerun* or Cameroun* or "Capo Verde*" or "Cape Verde*" or "Central African Republic"

or "central african*" or Ubangi-Shari* or Chad* or Comoros or "Comoro Islands" or "Glorioso Islands" or "iles comores" or Mayotte or Congo* or congolese or "Cote d'Ivoire" or "Cote d' Ivoire" or "Cote dIvoire" or "Cote d Ivoire" or "Ivory Coast" or ivorian* or "Democratic Republic of Congo" or "Democratic Republic of the Congo" or "DR Congo" or "DR of the Congo" or Congo-Kinshasa or "Belgian Congo" or Zaire or "Congo Free State" or Djibouti* or "french somaliland" or Egypt* or "united arab republic" or "Equatorial Guinea*" or equatoguinean* or "Spanish Guinea" or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or "Gabonese Republic" or Gambia* or Ghana* or "Gold Coast" or Guinea* or Guinea-Bissau or "bissau guinean" or "Portuguese Guinea*" or Kenya* or "East Africa Protectorate" or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or "libyan arab jamahiriya*" or Madagascar or "Malagasy Republic" or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or "Agalega Islands" or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or "Portuguese East Africa" or mozambican* or Namibia* or "German South West Africa" or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or "Saint Helena" or "Sao Tome" or "sao tomean*" or santomean* or Senegal* or Seychelles or seychellois or seychelloise or "Sierra Leone*" or Salone* or Somalia* or somali* or Somaliland* or "South Africa*" or "Cape Colony" or "British Bechuanaland" or "Boer Republics" or Zululand or Transvaal or "Natalia Republic" or "Orange Free State" or "South Sudan*" or Sudan* or Tanzania* or Tanganyika*or Zanzibar* or Togo* or "Togolese Republic" or Togoland* or Tunisia* or Uganda* or "Western Sahara" or Zambia* or "Northern Rhodesia*" or Zimbabwe*

Mesh Terms

Africa (exp) - includes Africa, Northern and Africa south of the sahara

4. Web of Science

<1900 to 20 February 2023> searched on 20 February 2023

Search terms:

NEWBORN

Keywords

Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*

ULTRASOUND/PATHOLOGY

Keywords Ultrasound

ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*

OR

Keywords Specific Pathology

"Hypoxic-Ischaemic Encephalopath*" or "Hypoxic ischaemic encephalopath*" or "hypoxic ischemic encephalopath*" or "hypoxic-ischemic encephalopath*" or HIE or "hypoxic encephalopath*" or "Ischaemia encephalopath*" or "ischaemic encephalopath*" or "ischemia encephalopath*" or "ischemic encephalopath*" or "neonatal encephalopath*" or "infant encephalopath*" or "newborn encephalopath*" or "epileptic encephalopath*" or "Neonatal hydrocephal*" or "newborn hydrocephal*" or "infant hydrocephal*" or "post haemorrhagic hydrocephal*" or "post-haemorrhagic hydrocephal*" or "posthaemorrhagic hydrocephal*" or "post hemorrhagic hydrocephal*" or "post-hemorrhagic hydrocephal*" or "posthemorrhagic hydrocephal*" or "congenital hydrocephal*" or IVH or "intraventricular haemorrhag*" or "intraventricular hemorrhag*" or "intra-ventricular haemorrhag*" or "intra-ventricular hemorrhag*" or "intraventricular bleed*" or "intra-ventricular bleed*" or "germinal matrix-intraventricular haemorrhage" or "germinal matrix-intraventricular hemorrhage" or "germinal matrix haemorrhage" or "germinal matrix hemorrhage" or "GMH-IVH" or PVI or "periventricular haemorrhagic infarct*" or "periventricular hemorrhagic infarct*" or HPI or "haemorrhagic parenchymal infarct*" or "hemorrhagic parenchymal infarct*" or "cerebellar haemorrhag*" or "cerebellar hemorrhag*" or "cerebral ventriculomegal*" or "hypoxic-ischaemic injur*" or "hypoxic ischaemic injur*" or "cerebral hypoxia ischemia" or "cerebral hypoxia-ischemia" or "cerebral hypoxia ischaemia" or "cerebral hypoxia-ischaemia" or "cerebral anoxia ischemia" or "cerebral anoxia-ischemia" or "cerebral anoxia ischaemia" or "cerebral anoxia-ischaemia" or "cerebral ischemia hypoxia" or "cerebral ischemia-hypoxia" or "cerebral ischaemia hypoxia" or "cerebral ischaemia-hypoxia" or "cerebral ischemia anoxia" or "cerebral ischemia-anoxia" or "cerebral ischaemia anoxia" or "cerebral ischaemia-anoxia" or "brain hypoxia ischemia" or "brain hypoxia-ischemia" or "brain hypoxia ischaemia" or "brain hypoxia-ischaemia" or "brain anoxia ischemia" or "brain anoxia-ischemia" or "brain anoxia ischaemia" or "brain anoxia-ischaemia" or "brain ischemia hypoxia" or "brain ischemia-hypoxia" or "brain ischaemia hypoxia" or "brain ischaemia-hypoxia" or "brain ischemia anoxia" or "brain ischemia-anoxia" or "brain ischaemia anoxia" or "brain ischaemia-anoxia" or PVL or "periventricular

leukomalacia*” or “periventricular encephalomalacia*” or “neonatal cerebral leukomalacia*” or “lenticulostriate vasculopath*” or “lenticulostriate vascular disease*” or “thalamostriate vasculopath*” or “absent corpus callosum” or “agenesis of the corpus callosum” or “agenesis of corpus callosum” or “corpus callosum absent” or “cerebellar hypoplasia” or “hypoplasia of the cerebellum” or “hypoplasia of cerebellum” or “central nervous system cyst*” or “cns cyst*” or “midline cyst*” or “subependymal cyst*” or “connatal cyst*” or “choroid plexus cyst*” or “arachnoid cyst*” or “porencephalic cyst*” or “periventricular flare*” or “periventricular bright*” or “parenchymal flare*” or “parenchymal echodensit*” or “cerebral echogenicit*” or “vein of galen aneurysm*” or “aneurysm* of vein of galen” or “vein of galen malformation*” or “malformation* of the vein of galen” or “germinolytic cyst*” or “congenital cytomegalovirus” or “congenital CMV” or “perinatal cytomegalovirus” or “perinatal CMV” or “congenital toxoplasmosis” or “congenital toxoplasma infection*” or “postinfectious hydroceph*” or “postinfective hydroceph*” or “post-infectious hydroceph*” or “post-infective hydroceph*”

OR

Keywords General Pathology (w adjacency to neonatal terms)

Encephalopath* or hydrocephal* or “brain hemorrhage*” or “intracranial haemorrhage*” or “intracranial hemorrhage*” or “cerebral haemorrhage*” or “cerebral hemorrhage*” or “cerebral parenchymal haemorrhage*” or “posterior fossa haemorrhage*” or “haemorrhagic brain lesion*” or “hemorrhagic brain lesion*” or “ischaemic brain lesion*” or “ischemic brain lesion*” or “haemorrhagic brain injur*” or “hemorrhagic brain injur*” or “ischaemic brain injur*” or “ischemic brain injur*” or “brain ischaemi*” or “brain ischemi*” or “haemorrhagic infarct*” or “hemorrhagic infarct*” or stroke* or “cerebrovascular accident*” or “cerebral infarct*” or “brain infarct*” or “cerebral calcification*” or “intracranial calcification*” or “brain calcification*” or “ventricular calcification*” or “thalamic calcification*” or cytomegalovirus or CMV or toxoplasm* or “cerebral abscess” or “intracranial abscess” or “brain abscess” or meningitis

NEAR/5

Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*

AFRICA

Keywords

Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or "Burkina Faso" or "Burkina Fasso" or "Upper Volta" or burkinabe or burkinese or Burundi* or Urundi* or Ruanda-Urundi* or Cameroon* or Kamerun* or Cameroun* or "Capo Verde*" or "Cape Verde*" or "Central African Republic" or "central african*" or Ubangi-Shari* or Chad* or Comoros or "Comoro Islands" or "Glorioso Islands" or "iles comores" or Mayotte or Congo* or congolese or "Cote d'Ivoire" or "Cote d' Ivoire" or "Cote dIvoire" or "Cote d Ivoire" or "Ivory Coast" or ivorian* or "Democratic Republic of Congo" or "Democratic Republic of the Congo" or "DR Congo" or "DR of the Congo" or Congo-Kinshasa or "Belgian Congo" or Zaire or "Congo Free State" or Djibouti* or "french somaliland" or Egypt* or "united arab republic" or "Equatorial Guinea*"

or equatoguinean* or "Spanish Guinea" or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or "Gabonese Republic" or Gambia* or Ghana* or "Gold Coast" or Guinea* or Guinea-Bissau or "bissau guinean" or "Portuguese Guinea*" or Kenya* or "East Africa Protectorate" or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or "libyan arab jamahiriya*" or Madagascar or "Malagasy Republic" or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or "Agalega Islands" or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or "Portuguese East Africa" or mozambican* or Namibia* or "German South West Africa" or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or "Saint Helena" or "Sao Tome" or "sao tomean*" or santomean* or Senegal* or Seychelles or seychellois or seychelloise or "Sierra Leone*" or Salone* or Somalia* or somali* or Somaliland* or "South Africa*" or "Cape Colony" or "British Bechuanaland" or "Boer Republics" or Zululand or Transvaal or "Natalia Republic" or "Orange Free State" or "South Sudan*" or Sudan* or Tanzania* or Tanganyika*or Zanzibar* or Togo* or "Togolese Republic" or Togoland* or Tunisia* or Uganda* or "Western Sahara" or Zambia* or "Northern Rhodesia*" or Zimbabwe*

5. MEDLINE

<1946 to 21 February 2023> searched on 21 February 2023

Search terms:

1 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*).mp.
2 exp Infant/
3 1 or 2
4 (ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*).mp.
5 ultrasonography/ or ultrasonics/ or echoencephalography/ or ultrasonography, doppler, transcranial/
6 Skull/dg
7 Brain/dg
8 4 or 5 or 6 or 7
9 (hypoxic-ischaemic encephalopath* or hypoxic ischaemic encephalopath* or HIE or hypoxic encephalopath* or Ischaemia encephalopath* or neonatal encephalopath* or infant encephalopath* or newborn encephalopathy* or epileptic encephalopath* or neonatal hydrocephal* or newborn hydrocephal* or infant hydrocephal* or post haemorrhagic hydrocephal* or post-haemorrhagic hydrocephal* or posthaemorrhagic hydrocephal* or congenital hydrocephal* or IVH or intraventricular haemorrhag* or intraventricular hemorrhag* or intra-ventricular haemorrhag* or intra-ventricular hemorrhag* or intraventricular bleed* or intra-ventricular bleed* or germinal matrix-intraventricular haemorrhage or germinal matrix-intraventricular hemorrhage or germinal matrix haemorrhage or GMH-IVH or brain haemorrhage* or PVI or periventricular haemorrhagic infarct* or periventricular hemorrhagic infarct* or HPI or haemorrhagic parenchymal infarct* or hemorrhagic parenchymal infarct* or cerebellar haemorrhag* or cerebellar hemorrhag* or cerebral ventriculomegal* or hypoxic-ischaemic injur* or hypoxic ischaemic injur* or cerebral hypoxia ischemia or cerebral hypoxia-ischemia or cerebral hypoxia ischaemia or cerebral hypoxia-ischaemia or cerebral anoxia ischemia or cerebral anoxia-ischemia or cerebral anoxia ischaemia or cerebral anoxia-ischaemia or cerebral ischemia hypoxia or cerebral ischemia-hypoxia or cerebral ischaemia hypoxia or cerebral ischaemia-hypoxia or cerebral ischemia anoxia or cerebral ischemia-anoxia or cerebral ischaemia anoxia or cerebral ischaemia-anoxia or brain hypoxia ischemia or brain hypoxia-ischemia or brain hypoxia ischaemia or brain hypoxia-ischaemia brain anoxia ischemia or brain anoxia-ischemia or brain anoxia ischaemia or brain anoxia-ischaemia or brain ischemia hypoxia or brain ischemia-hypoxia or brain ischaemia hypoxia or brain ischaemia-hypoxia or brain ischemia anoxia or brain ischemia-anoxia or brain ischaemia anoxia or brain ischaemia-anoxia or PVL or periventricular leukomalacia* or periventricular encephalomalacia* or neonatal cerebral leukomalacia* or lenticulostriate vasculopath* or lenticulostriate vascular disease* or thalamostriate vasculopath* or absent corpus callosum or agenesis of the corpus callosum or agenesis of corpus callosum or corpus callosum absent or cerebellar hypoplasia or hypoplasia of the cerebellum or hypoplasia of cerebellum or central nervous system cyst* or cns cyst* or midline cyst* or subependymal cyst* or connatal cyst* or choroid plexus cyst* or arachnoid cyst* or porencephalic cyst* or periventricular flare* or periventricular bright* or parenchymal flare* or parenchymal echodensit* or cerebral echogenicit* or vein of galen aneurysm* or aneurysm* of vein of galen or vein of galen malformation* or malformation* of the vein of galen or germinolytic cyst* or congenital cytomegalovirus or congenital CMV or perinatal cytomegalovirus or perinatal CMV or congenital toxoplasmosis or congenital

toxoplasma infection* or post-infectious hydroceph* or postinfectious hydroceph* or post-infective hydroceph* or postinfective hydroceph*).mp.
10 ((encephalopath* or hydrocephal* or brain hemorrhage* or intracranial haemorrhage* or intracranial hemorrhage* or cerebral haemorrhage* or cerebral hemorrhage* or cerebral parenchymal haemorrhage* or posterior fossa haemorrhage* or haemorrhagic brain lesion* or hemorrhagic brain lesion* or ischaemic brain lesion* or ischemic brain lesion* or haemorrhagic brain injur* or hemorrhagic brain injur* or ischaemic brain injur* or ischemic brain injur* or brain ischaemi* or brain ischemi* or haemorrhagic infarct* or hemorrhagic infarct* or stroke* or cerebrovascular accident* or cerebral infarct* or brain infarct* or cerebral calcification* or intracranial calcification* or brain calcification* or ventricular calcification* or thalamic calcification* or cytomegalovirus or CMV or toxoplasm* or cerebral abscess or intracranial abscess or brain abscess or meningitis) adj5 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*)).mp.
11 leukomalacia, periventricular/ or hypoxia-ischemia, brain/ or exp "Agenesis of Corpus Callosum"/ or exp Central Nervous System Cysts/ or Arachnoid Cysts/ or Toxoplasmosis, Congenital/
12 9 or 10 or 11
13 8 or 12
14 (Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or Burkina Faso or Burkina Fasso or Upper Volta or burkinabe or burkinese or Burundi* or Urundi* or Ruanda-Urundi* or Cameroon* or Kamerun* or Cameroun* or Capo Verde* or Cape Verde* or Central African Republic or central african* or Ubangi-Shari* or Chad* or Comoros or Comoro Islands or Glorioso Islands or iles comores or Mayotte or Congo* or congolese or Cote d'Ivoire or Cote d' Ivoire or Cote dIvoire or Cote d Ivoire or Ivory Coast or ivorian* or Democratic Republic of Congo or Democratic Republic of the Congo or DR Congo or DR of the Congo or Congo-Kinshasa or Belgian Congo or Zaire or Congo Free State or Djibouti* or french somaliland or Egypt* or united arab republic or Equatorial Guinea* or equatoguinean* or Spanish Guinea or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or Gabonese Republic or Gambia* or Ghana* or Gold Coast or Guinea* or Guinea-Bissau or bissau guinean or Portuguese Guinea* or Kenya* or East Africa Protectorate or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or libyan arab jamahiriya* or Madagascar or Malagasy Republic or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or Agalega Islands or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or Portuguese East Africa or mozambican* or Namibia* or German South West Africa or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or Saint Helena or Sao Tome or sao tomean* or santomean* or Senegal* or Seychelles or seychellois or seychelloise or Sierra Leone* or Salone* or Somalia* or somali* or Somaliland* or South Africa* or Cape Colony or British Bechuanaland or Boer Republics or Zululand or Transvaal or Natalia Republic or Orange Free State or South Sudan* or Sudan* or Tanzania* or Tanganyika* or Zanzibar* or Togo* or Togolese Republic or Togoland* or Tunisia* or Uganda* or Western Sahara or Zambia* or Northern Rhodesia* or Zimbabwe*).mp.
15 exp Africa/ or comoros/ or madagascar/ or mauritius/ or seychelles/
16 14 or 15
17 3 and 13 and 16

6. Embase

<1947 to 21 February 2023> searched on 21 February 2023

Search terms:

1 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*).mp.
2 exp Infant/ or prematurity/
3 1 or 2
4 (ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*).mp.
5 ultrasound/ or echography/ or exp doppler ultrasonography/ or echoencephalography/
6 (hypoxic-ischaemic encephalopath* or hypoxic ischaemic encephalopath* or HIE or hypoxic encephalopath* or Ischaemia encephalopath* or neonatal encephalopath* or infant encephalopath* or newborn encephalopathy* or epileptic encephalopath* or neonatal hydrocephal* or newborn hydrocephal* or infant hydrocephal* or post haemorrhagic hydrocephal* or post-haemorrhagic hydrocephal* or posthaemorrhagic hydrocephal* or congenital hydrocephal* or IVH or intraventricular haemorrhag* or intraventricular hemorrhag* or intra-ventricular haemorrhag* or intra-ventricular hemorrhag* or intraventricular bleed* or intra-ventricular bleed* or germinal matrix-intraventricular haemorrhage or germinal matrix-intraventricular hemorrhage or germinal matrix haemorrhage or GMH-IVH or brain haemorrhage* or PVI or periventricular haemorrhagic infarct* or periventricular hemorrhagic infarct* or HPI or haemorrhagic parenchymal infarct* or hemorrhagic parenchymal infarct* or cerebellar haemorrhag* or cerebellar hemorrhag* or cerebral ventriculomegal* or hypoxic-ischaemic injur* or hypoxic ischaemic injur* or cerebral hypoxia ischemia or cerebral hypoxia-ischemia or cerebral hypoxia ischaemia or cerebral hypoxia-ischaemia or cerebral anoxia ischemia or cerebral anoxia-ischemia or cerebral anoxia ischaemia or cerebral anoxia-ischaemia or cerebral ischemia hypoxia or cerebral ischemia-hypoxia or cerebral ischaemia hypoxia or cerebral ischaemia-hypoxia or cerebral ischemia anoxia or cerebral ischemia-anoxia or cerebral ischaemia anoxia or cerebral ischaemia-anoxia or brain hypoxia ischemia or brain hypoxia-ischemia or brain hypoxia ischaemia or brain hypoxia-ischaemia brain anoxia ischemia or brain anoxia-ischemia or brain anoxia ischaemia or brain anoxia-ischaemia or brain ischemia hypoxia or brain ischemia-hypoxia or brain ischaemia hypoxia or brain ischaemia-hypoxia or brain ischemia anoxia or brain ischemia-anoxia or brain ischaemia anoxia or brain ischaemia-anoxia or PVL or periventricular leukomalacia* or periventricular encephalomalacia* or neonatal cerebral leukomalacia* or lenticulostriate vasculopath* or lenticulostriate vascular disease* or thalamostriate vasculopath* or absent corpus callosum or agenesis of the corpus callosum or agenesis of corpus callosum or corpus callosum absent or cerebellar hypoplasia or hypoplasia of the cerebellum or hypoplasia of cerebellum or central nervous system cyst* or cns cyst* or midline cyst* or subependymal cyst* or connatal cyst* or choroid plexus cyst* or arachnoid cyst* or porencephalic cyst* or periventricular flare* or periventricular bright* or parenchymal flare* or parenchymal echodensit* or cerebral echogenicit* or vein of galen aneurysm* or aneurysm* of vein of galen or vein of galen malformation* or malformation* of the vein of galen or germinolytic cyst* or congenital cytomegalovirus or congenital CMV or perinatal cytomegalovirus or perinatal CMV or congenital toxoplasmosis or congenital toxoplasma infection* or post-infectious hydroceph* or postinfectious hydroceph* or post-infective hydroceph* or postinfective hydroceph*).mp.
7 ((encephalopath* or hydrocephal* or brain hemorrhage* or intracranial haemorrhage* or intracranial hemorrhage* or cerebral haemorrhage* or cerebral hemorrhage* or cerebral

parenchymal haemorrhage* or posterior fossa haemorrhage* or haemorrhagic brain lesion* or hemorrhagic brain lesion* or ischaemic brain lesion* or ischemic brain lesion* or haemorrhagic brain injur* or hemorrhagic brain injur* or ischaemic brain injur* or ischemic brain injur* or brain ischaemi* or brain ischemi* or haemorrhagic infarct* or hemorrhagic infarct* or stroke* or cerebrovascular accident* or cerebral infarct* or brain infarct* or cerebral calcification* or intracranial calcification* or brain calcification* or ventricular calcification* or thalamic calcification* or cytomegalovirus or CMV or toxoplasm* or cerebral abscess or intracranial abscess or brain abscess or meningitis) adj5 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*)).mp.
8 leukomalacia/ or hypoxic ischemic encephalopathy/ or brain malformation/ or corpus callosum agenesis/ or "vein of galen malformation"/ or brain cyst/ or arachnoid cyst/ or congenital toxoplasmosis/
9 4 or 5 or 6 or 7 or 8
10 (Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or Burkina Faso or Burkina Fasso or Upper Volta or burkinabe or burkinese or Burundi* or Urundi* or Ruanda-Urundi* or Cameroon* or Kamerun* or Cameroun* or Capo Verde* or Cape Verde* or Central African Republic or central african* or Ubangi-Shari* or Chad* or Comoros or Comoro Islands or Glorioso Islands or iles comores or Mayotte or Congo* or congolese or Cote d'Ivoire or Cote d' Ivoire or Cote dIvoire or Cote d Ivoire or Ivory Coast or ivorian* or Democratic Republic of Congo or Democratic Republic of the Congo or DR Congo or DR of the Congo or Congo-Kinshasa or Belgian Congo or Zaire or Congo Free State or Djibouti* or french somaliland or Egypt* or united arab republic or Equatorial Guinea* or equatoguinean* or Spanish Guinea or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or Gabonese Republic or Gambia* or Ghana* or Gold Coast or Guinea* or Guinea-Bissau or bissau guinean or Portuguese Guinea* or Kenya* or East Africa Protectorate or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or libyan arab jamahiriya* or Madagascar or Malagasy Republic or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or Agalega Islands or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or Portuguese East Africa or mozambican* or Namibia* or German South West Africa or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or Saint Helena or Sao Tome or sao tomean* or santomean* or Senegal* or Seychelles or seychellois or seychelloise or Sierra Leone* or Salone* or Somalia* or somali* or Somaliland* or South Africa* or Cape Colony or British Bechuanaland or Boer Republics or Zululand or Transvaal or Natalia Republic or Orange Free State or South Sudan* or Sudan* or Tanzania* or Tanganyika* or Zanzibar* or Togo* or Togolese Republic or Togoland* or Tunisia* or Uganda* or Western Sahara or Zambia* or Northern Rhodesia* or Zimbabwe*).mp.
11 exp Africa/ or mauritius/ or seychelles/ or saint helena/ or "sao tome and principe"/
12 10 or 11
13 3 and 9 and 12

7. Global Health

<1910 to 2023 week 7> searched on 21 February 2023

1 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*).mp.
2 exp infants/ or prematurity/
3 1 or 2
4 (ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*).mp.
5 ultrasound/ or ultrasonics/ or ultrasonography/
6 (hypoxic-ischaemic encephalopath* or hypoxic ischaemic encephalopath* or HIE or hypoxic encephalopath* or Ischaemia encephalopath* or neonatal encephalopath* or infant encephalopath* or newborn encephalopathy* or epileptic encephalopath* or neonatal hydrocephal* or newborn hydrocephal* or infant hydrocephal* or post haemorrhagic hydrocephal* or post-haemorrhagic hydrocephal* or posthaemorrhagic hydrocephal* or congenital hydrocephal* or IVH or intraventricular haemorrhag* or intraventricular hemorrhag* or intra-ventricular haemorrhag* or intra-ventricular hemorrhag* or intraventricular bleed* or intra-ventricular bleed* or germinal matrix-intraventricular haemorrhage or germinal matrix-intraventricular hemorrhage or germinal matrix haemorrhage or GMH-IVH or brain haemorrhage* or PVI or periventricular haemorrhagic infarct* or periventricular hemorrhagic infarct* or HPI or haemorrhagic parenchymal infarct* or hemorrhagic parenchymal infarct* or cerebellar haemorrhag* or cerebellar hemorrhag* or cerebral ventriculomegal* or hypoxic-ischaemic injur* or hypoxic ischaemic injur* or cerebral hypoxia ischemia or cerebral hypoxia-ischemia or cerebral hypoxia ischaemia or cerebral hypoxia-ischaemia or cerebral anoxia ischemia or cerebral anoxia-ischemia or cerebral anoxia ischaemia or cerebral anoxia-ischaemia or cerebral ischemia hypoxia or cerebral ischemia-hypoxia or cerebral ischaemia hypoxia or cerebral ischaemia-hypoxia or cerebral ischemia anoxia or cerebral ischemia-anoxia or cerebral ischaemia anoxia or cerebral ischaemia-anoxia or brain hypoxia ischemia or brain hypoxia-ischemia or brain hypoxia ischaemia or brain hypoxia-ischaemia brain anoxia ischemia or brain anoxia-ischemia or brain anoxia ischaemia or brain anoxia-ischaemia or brain ischemia hypoxia or brain ischemia-hypoxia or brain ischaemia hypoxia or brain ischaemia-hypoxia or brain ischemia anoxia or brain ischemia-anoxia or brain ischaemia anoxia or brain ischaemia-anoxia or PVL or periventricular leukomalacia* or periventricular encephalomalacia* or neonatal cerebral leukomalacia* or lenticulostriate vasculopath* or lenticulostriate vascular disease* or thalamostriate vasculopath* or absent corpus callosum or agenesis of the corpus callosum or agenesis of corpus callosum or corpus callosum absent or cerebellar hypoplasia or hypoplasia of the cerebellum or hypoplasia of cerebellum or central nervous system cyst* or cns cyst* or midline cyst* or subependymal cyst* or connatal cyst* or choroid plexus cyst* or arachnoid cyst* or porencephalic cyst* or periventricular flare* or periventricular bright* or parenchymal flare* or parenchymal echodensit* or cerebral echogenicit* or vein of galen aneurysm* or aneurysm* of vein of galen or vein of galen malformation* or malformation* of the vein of galen or germinolytic cyst* or congenital cytomegalovirus or congenital CMV or perinatal cytomegalovirus or perinatal CMV or congenital toxoplasmosis or congenital toxoplasma infection* or post-infectious hydroceph* or postinfectious hydroceph* or post-infective hydroceph* or postinfective hydroceph*).mp.
7 ((encephalopath* or hydrocephal* or brain hemorrhage* or intracranial haemorrhage* or intracranial hemorrhage* or cerebral haemorrhage* or cerebral hemorrhage* or cerebral parenchymal haemorrhage* or posterior fossa haemorrhage* or haemorrhagic brain lesion* or hemorrhagic brain lesion* or ischaemic brain lesion* or ischemic brain lesion* or haemorrhagic brain injur* or hemorrhagic brain injur* or ischaemic brain injur* or ischemic

brain injur* or brain ischaemi* or brain ischemi* or haemorrhagic infarct* or hemorrhagic infarct* or stroke* or cerebrovascular accident* or cerebral infarct* or brain infarct* or cerebral calcification* or intracranial calcification* or brain calcification* or ventricular calcification* or thalamic calcification* or cytomegalovirus or CMV or toxoplasm* or cerebral abscess or intracranial abscess or brain abscess or meningitis) adj5 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*)).mp.
8 congenital toxoplasmosis/ or neonatal meningitis/
9 4 or 5 or 6 or 7 or 8
10 (Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or Burkina Faso or Burkina Fasso or Upper Volta or burkinabe or burkinese or Burundi* or Urundi* or Ruanda-Urundi* or Cameroon* or Kamerun* or Cameroun* or Capo Verde* or Cape Verde* or Central African Republic or central african* or Ubangi-Shari* or Chad* or Comoros or Comoro Islands or Glorioso Islands or iles comores or Mayotte or Congo* or congolese or Cote d'Ivoire or Cote d' Ivoire or Cote dIvoire or Cote d Ivoire or Ivory Coast or ivorian* or Democratic Republic of Congo or Democratic Republic of the Congo or DR Congo or DR of the Congo or Congo-Kinshasa or Belgian Congo or Zaire or Congo Free State or Djibouti* or french somaliland or Egypt* or united arab republic or Equatorial Guinea* or equatoguinean* or Spanish Guinea or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or Gabonese Republic or Gambia* or Ghana* or Gold Coast or Guinea* or Guinea-Bissau or bissau guinean or Portuguese Guinea* or Kenya* or East Africa Protectorate or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or libyan arab jamahiriya* or Madagascar or Malagasy Republic or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or Agalega Islands or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or Portuguese East Africa or mozambican* or Namibia* or German South West Africa or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or Saint Helena or Sao Tome or sao tomean* or santomean* or Senegal* or Seychelles or seychellois or seychelloise or Sierra Leone* or Salone* or Somalia* or somali* or Somaliland* or South Africa* or Cape Colony or British Bechuanaland or Boer Republics or Zululand or Transvaal or Natalia Republic or Orange Free State or South Sudan* or Sudan* or Tanzania* or Tanganyika* or Zanzibar* or Togo* or Togolese Republic or Togoland* or Tunisia* or Uganda* or Western Sahara or Zambia* or Northern Rhodesia* or Zimbabwe*).mp.
11 exp Africa/
12 10 or 11
13 3 and 9 and 12

8. PsycINFO

<1806 to February week 2 2023> searched on 21 February 2023

1 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*).mp.
2 neonatal period/
3 1 or 2
4 (ultrasound* or ultrasonograph* or sonograph* or ultrasonic* or echoencephalograph*).mp.
5 ultrasound/ or echoencephalography/
6 (hypoxic-ischaemic encephalopath* or hypoxic ischaemic encephalopath* or HIE or hypoxic encephalopath* or Ischaemia encephalopath* or neonatal encephalopath* or infant encephalopath* or newborn encephalopathy* or epileptic encephalopath* or neonatal hydrocephal* or newborn hydrocephal* or infant hydrocephal* or post haemorrhagic hydrocephal* or post-haemorrhagic hydrocephal* or posthaemorrhagic hydrocephal* or congenital hydrocephal* or IVH or intraventricular haemorrhag* or intraventricular hemorrhag* or intra-ventricular haemorrhag* or intra-ventricular hemorrhag* or intraventricular bleed* or intra-ventricular bleed* or germinal matrix-intraventricular haemorrhage or germinal matrix-intraventricular hemorrhage or germinal matrix haemorrhage or GMH-IVH or brain haemorrhage* or PVI or periventricular haemorrhagic infarct* or periventricular hemorrhagic infarct* or HPI or haemorrhagic parenchymal infarct* or hemorrhagic parenchymal infarct* or cerebellar haemorrhag* or cerebellar hemorrhag* or cerebral ventriculomegal* or hypoxic-ischaemic injur* or hypoxic ischaemic injur* or cerebral hypoxia ischemia or cerebral hypoxia-ischemia or cerebral hypoxia ischaemia or cerebral hypoxia-ischaemia or cerebral anoxia ischemia or cerebral anoxia-ischemia or cerebral anoxia ischaemia or cerebral anoxia-ischaemia or cerebral ischemia hypoxia or cerebral ischemia-hypoxia or cerebral ischaemia hypoxia or cerebral ischaemia-hypoxia or cerebral ischemia anoxia or cerebral ischemia-anoxia or cerebral ischaemia anoxia or cerebral ischaemia-anoxia or brain hypoxia ischemia or brain hypoxia-ischemia or brain hypoxia ischaemia or brain hypoxia-ischaemia brain anoxia ischemia or brain anoxia-ischemia or brain anoxia ischaemia or brain anoxia-ischaemia or brain ischemia hypoxia or brain ischemia-hypoxia or brain ischaemia hypoxia or brain ischaemia-hypoxia or brain ischemia anoxia or brain ischemia-anoxia or brain ischaemia anoxia or brain ischaemia-anoxia or PVL or periventricular leukomalacia* or periventricular encephalomalacia* or neonatal cerebral leukomalacia* or lenticulostriate vasculopath* or lenticulostriate vascular disease* or thalamostriate vasculopath* or absent corpus callosum or agenesis of the corpus callosum or agenesis of corpus callosum or corpus callosum absent or cerebellar hypoplasia or hypoplasia of the cerebellum or hypoplasia of cerebellum or central nervous system cyst* or cns cyst* or midline cyst* or subependymal cyst* or connatal cyst* or choroid plexus cyst* or arachnoid cyst* or porencephalic cyst* or periventricular flare* or periventricular bright* or parenchymal flare* or parenchymal echodensit* or cerebral echogenicit* or vein of galen aneurysm* or aneurysm* of vein of galen or vein of galen malformation* or malformation* of the vein of galen or germinolytic cyst* or congenital cytomegalovirus or congenital CMV or perinatal cytomegalovirus or perinatal CMV or congenital toxoplasmosis or congenital toxoplasma infection* or post-infectious hydroceph* or postinfectious hydroceph* or post-infective hydroceph* or postinfective hydroceph*).mp.
7 ((encephalopath* or hydrocephal* or brain hemorrhage* or intracranial haemorrhage* or intracranial hemorrhage* or cerebral haemorrhage* or cerebral hemorrhage* or cerebral parenchymal haemorrhage* or posterior fossa haemorrhage* or haemorrhagic brain lesion* or hemorrhagic brain lesion* or ischaemic brain lesion* or ischemic brain lesion* or haemorrhagic brain injur* or hemorrhagic brain injur* or ischaemic brain injur* or ischemic

brain injur* or brain ischaemi* or brain ischemi* or haemorrhagic infarct* or hemorrhagic infarct* or stroke* or cerebrovascular accident* or cerebral infarct* or brain infarct* or cerebral calcification* or intracranial calcification* or brain calcification* or ventricular calcification* or thalamic calcification* or cytomegalovirus or CMV or toxoplasm* or cerebral abscess or intracranial abscess or brain abscess or meningitis) adj5 (Infant* or newborn* or neonat* or baby or babies or preterm* or pre-term*)).mp.
8 periventricular leukomalacia/
9 4 or 5 or 6 or 7 or 8
10 (Africa* or Algeria* or Angola* or Benin* or Dahomey or Botswana* or Batswana* or Bechuanaland* or Kalahari* or Burkina Faso or Burkina Fasso or Upper Volta or burkinabe or burkinese or Burundi* or Urundi* or Ruanda-Urundi* or Cameroon* or Kamerun* or Cameroun* or Capo Verde* or Cape Verde* or Central African Republic or central african* or Ubangi-Shari* or Chad* or Comoros or Comoro Islands or Glorioso Islands or iles comores or Mayotte or Congo* or congolese or Cote d'Ivoire or Cote d' Ivoire or Cote dIvoire or Cote d Ivoire or Ivory Coast or ivorian* or Democratic Republic of Congo or Democratic Republic of the Congo or DR Congo or DR of the Congo or Congo-Kinshasa or Belgian Congo or Zaire or Congo Free State or Djibouti* or french somaliland or Egypt* or united arab republic or Equatorial Guinea* or equatoguinean* or Spanish Guinea or Eritrea* or Abyssinia* or Eswatini* or eSwatini* or Swaziland* or swazi* or swati* or Ethiopia* or Gabon* or Gabonese Republic or Gambia* or Ghana* or Gold Coast or Guinea* or Guinea-Bissau or bissau guinean or Portuguese Guinea* or Kenya* or East Africa Protectorate or Lesotho* or Basutoland or mosotho or basotho or Liberia* or Libya* or libyan arab jamahiriya* or Madagascar or Malagasy Republic or malagasy or madagascan or Malawi* or Malior or Mali* or Mauritania* or mauritanian* or Mauritius or mauritian* or Agalega Islands or Mayotte or Morocco or moroccan* or Mozambique or Nyasaland or Mocambique or Portuguese East Africa or mozambican* or Namibia* or German South West Africa or Niger or Nigeria or nigerien* or nigerian* or Rwanda* or Ruanda* or rwandese or ruandese or Saint Helena or Sao Tome or sao tomean* or santomean* or Senegal* or Seychelles or seychellois or seychelloise or Sierra Leone* or Salone* or Somalia* or somali* or Somaliland* or South Africa* or Cape Colony or British Bechuanaland or Boer Republics or Zululand or Transvaal or Natalia Republic or Orange Free State or South Sudan* or Sudan* or Tanzania* or Tanganyika* or Zanzibar* or Togo* or Togolese Republic or Togoland* or Tunisia* or Uganda* or Western Sahara or Zambia* or Northern Rhodesia* or Zimbabwe*).mp.
11 exp Developing Countries/
12 10 or 11
13 3 and 9 and 12

9. Google Scholar

<1730 to 21 February 2023> searched on 21 February 2023

Search terms:

infant|newborn|neonate

cranial|head

ultrasound|ultrasonography|sonography|ultrasonic

Africa|Angola|Botswana|Burkina|Burundi|Cameroon|"Capo Verde"|"Central African Republic"|Chad|Comoros|Congo|"Cote d'Ivoire"|"Democratic Republic of Congo"|"Equatorial Guinea"|Eritrea|Eswatini|Ethiopia|Gabon|Gambia|Ghana|Guinea|Guinea-Bissau|Kenya|Lesotho|Liberia|Madagascar|"Sao Tome"|Senegal|Seychelles|Sierra Leone|"South Africa"|Malawi|Mali|Mauritania|Mauritius|Mozambique|Namibia|Niger|Nigeria| Rwanda| "Saint Helena" |Somalia|Somaliland|Sudan|Tanzania|Togo|Uganda|"Western Sahara"|Zambia|Zimbabwe

Supplemental Table S1. Characteristics of studies utilising CUS for Non-IVH outcomes

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
Congenital structural brain abnormalities						
Fisher 1988 [1]	South Africa (UMI)	1st and only paediatric tertiary children's hospital in sub-Saharan Africa	CR	1	Pop: Newborn with bulging anterior fontanelle G: Not detailed A: Not detailed L: Not detailed: B: Not detailed	T: 5 weeks of age R: Lipoma of the corpus callosum (echogenic central mass with bilateral superior inferior and lateral extensions with dilatation of the ventricular system) N: 1 M: Not detailed O: Not detailed
Badiane 1989 [2]	Senegal (LMI)	National university hospital	CR	1	Pop: Newborn with suspected intracranial pathology G: Term A: Not detailed L: Not detailed B: 3180g	T: 3 weeks of age R: Hydranencephaly N: 1 M: Not detailed O: Not detailed
Nko'o Amvene 1992 [3]	Cameroon (LMI)	University teaching hospital	O – P	11	Pop: Newborns with myelomeningocele G: Not detailed A: Not detailed L: Not detailed B: Not detailed	T: 7 neonates, 4 aged 1-3 months R: Arnold-Chiari malformation (11) with minimal/moderate ventricular dilatation (5) and severe ventricular dilation (6), other structural abnormalities included fenestration of the septum pellucidum (3), partial agenesis corpus callosum (2) N: 1 M: Sonel 400 CGR (France) or Siemens CD (Germany) O: Not detailed
Ly Ba 2007 [4]	Senegal (LMI)	National university hospital	CR	1	Pop: Newborn with abnormal antenatal imaging G: 36+5 A: Antenatal scans showed(ventriculomegaly, absence of cerebellar vermis; symmetrical IUGR L: SVD B: 2000g	T: Day 7 R: Type 3 Lissencephaly N: 1 M: Not detailed O: Not detailed
Urban 2007 [5]	South Africa (UMI)	Hospital not detailed (Genetics department at university)	CR	1	Pop: Newborn with antenatal diagnosis of Dandy-Walker malformation exposed to antiretroviral medication G: Term A: Mother received antivirals for HIV and antibiotics for tuberculosis, antenatal diagnosis of Dandy-Walker malformation at 29 weeks L: Not detailed B: Not detailed	T: Not specified R: Dandy-Walker malformation with mild ventriculomegaly N: 1 M: Not detailed O: Not detailed
Horn 2010 [6]	South Africa (UMI)	Hospital not detailed	CR	1	Pop: Newborn with antenatal dilation lateral ventricles G: 30 A: Not detailed L: Not detailed	T: Not detailed R: asymmetric ventricular dilation, periventricular nodular heterotopia N: 1 M: Not detailed

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
					B: Not detailed	O: Not detailed
Mashuda 2014 [7]	Tanzania (LMI)	Referral hospital	O – P	(total 445)	Pop: Newborns with congenital anomalies G: Not detailed A: 15% mothers took folic acid L: Not detailed B: Not detailed	T: Range 1 day to 60 days (median age 4 days) R: 23 had abnormal scans: hydrocephalus, Dandy-Walker cyst, 'abnormal brain tissue', encephalocele and meningoencephalocele N: 1 M: Not detailed O: Radiologists and senior sonographer
Akanni 2018 [8]	Benin (LMI)	National university hospital centre	CR	1	Pop: Newborn with abnormal antenatal imaging G: Term A: suspicious prenatal USS third trimester L: Not detailed B: No detailed	T: Day 11 R: Vein of Galen malformation N: 1 M: Not detailed O: Not detailed
Taylor 2018 [9]	Rwanda (LI)	University teaching hospital	CR	1	Pop: Newborn with macrocephaly and multiple congenital abnormalities G: Not detailed A: No antenatal imaging L: Not detailed B: Not detailed	T: Not specified R: Findings consistent with semilobar holoprosencephaly with schizencephaly (monoventricle, absent cavum septum pellucidum, fusion across the midline anteriorly and separate occipital horns with a thin roof and a left subdural effusion) N: 1 M: Philips International Systems (Netherlands) and Sonosite Fuji Healthcare Systems, (Japan) O: Paediatricians, occasionally radiologists
Tunde-Oremodu 2018 [10]	Nigeria (LMI)	Tertiary health facility	CR	1	Pop: Newborn with multiple congenital abnormalities, seizures and sepsis G: 42 A: Late booking, febrile illness in first trimester L: 'prolonged obstructed labour', home delivery B: 2800	T: Before Day 13 R: Semi-lobar holoprosencephaly (absent midline structures; poorly developed forebrain; well developed posterior fossa and thalami) N: 1 M: Not detailed O: Not detailed
Amiji 2019 [11]	Tanzania (LMI)	National referral hospital	CR	1	Pop: Preterm newborn with septic optic dysplasia with amniotic band syndrome sequence G: 32 A: 'Uneventful' pregnancy L: CS due to breech B: 1900g	T: Before day 21 R: Agenesis of the septum pellucidum and dilation of the third ventricle N: 1 M: Not detailed O: Neonatologist
Idowu 2019 [12]	Nigeria (LMI)	University teaching hospital	CR	1	Pop: Newborn who only cried after active resuscitation and administration of hydrocortisone G: Term A: DCDA twin 2, no antenatal imaging L: SVD B: Not detailed	T: Day 19 R: Holoprosencephaly (fused thalami, absent falx cerebri and interhemispheric fissure and monoventricle with no visualisation of the third and fourth ventricles and preserved midbrain and cerebellum) N: 1 M: Not detailed O: Not detailed

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
Daniyan 2020 [13]	Nigeria (LMI)	University teaching hospital	CR	1	Pop: Newborn with increasing head circumference G: Not detailed A: Received antenatal care including folic acid and fersolate L: Em-CS due to cephalopelvic disproportion B: 3200g	T: Day 20 R: Hydranencephaly (absent cerebral hemispheres bilaterally with massive cerebrospinal fluid filling the supratentorial space,, incomplete echogenic falx cerebri) N: 1 M: Not detailed O: Not detailed
Intracranial infection						
Friedland 1990 [14]	South Africa (UMI)	Tertiary hospital	CR	1	Pop: Newborn with Leuconostoc meningitis and Hirschsprung's G: Term A: Not detailed L: Not detailed B: 2340g	T: 1 month R: Marked hydrocephalus involving all the ventricles. No abscess, subdural effusion, or midline shift. Repeat scans showed pus casts. N: ≥1 (not specified) M: Not detailed O: Not detailed
Adhikari 1995 [15]	South Africa (UMI)	Tertiary hospital	O – R	18 (total 44)	Pop: Newborns with confirmed bacterial meningitis G: Not detailed A: Not detailed L: Not detailed B: <1500g (8), 1500-2500g (15), >2500g (21)	T: Not detailed R: Normal (8), Grade 1 or 2 IVH (3), ventricular dilatation +/- ventriculitis (7) N: ≥1 (not specified) M: Not detailed O: Not detailed
Adeboye 2010 [16]	Nigeria (LMI)	University teaching hospital	CR	1	Pop: Newborn with Haemophilus influenzae meningitis G: Term A: Not detailed L: Not detailed B: Not detailed	T: After day 22 R: Normal scan after antibiotic treatment N: 1 M: Not detailed O: Not detailed
Madide 2016 [17]	South Africa (UMI)	Tertiary hospital	CS	5	Pop: Preterm newborns with hospital acquired Serratia marcescens G: 26-33 A: Not detailed L: 1 CS due to maternal PET, remainder not detailed B: 840-1608g	T: Day 0-47 R: All abnormal findings consistent with ischaemic parenchymal injury, white matter infarcts, LSP, abscess formation N: 1-3 M: Vivid S5 General Electric Healthcare (USA) O: Neonatal staff
Dramowski 2018 [18]	South Africa (UMI)	Tertiary hospital	CS	6 (total 12)	Pop: Newborns with listeriosis G: Median 35 A: HIV (2) L: VD (7), CS (5) B: Median 2020g	T: Before Day 16 R: Normal (3), IVH +/- PVL (2), hydrocephalus (1) N: 1-2 M: Not detailed O: Not detailed
Mahabeer 2018 [19]	South Africa (UMI)	Tertiary hospital	CR	1	Pop: Preterm newborn with ventriculitis caused by Colistin-resistant Acinetobacter baumannii G: 28	T: Day 14 R: Dilated ventricles with resolving grade 3 bilateral IVH N: 1

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
					A: Uneventful pregnancy L: SVD B: 1020g	M: Not detailed O: Not detailed
Pillay 2019 [20]	South Africa (UMI)	Tertiary referral hospital	O – R	32 (total 50)	Pop: Newborns with symptomatic congenital syphilis G: Median 34 A: Unbooked (28) L: CS (19), VD (31) B: Median 1933g	T: Not detailed R: normal (9), mild such as PV flare/grade 1 or 2 IVH (9), moderate such as unilateral grade 3 IVH (2), cerebral oedema (5), severe such as grade 4 IVH or bleeds with PVL/hydrocephalus/infarct (7) N:1 M: Not detailed O: Senior clinicians
Alemayehu 2021 [21]	Ethiopia (LI)	'American Medical Centre' - level of care not detailed	CS	2	Pop: Newborns with congenital toxoplasmosis G: 1 term and 1 preterm (34) A: 1 maternal neurotoxoplasmosis in third trimester and 1 Rhesus haemolytic disease-induced hydrops fetalis L: 1 CS, 1 not specified B: 2400-4600g	T: Not detailed R: Normal N: 1 M: Not detailed O: Not detailed
Missker 2021 [22]	Ethiopia (LI)	Specialised hospital	O – R	83	Pop: Newborns with meningitis G: Not detailed A: Not detailed L: Not detailed B: Not detailed	T: 1-18 days after diagnosis R: Normal (69), Abnormal (14). [13/14 had hydrocephalus, 1/14 had subdural effusion and 2/14 had ventriculitis] N: 1 M: Not detailed O: Radiologist
Morton 2022 [23]	Uganda (LI)	Private tertiary neurosurgery hospital	O – P	2	Pop: Newborns with P. thiaminolyticus meningitis G: 43 and 1 not detailed A: Reported episodes of fever during pregnancy (1) L: Maternal fever (2), home birth (2), health centre delivery (1) B: Not detailed	T: 7-8 days of age R: Cortical and subcortical WM lesions with extensive cystic changes, enlarged lateral ventricles filled with debris and loculated fluid with thickened hyperechogenic ventricular ependymal lining, cerebritis, frontal lobe lesion N: 1 M: Not detailed O: Not detailed
Nagalo 2022 [24]	Burkina Faso (LI)	University hospital	CS	2	Pop: Newborns with congenital toxoplasmosis G: 1 term and 1 not detailed A: Abnormal prenatal scans (2; ascites and hydrocephalus), poor antenatal monitoring (1), unexplained maternal fever in second trimester (1) L: SVD B: 2100-2725g	T: After Day 7 R: multiple intraparenchymal calcifications related to left para-ventricular hyperechoic formation and left subependymal haemorrhage (1), hydranencephaly and calcifications of the left vitreous (1) N: 1 M: Not detailed O: Not detailed
Ventriculomegaly/hydrocephalus						

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
Odebode 2007 [25]	Nigeria (LMI)	Teaching hospital	CR	1	Pop: Newborn with neck swelling at birth G: Term A: 'Uneventful' L: 'Uneventful' B: Not detailed	T: Day 9 R: Dilated lateral, third and fourth ventricles without an evidence of a Chiari type II or III anomaly N: 1 M: Not detailed O: Not detailed
Gathura 2010 [26]	Kenya (LMI)	Referral hospital	O – R	(total 574)	Pop: Newborns who underwent ventriculoperitoneal shunt insertion for hydrocephalus [27-29] G: No distinct data detailed A: No distinct data detailed L: No distinct data detailed B: No distinct data detailed	T: Day 0 to 3 months R: All had hydrocephalus based on ventricular size measurement across the frontal horns of the lateral ventricles in the axial projection. CUS findings were used to postulate aetiology of hydrocephalus: post-infectious (10.1%) , non-post infectious (13.7%), spina bifida (66.2%), prematurity (0.4%), unknown (9.7%) N: 1 M: Not detailed O: Not detailed
Marchie 2013 [30]	Nigeria (LMI)	Teaching hospital	O – P	71	Pop: Newborns with clinical diagnosis of hydrocephalus and healthy controls G: No distinct data detailed A: Not detailed L: Not detailed B: No distinct data detailed	T: Days 0-60 R: No distinct results detailed N: 1 M: Sonoace 1,500 Medison Corporation (South Korea) O: Not detailed
Chima 2015 [31]	South Africa (UMI)	Regional Hospital	CR	1	Pop: Newborn with macrocephaly G: 36 A: Maternal HIV, twin pregnancy, antenatally diagnosed CNS anomaly L: El-CS B: 2500g	T: Before day 16 R: Dilated ventricles with cerebellar hypoplasia, felt to be secondary to antenatal vascular insult. N: 1 M: Not detailed O: Not detailed
Mboka 2017 [32]	Tanzania (LMI)	National referral hospital	O – P	45	Pop: Newborns with clinical diagnosis of hydrocephalus G: No distinct data detailed A: No distinct data detailed L: No distinct data detailed B: No distinct data detailed	T: 1 to 3 months of age R: All had hydrocephalus; non-communicating was more common N: 1 M: Phillips HP5000 (Netherlands) O: Radiologist
Aliyu 2016 [33]	Nigeria (LMI)	Referral hospital	CR	1	Pop: 1 newborn with congenital anomalies in missed advanced abdominal pregnancy G: Term A: Unbooked advanced abdominal pregnancy L: Explorative laparotomy due to concern regarding rupture of uterus B: 3400g	T: Before day 7 R: Communicating hydrocephalus N: 1 M: Not detailed O: Not detailed

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
Dike M Chinedu 2021 [34]	Nigeria (LMI)	Private hospital	CR	1	Pop: Newborn with bulging non-tense fontanelle following routine immunisation G: Not detailed A: Not detailed L: Not detailed B: Not detailed	T: 11 weeks R: Normal scan N: 1 M: Not detailed O: Not detailed
Adebayo 2022 [35]	Nigeria (LMI)	University teaching hospital	O – P	(total 28)	Pop: Newborns post myelomeningocele repair G: Term A: Not detailed L: Not detailed B: Not detailed	T: After day 23 R: Ventricular index and lateral ventricular ratio were not significant predictors of development of hydrocephalus N: 1-2 M: Toshiba Nemio XG (not detailed) R: Consultant radiologist
Obilo 2022 [36]	Nigeria (LMI)	University teaching hospital	O – P	21	Pop: Newborns with clinical suspicion of hydrocephalus G: Not detailed A: Not detailed L: Not detailed B: Not detailed	T: 1-2 months R: All had hydrocephalus, non-communicating was more common N: 1 M: Aloka Prosound SSD SX (Japan) O: Radiologist
Hypoxic ischaemic encephalopathy (HIE)						
Adhikari 1993 [37]	South Africa (UMI)	Tertiary hospital	O – P	28 (total 30)	Pop: Newborns with moderate-severe HIE G: Not detailed A: Note detailed L: VD (14), CS (8), instrumental (4), symphysiotomy (4) B: mean 3240g (moderate HIE), mean 2990g (severe HIE)	T: From Day 0 R: Normal (16), persistent diffuse cerebral oedema >48 hours (9), transient cerebral oedema <48 hours (2), echodense thalami with bilateral IVH (1) N: ≥1 (daily until discharge/death) M: 'Advanced technical laboratory sector scanner' O: Neonatologists
Horn 2006 [38]	South Africa (UMI)	Multi-centre – 2 tertiary referral hospitals	I	4	Pop: Newborns with HIE who underwent selective head cooling G: Term A: Not detailed L: Not detailed B: 2730-3100g	T: Within 8 hours of life R: Cerebral oedema (3) N: 1 M: Not detailed O: Not detailed
Harrison 2007 [39]	South Africa (UMI)	Multi-centre (1 midwifery operated unit and 2 tertiary referral hospitals)	I	4078	Pop: Newborns in a trial of magnesium supplementation from booking G: Mean 38.2 (both groups) A: Antenatal care as per research protocol L: NVD (75.4% of all participants), CS due to previous CS, foetal distress or failure to progress B: mean 3002g (supplementation), mean 3021g (placebo)	T: Within 24 hours of birth R: Findings suggestive of HIE (cerebral oedema with ventricular compression) were used as part of a composite score in 37 (0.9%) N: 1 M: Not detailed O: Neonatologists

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
Kali 2016 [40] *Kali 2015* [41]	South Africa (UMI)	Multi-centre Tertiary hospital and other referral hospitals	O – R	81 (total 99)	Pop: Newborns with HIE who underwent therapeutic cooling G: Median 39 (35-43) A: Maternal HIV (19) L: Em-CS (21), sentinel event such as uterine rupture (8) B: Median 3060g	T: Median Day 1 (range Day 1-5) R: Subependymal/choroid plexus cysts (5), cerebral oedema (28), BGT abnormalities (24), WM/cortex (43), IVH (6), infarct (1), RI <0.55 (8) N: 1-3 M: Not detailed O: Not detailed but images reviewed by 2 neonatologists independently
Tann 2016 [42] *Tann 2018* [43] *Tann 2014* [44]	Uganda (LI)	National referral hospital	O – P	284	Pop: Newborns with HIE and healthy term controls G: Term A: 56% primiparous L: Em-CS (59) B: mean 3196g (HIE), mean 3065g (control)	T: Within 36 hours of birth and repeat on day 4/5 R: Normal (83 HIE, 67 Control), mild WM changes (43 HIE, 11 Control), mild echogenicity in BGT (19 HIE, 1 Control), major abnormality in BGT (22 HIE, 1 Control), major WM abnormality (25 HIE, 0 Control), global abnormality (8 HIE) N: 1-2 M: Z.one ultra-Convertible Ultrasound System Zonare Medical Systems (USA) O: International neonatology doctors who also trained local neonatal doctors.
Sidibe 2019 [45]	Mali (LI)	Tertiary hospital	O – P	24 (total 76)	Pop: Newborns with perinatal asphyxia G: Term A: Most (72) received antenatal care L: Most (75) were born at health centre, VD (58), CS (18) B: Mean 2876g	T: Day 1-16 R: Normal (20), increased index of resistance of the cerebral artery (4) N: 1 M: Not detailed O: Not detailed
Bundi 2020 [46]	Kenya (LMI)	National referral hospital	O – P	45	Pop: Term newborns with HIE G: Mean 38.8 A: Not detailed L: Prolonged labour (19), meconium-stained liquor (7) B: Mean 3120g	T: Day 2-13 R: Normal (19), abnormal findings included mild to severe BGT and WM changes consistent with HIE N: 1 M: Mindray M7 (not detailed) O: Principal investigator
Non-intraventricular haemorrhage						
Adedoyin 2003 [47]	Nigeria (LMI)	Teaching hospital	CR	1	Pop: Term newborn with acute renal failure complicated subgaleal haemorrhage G: Term A: Not detailed L: Induced VD B: 2800g	T: Before day 7 R: Subgaleal haemorrhage - cerebral oedema, no intracranial collection N: 1 M: Not detailed O: Not detailed
Audu 2015 [48]	Nigeria (LMI)	Referral hospital	CR	1	Pop: Term newborn G: Term	T: Before day 7 R: Right cerebral mass associated with marked shift of the right hemisphere to the left (massive subdural haematoma)

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
					A: Received antenatal care and normal scan in private hospital L: El-CS B: 3200g	N: 1 M: Not detailed O: Not detailed
Andualem 2023 [49]	Ethiopia (LI)	District hospital	CR	1	Pop: Term newborn G: 44+4 A: Received antenatal care and normal scan L: SVD B: 3680g	T: Before day 2 R: Right subdural haematoma N: 1 M: Not detailed O: Not detailed
Screening for pathology in presence of risk factors/symptoms						
Tabari 2008 [50]	Nigeria (LMI)	Teaching hospital	O – R	10	Pop: Newborns referred due to meningitis, increasing head size, birth asphyxia or swollen occiput N: 10 G: Not detailed A: Not detailed L: Not detailed B: Not detailed	T: range 2-53 days R: 1 arachnoid cyst, 1 aqueductal stenosis, 1 occipital cephalocele, no distinct neonatal data presented for hydrocephalus or normal scans N: 1 M: ATL HDI 1500 and ATL Ultramark 9 (USA) O: Radiology department
Eze 2010 [51]	Nigeria (LMI)	Teaching hospital	O – R	68	Pop: Newborns referred from the neonatal unit or private hospitals with hydrocephalus, seizure disorder, intracranial haemorrhage, post meningitis treatment, encephalocoele, birth trauma, hemiatrophy, unilateral proptosis, microcephaly, subcutaneous scalp swelling, parietal prominence G: Term A: Not detailed L: Not detailed B: Not detailed	T: Before day 28 R: No distinct neonatal results presented N: 1 A: Sonoace 1500 Medison Inc (South Korea) O: Radiologists
Krüger 2010 [52]	Tanzania (LMI)	Rural hospital	O – R	~140 (total 293)	Pop: Newborns referred with birth asphyxia, congenital syndromes, spina bifida, macrocephaly, post meningitis, seizures, developmental/neuromuscular abnormalities, head trauma, 'miscellaneous' G: Not detailed A: Not detailed L: Not detailed B: Not detailed	T: Up until 3 months of age R: No distinct neonatal results presented N: ≥1 (not specified) M: Aloka Echo Camera SSD 500 (Japan) O: Internationally trained paediatrician who trained a local assistant medical officer (non-university trained).
Matthias 2014 [53]	Nigeria (LMI)	Private hospital	CR	1	Pop: Preterm newborn G: 28 A: IVF, IUGR L: Em-CS for maternal PIH	T: Not specified R: Normal scan N: 1 M: Not detailed

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
					B: 590g	O: Not detailed
Adeniji-Sofoluwe 2017 [54]	Nigeria (LMI)	University teaching hospital	O – R	213	Pop: Newborns referred from emergency department/clinic G: 'Most' were term. A: Not detailed L: Not detailed B: Not detailed	T: Before day 28 R: No distinct neonatal results presented N: 1 A: 'General Electric ultrasound machine' O: Radiology department
Ugowe 2021 [55]	Nigeria (LMI)	University teaching hospital	CR	1	Pop: Preterm newborn with aplasia cutis congenita G: 31 A: Received antenatal care, no risk factors L: Em-CS for maternal PET B: 1630g	T: Before day 7 R: Normal scan N: 1 M: Not detailed O: Not detailed
Defining parameters and baseline data in healthy newborns						
Ebruke 2008 [56]	Nigeria (LMI)	University teaching hospital	O – P	103	Pop: Healthy term newborns G: Term (mean 39) A: Not detailed L: 55.3% via VD, 44.7% via CS B: mean 3200g (M); mean 3050g (F)	T: Before day 3 R: Reference ranges for intracranial ventricles ventricular sizes at birth and at 6 weeks of age N: 1-2 M: Aloka SSD-1700 Scanner (Japan) O: Not detailed
Hagmann 2010 [57] *Hagmann 2011* [58]	Uganda (LI)	National referral hospital	O – P	115	Pop: Well term newborns G: mean 38.2 A: Not detailed L: 70 SVD, 16 Em-CS, 14 El-CS B: mean 3202g	T: Median day 1 (range 0-4) R: 54 had abnormalities [grey and white matter changes, SEP, choroid plexus cyst, LSV, 1 IVH, 1 infarct, I parenchymal haemorrhage] N: 1 M: Z.one ultra-Convertible Ultrasound System Zonare Medical Systems (USA) O: International neonatology doctors who also trained local neonatal doctors.
Yekpe Ahouansou 2015 [59]	Benin (LMI)	2 hospitals – 1 national university hospital, 1 not detailed	O – P	100	Pop: Preterm newborn admitted to NICU and healthy term newborns G: 50 preterm (26-36), 50 term (37-40) A: Not detailed L: Not detailed B: 15 <1500g, 49 1500-2500g, 36 ≥2500g	T: mean day 7 R: Cranial perimeter and cerebral ventricular size according to GA N: 1 M: Siemen Acuson X150 (not detailed) O: Not detailed
Miscellaneous						
Engsner 1974 [60]	Ethiopia (LI)	Etho-Swedish paediatric clinic	O – P	27	Pop: Newborns with marasmus G: Not detailed A: Not detailed L: Not detailed	T: Between 2 and 3 months of age R: Lateral ventricle index (no abnormality detected) N: ≥1 (not specified) M: Siemens apparatus Kraut-Kramer system (not detailed) O: Internationally trained paediatrician

Study	Country (WB economic status)	Setting *	Study Design	Study size N (N)†	Population description: Pop; Gestation in weeks (G); Antenatal care (A); Labour and delivery (L); Birth weight (B)	CUS details: Timing of scan (T); Results (R); Number of Scans (N); Machine details (M); Operator details (O)
					B: Not detailed (infants with known B ≤2500g excluded but most did not have birth records)	
Clay 2017 [61] *Clay 2014* [62]	Rwanda (LI) and Kenya (LMI)	University teaching hospital and national referral hospital	O – P	41	Pop: Newborns admitted to the NICU with prematurity and/or perinatal asphyxia and healthy term newborns on the postnatal ward G: 7 NICU newborns were premature (mean 32.8), 17 NICU newborns had perinatal asphyxia and 14 healthy newborns (mean 39.8) A: Not detailed L: Not detailed B: Prematurity group (mean 1736g), perinatal asphyxia group (mean 3045g), healthy group (mean 3023g)	T: Before 48 hours of age R: Quantitative measurements (VBR, AHW) and abnormalities (GMH, IVH, parenchymal echodensities, oedema, cysts) N: 1 M: EMP-N Emperor Medical (China) O: Internationally trained researchers

WB: World Bank with economic status: LI – low income, LMI – low middle income, UMI – upper middle income

∗ single centre unless stated otherwise

† denotes the number of newborns who received a cranial USS. Where N not distinctly presented, total study N presented.

O - P: Prospective observational study

O - R: Retrospective observational study

I: Interventional study

CR: Case report

CS: Case series

AHW: anterior horn width

BGT: Basal ganglia-thalami tract

El-CS: elective caesarean section, Em-CS: emergency caesarean section

GMH: germinal matrix haemorrhage

HIE: hypoxic ischaemic encephalopathy

HIV: human immunodeficiency virus

IUGR: intrauterine growth restriction

IVF: in vitro fertilisation pregnancy

IVH: intraventricular haemorrhage

LSP: Lenticulostriate vasculopathy

NICU: Neonatal intensive care unit

PET: pre-eclampsia

PIH: pregnancy induced hypertension

PVL: periventricular leukomalacia

RI: resistive index

SEP: subependymal cyst

SVD: spontaneous vaginal delivery

VBR: ventricular brain ratio

WM: white matter

Supplemental Table S2. Characteristics of IVH studies not included in meta-analysis.

Study	Setting		Study Size	Population			IVH Prevalence estimate(s)			Study Design	Reason for exclusion from meta-analysis
	Country (WB economic status)	Facility	N(x)	Gestation (weeks)	Birthweight (g)	Male sex (%)	Any	Grade I/II	Grade III/IV		
Muhe, 2019 [63]	Ethiopia (LI)	Multicentre	ND (3852)	2.7% <28 24.2% 28-31 42.5% 32-34 30.6%35-36	2.9% 1000-1499 39.2% 1500-1999 56.2%	52.7	1.5% (57/3852)	ND	ND	O - P	No available denominator of at risk newborns that underwent CUS
Fajolu, 2023 [64]	Nigeria (LMI)	Multicentre (Tertiary)	ND (1161)	Mean: 29 (SD 3 weeks)	Mean: 1142 (SD 254)	46.3	3.1% (36/1161)	ND	ND	O - R	No available denominator of at risk newborns that underwent CUS
Kuti, 2015 [65]	Nigeria (LMI)	Teaching hospital	52 (55)	Mean: 37.5 (SD 3.8) Range: 26-44	Mean: 3000 (SD 600) Range: 1400-4000	77.4	7.7% (4/52)	7.7% (4/52)	0% (0/52)	O - P	Included term neonates, no disaggregated data for preterms available
WHO ACTION-I trial, 2020 [66]	Nigeria (LMI), Kenya (LMI)	Level 2 and Tertiary hospitals Multicentre	ND	ND	ND	ND	ND	ND	ND	I	International study, no sSA specific data available
Clay, 2016 [61]	Rwanda (LI), Kenya (LMI)	Teaching and referral hospitals Multicentre	38	Mean healthy term group: 39.8 (SD 0.73) Mean perinatal asphyxia group: 39.8 (SD 1.5) Mean preterm group: 32.8 (SD 2.1)	Mean healthy term group: 3023 (SD 368) Mean perinatal asphyxia group: 3045 (SD 468) Mean preterm group: 1736 (SD 424)	55.3	Healthy term group: 22% Perinatal asphyxia group: 30% Preterm group: 72%	ND	ND	O - P	Results presented as bar chart percentage in proportion to study population
Diagne, 2021 [67]	Senegal (LMI)	National	22	Mean: 35 Range: 28-43	Mean: 1920 Range: 910-3700	39.1	82.6% (19/23)	ND	ND	O - R	Included term neonates, no disaggregated data for preterms available
Davies, 1995[a] [68] Davies, 1995[b] [69]	South Africa (UMI)	Multicentre (academic or private)	ND (155)	Mean between 29.2-31.4 across hospitals	Mean between 1270-1751 across hospitals	ND	35.5% (55/155)	18.1% (28/155)	17.4% (27/155)	O - R	No available denominator of at risk newborns that underwent CUS
Ballot, 2015 [70]	South Africa (UMI)	Academic hospital (Tertiary)	297 (562)	Mean: 29.3 (SD 2.8)	Mean: 1120 (SD 248) Range: 500-1500	45.2	ND	ND	7.4% (22/297)	O - R	Incomplete IVH data (only severe available)
Gibbs, 2017 [71]	South Africa (UMI)	Tertiary	892 (1032)	Not detailed	Upper limit: 1500	ND	ND	ND	4.9% (44/892)	O - R	Incomplete IVH data (only severe available)

Study	Setting		Study Size	Population			IVH Prevalence estimate(s)			Study Design	Reason for exclusion from meta-analysis
	Country (WB economic status)	Facility	N(x)	Gestation (weeks)	Birthweight (g)	Male sex (%)	Any	Grade I/II	Grade III/IV		
Tiam, 2017 [72]	South Africa (UMI)	Academic hospital (Tertiary)	63 (302)	20.9% <28 64.9% 28-32 14.2% >32	29.1% <1000 70.9% 1000-1499	45.4	73% (46/63)	41.3% (26/63)	31.7% (20/63)	O - R	No CUS data for >⅔ of study population
Ntuli, 2020 [73]	South Africa (UMI)	Referral	ND (252)	1% 24-25 9% 26-27 48% 28-31 42% 32-36	6% 600-799 14% 800-999 81% 1000-1499	40.5	1.6% (4/252)	ND	ND	O - R	Total n who underwent CRUSS not detailed
Ramdin, 2021 [74]	South Africa (UMI)	Academic hospital (Tertiary)	981	Mean: 29.6 (SD 2.4)	Mean: 1185 (SD 205.6)	42.7	25.5% (250/981)	ND	ND	O - R	No available denominator of at risk newborns that underwent CUS
Rothberg, 2021[75]	South Africa (UMI)	Level 2 hospital	1	32	1940	0	100% (1/1)	0% (0/1)	100% (1/1)	CR	Case report
Dormohamed, 2022 [76]	South Africa (UMI)	Tertiary hospital	124 (186)	Mean: 26.2 (SD 1.29)	Mean: 773 (SD 125)	46.8	ND	ND	8.1% (10/124)	O - R	Incomplete IVH data (only severe available)
Hagmann 2010, 2015 [57,77]	Uganda (LI)	Teaching hospital	112	Mean: 38.2 (SD 1.58)	Mean: 3202 (SD 516)	53.6	0.89% (1/112)	ND	ND	O - P	Included term neonates, no disaggregated data for preterms available

WB: World Bank with economic status: LI – low income, LMI – low middle income, UMI – upper middle income

ND: not detailed

SD: standard deviation

Facility: Based on description within paper

Study size: n who underwent cranial ultrasound, (x) if n different to total study population *x*. Where *x* is different to n, population characteristics describe *x*.

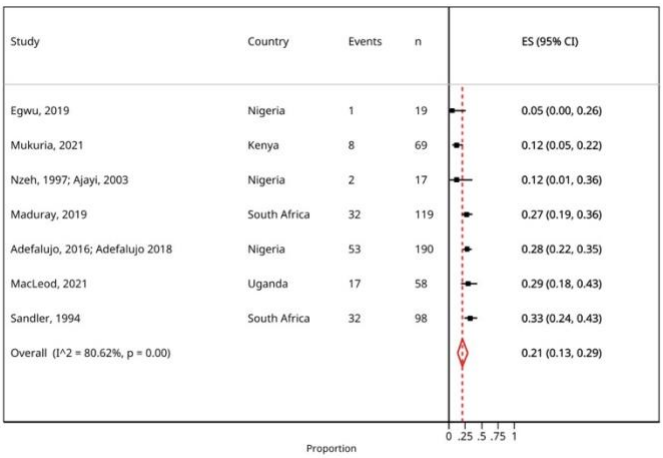
Gest.: Mean and range of gestation where detailed. Other parameters detailed as available.

BW: Mean and range of birth weight where detailed. Other parameters detailed as available.

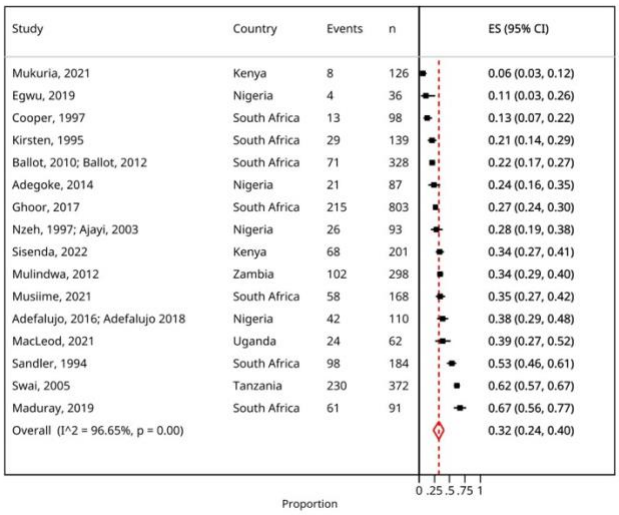
Study Design: O= observation, P = prospective, R = retrospective, I = interventional, CR = case report

Supplementary Fig. S1 Forrest plots subgroup analysis and meta-regression

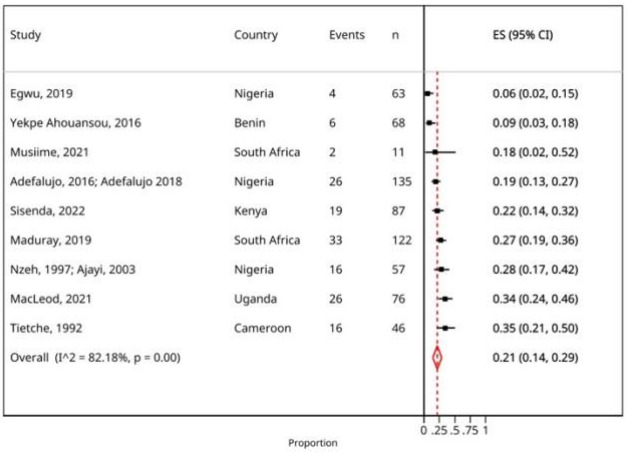
Birthweight ≥1500g



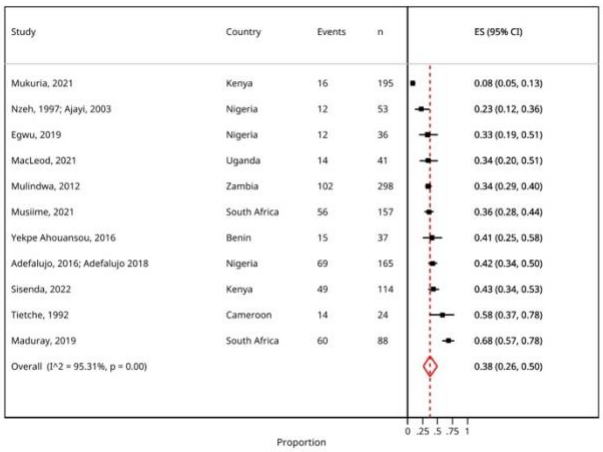
Birthweight <1500g



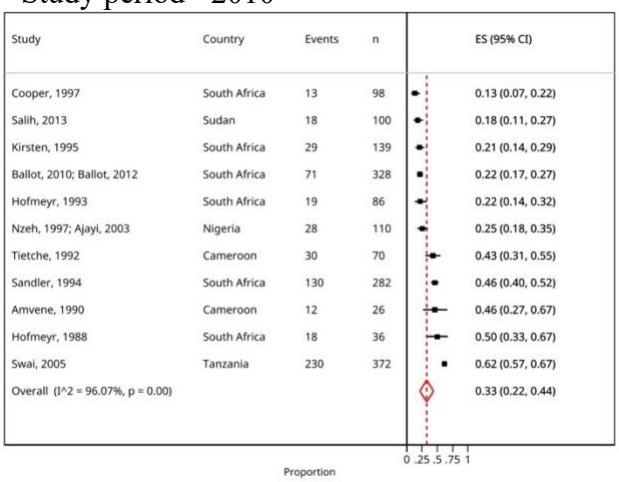
Gestation ≥32 weeks



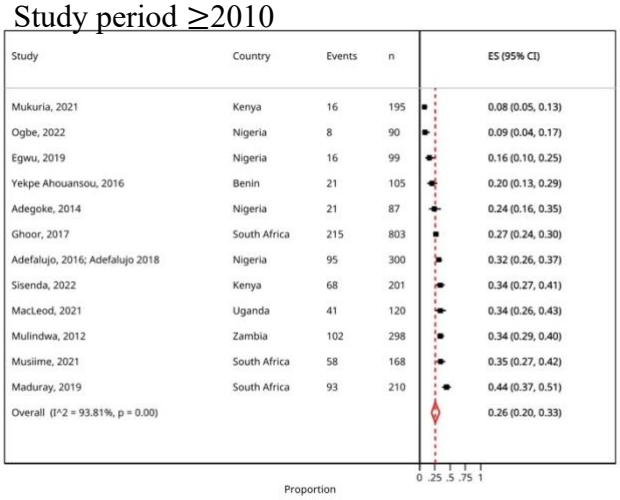
Gestation <32 weeks



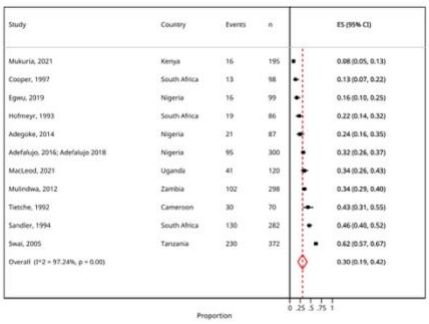
Study period <2010



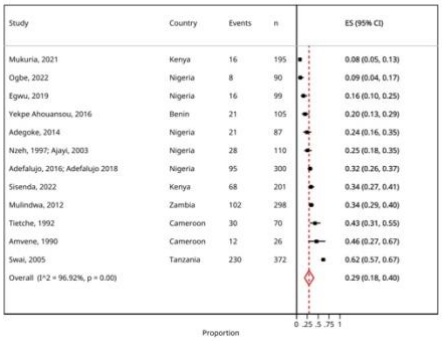
Study period ≥2010



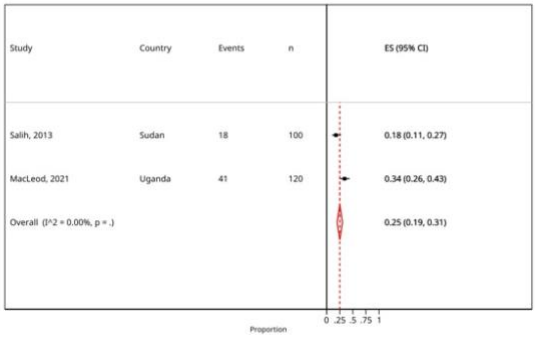
High middle income country



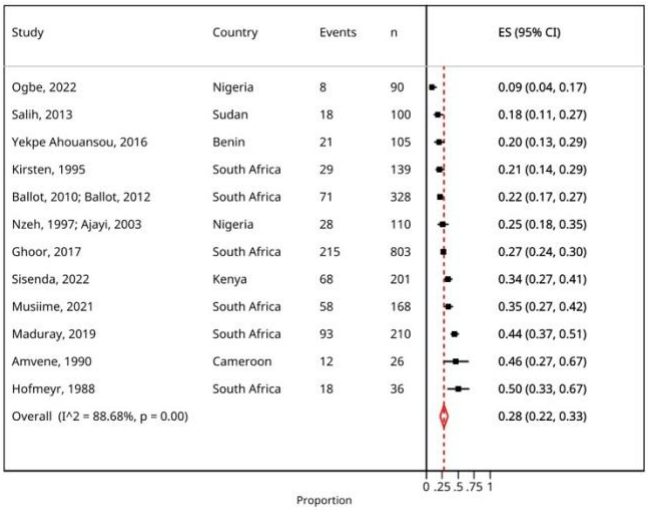
Low middle income country



Low income country



Intermediate quality score



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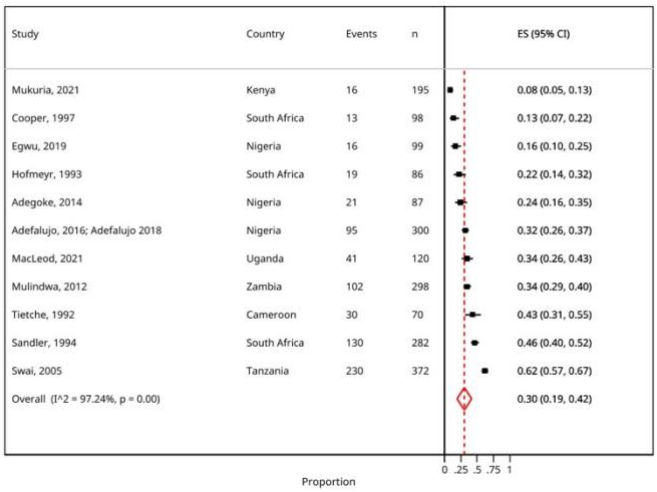
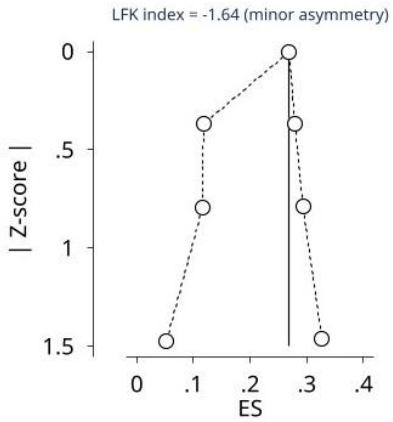
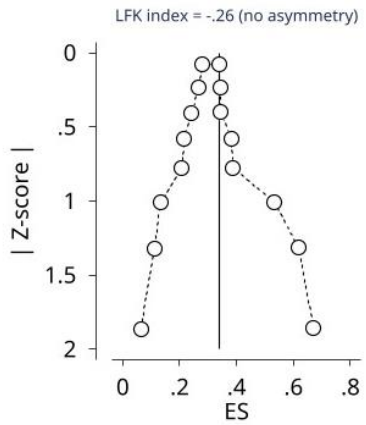


Supplementary Fig. S2 DOI plots and Luis Furukya-Kanamori (LFK) indeces for subgroup analysis and meta-regression

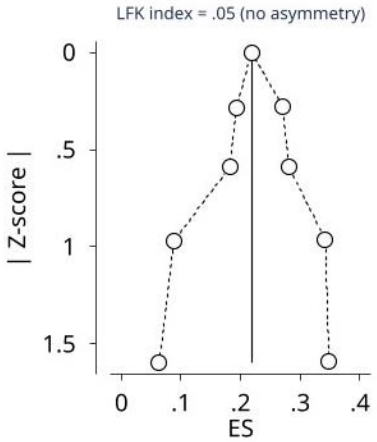
Birthweight ≥1500g



Birthweight <1500g



Gestation ≥32 weeks



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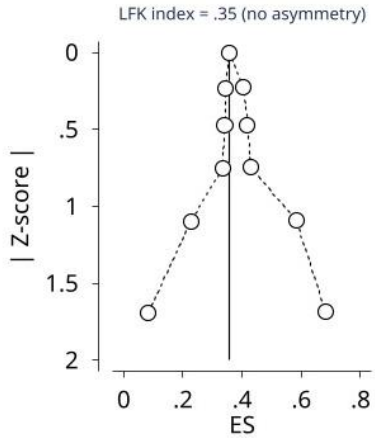
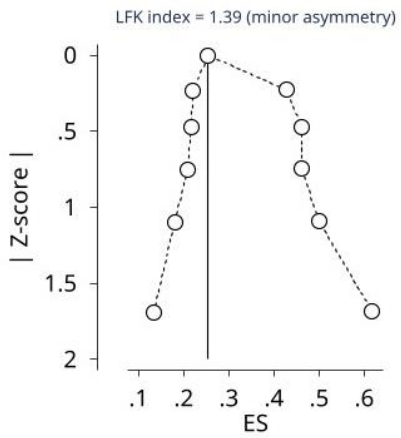
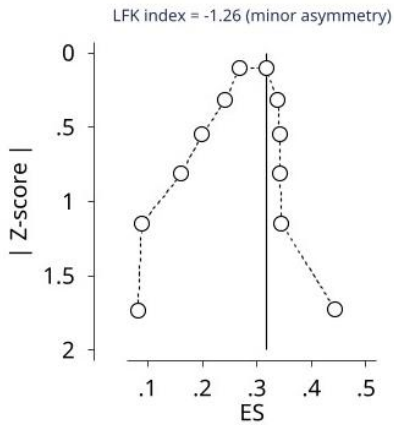


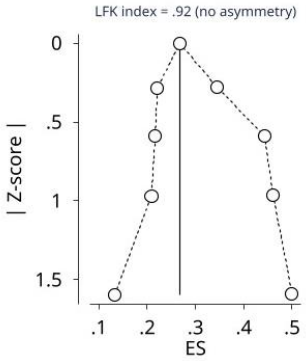
Study period <2010



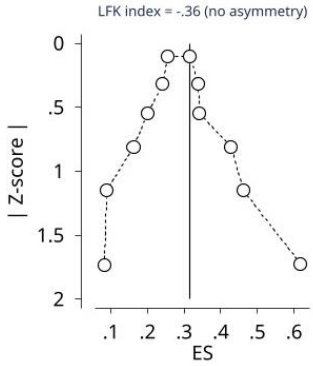
Study period ≥2010



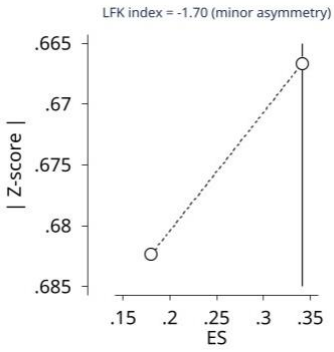
High middle income country



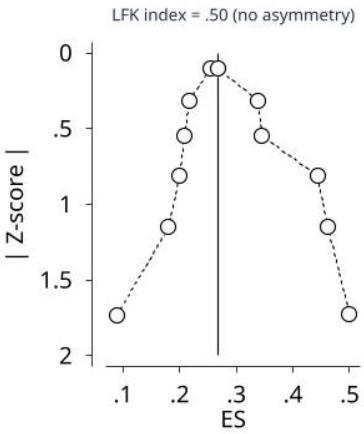
Low middle income country



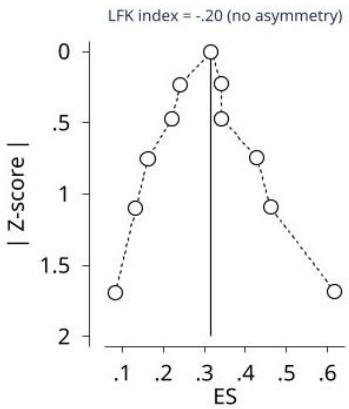
Low income country



Intermediate quality score



High quality score



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