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A pilot implementation study to detect neonatal critical congenital heart disease using pulse oximetry screening in Accra, Ghana

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ABSTRACT

Background Congenital heart disease (CHD) is the leading congenital cause of death in newborns worldwide. Approximately one-quarter of CHDs are considered critical, requiring intervention during the first year of life to enable survival. While pulse oximetry screening (POS) for critical CHD (CCHD) is now standard in high-income countries, its use in low-resource settings remains limited.

Methods This prospective cohort study aimed to: (1) assess the feasibility of implementing routine POS and (2) estimate the incidence of CCHDs in two large tertiary hospitals in Accra, Ghana with high delivery volumes. Eligible participants included all live-born infants less than 48 hours old who were not receiving supplemental oxygen at the time of enrolment. Newborns underwent POS, and those with positive POS screening were referred for echocardiography.

Results Over the 1-year study period (February 2024 to January 2025), a total of 7889 deliveries were recorded at Korle-Bu Teaching Hospital and 37 Military Hospital. Among eligible infants, 96% (5725/5981) underwent POS screening. 29 newborns failed screening. CHD was confirmed in 19 cases (0.33% of all screened). Nine infants had CCHD (0.16%). Ten were diagnosed with non-CCHD (0.17%).

Conclusions POS was successfully implemented in two large tertiary hospitals in Accra, Ghana and identified newborns with CHD. Early detection of cases that would have otherwise gone undiagnosed underscores the importance of systematic screening for timely recognition. These findings support the integration of pulse oximetry into routine newborn care in resource-limited settings.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The true prevalence of congenital heart disease (CHD) in low-income countries (LICs) remains challenging to ascertain due to converging structurally obstinate resource constraints. Pulse oximetry is a proven screening tool that in functionally sophisticated clinical settings provides reliable opportunity for early detection of critical CHD. There is very limited research reporting its uptake and use in Africa.

WHAT THIS STUDY ADDS

⇒ This is the first prospective study to report the incidence of neonatal CHD in two high volume delivery hospitals in Ghana and to demonstrate the feasibility of implementing a pulse oximetry screening protocol to identify at-risk neonates.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study demonstrates that pulse oximetry can effectively be implemented as a screening tool for CHD in LICs, and as such, argues for further investment in systems-level resources to support clinicians in LICs in their efforts to improve holistic care for a highly vulnerable population at high risk for early demise and/or disability.

INTRODUCTION

Congenital heart disease (CHD) is defined as a structural anomaly of the heart and/or major vessels that exists at birth. It is the most common congenital disorder worldwide and accounts for approximately one-third of all birth defects.[1] The reported birth prevalence of CHD varies globally; accurate estimates depend on local and regional capacity to reliably identify and record cases.[2] For example, a 15-year review of over 322 000 documented births in the city of Jinan, China, reported a prevalence of CHD to be 3.92 per 1000 live births, whereas a multi-institutional review from Khartoum State, Sudan, reported a prevalence of 14.3 per 1000 live births.[3 4] In low-income and middle-income countries (LMICs) where CHD causes the highest degree of mortality and morbidity due to insufficient supportive clinical resources, a paucity of data exists.[5] Critical CHD (CCHD), defined as CHD requiring surgery or a catheter-based intervention within the first year and oftentimes within the first few days to weeks of life to prevent death or severe

disability, presents in an estimated quarter of all CHD.[6] Neonates born with CCHD can appear healthy in the first few hours to days of life, allowing for the possibility of being discharged undetected and presenting later for emergency care.[7]

In the USA, because of the ready availability of technologically sophisticated surgical and medical care to mitigate early mortality and/or severe morbidity, the American Academy of Pediatrics (AAP) and the American Heart Association recommended universal screening for CCHD for neonates through pulse oximetry screening (POS) in 2011.[8] In 2025, the AAP published a new algorithm and additional screening recommendations.[9] POS is an established method routinely employed to measure the arterial oxygen saturation of haemoglobin in the blood.[7 9 10] However, conducting pulse oximetry on neonates less than 6 hours old to evaluate for possible underlying CCHD yields a high false positive rate due to haemodynamic transition from fetal to neonatal circulation that occurs during the initial hours after birth. POS performed after 24 hours of birth exhibits much higher specificity and moderate sensitivity and a significantly lower false positive rate for detecting CCHD.[11] A nuanced understanding of false positivity is necessary when determining the diagnostic value of POS in clinical settings, especially where it is likely to be administered within 24 hours of birth due to the routine practice of early discharge.[10] Several studies have demonstrated that POS false positives frequently detect treatable, non-cardiac causes of hypoxaemia such as persistent pulmonary hypertension of the newborn (PPHN), sepsis, pneumonia and other primary lung pathologies, which strengthens the argument for its uptake even in settings that lack the capacity to provide advanced cardiac medical and/or surgical care.[12–15] Neonatal POS within the first few days of life is not, by itself, typically able to identify common causes of non-CCHD (eg, isolated small ventricular and/or atrial septal defects).

While CCHD screening with POS is now standard of care practice in HIC such as the USA and many European countries, its uptake and implementation in LMICs remains very low.[16] The reasons for this are many and substantial, including lack of health system infrastructure, equipment availability, operational support, trained personnel, all compounded by the frequent inability to access timely life-saving surgery or critical care.[17] Nevertheless, interest in piloting POS is increasing in diverse under-resourced settings, as evidenced by recent published reports from tertiary-level institutions in Tanzania, Morocco, Saudi Arabia and South Africa.[7 10 18 19]

The primary aim of this study was to add to the epidemiological database with respect to the incidence of CCHD in Africa using POS shortly after the time of birth. To our knowledge, this is the first report to prospectively capture the birth prevalence of CCHD in the country of Ghana. A secondary aim of this study was to test and evaluate the feasibility of implementing a longitudinal POS programme in operationally distinct, high volume delivery units in Accra, Ghana (separate manuscript forthcoming).

Ghana's healthcare system has both public and private delivery sectors regulated by the Ministry of Health. Healthcare levels in Ghana include National (tertiary and quaternary hospitals), Regional and District levels. Most specialists are concentrated at the National level, including paediatric cardiology. The National Health Insurance Scheme is a national initiative to subsidise personal healthcare costs; however, it provides limited coverage and does not cover cardiac care.

Ghana has made significant progress in reducing neonatal and infant mortality. The infant mortality rate is 28 deaths per 1000 live births, and the neonatal mortality rate is 17 deaths per 1000 live births.[20] Access to CHD treatment in Ghana remains severely limited due to a critical shortage of paediatric cardiac surgery, limited diagnostic and treatment options and high costs of care. Consequently, some families with means are compelled to seek expensive treatment abroad, while the majority of children lack access to timely or any surgical intervention, resulting in elevated mortality rates.

METHODS

Study setting

This study was conducted at two tertiary care hospitals in Accra, Ghana, from 1 February 2024 to 1 February 2025. Korle Bu Teaching Hospital (KBTH), located in the Ablekuma-South Metropolitan District of Accra, is the third-largest hospital in Africa, with approximately 10 000 deliveries annually. The 37 Military Hospital (37MH) serves as the West Sub-Regional United Nations Level IV referral hospital and Ghana's primary emergency and disaster hospital. It provides medical services to both military personnel and the public, with approximately 4000 annual deliveries.

Study design and data collection

This prospective study aimed to screen all neonates born at the study sites for CHD using pulse oximetry and newborn clinical examination. Inclusion criteria encompassed all newborns delivered in the study hospitals, including preterm neonates greater than 28 weeks and those admitted to the neonatal intensive care unit (NICU), provided they were not receiving supplemental oxygen at the time of screening. Neonates on supplemental oxygen or assisted ventilation were excluded.

POS was performed using a modified AAP standardised algorithm.[8] Due to the local practice of early maternal discharge, often occurring before 24 hours post partum, the algorithm was adjusted to accommodate screening neonates younger than 24 hours of age. Oxygen saturation measurements were obtained using the MASIMO RAD-97 pulse oximeter, with readings taken from the right hand (preductal) and either foot (postductal) of calm, warm infants. Caregivers were recruited to swaddle or soothe crying or fussy infants as needed prior to

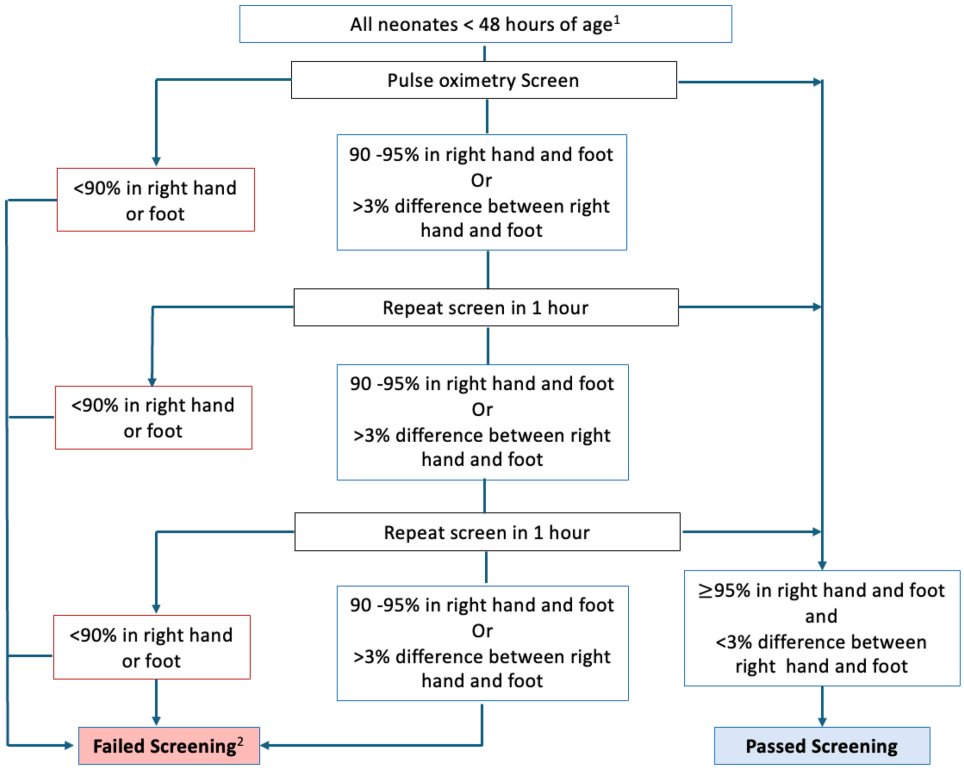


Figure 1 Neonatal Critical Congenital Heart Screening Algorithm. The algorithm for critical congenital heart disease screening protocol was adapted from AAP guidelines. The study included all neonates <48 hours old who did not require supplemental oxygen at the time of enrolment.[2] Those who failed screening were followed by the paediatric cardiology team, received a detailed newborn physical exam and echocardiography by paediatric cardiologist or appropriately trained paediatric cardiology resident. AAP, American Academy of Pediatrics.

measurement. Reusable sensors attached to Velcro foam wraps and snugly secured around the appropriate limb. Device readings were allowed to stabilise for a minute before being recorded. A screen was considered negative or passed if the oxygen saturation was at least 95% in both the right hand and foot, with a preductal and postductal difference of <3%. A positive or failed screen was defined by an oxygen saturation of less than 90% in either extremity, a preductal and postductal saturation difference of ≥3%, or oxygen saturations between 90% and 94% persisting for three consecutive measurements taken at 1-hour intervals. In addition to pulse oximetry, neonates at 37 MH received a newborn physical exam by a paediatrician. The screening algorithm is presented in figure 1.

In cases of a failed screening, the neonatal staff and paediatric cardiologist were notified and performed a detailed newborn physical exam. A diagnostic echocardiogram was scheduled and, as able, performed within 48 hours of the failed screening. Infants who screened positive were clinically monitored and stabilised as able while awaiting echocardiography. A delay of up to 48 hours was typically due to resource (human and material), logistical and transportation challenges. Delays beyond 48 hours were rare. Infants with confirmed CCHD were referred to the National Cardiothoracic Centre for further evaluation and management, including medical treatment and surgical planning as indicated. Echocardiograms were obtained and read by a paediatric cardiologist (first author Yao) using a Phillips CX50 machine. Following the echocardiogram, a 6-week follow-up visit was arranged, but follow-up was frequently limited. For patients who did follow up, ongoing evaluation and treatment was determined on a case-by-case basis at the discretion of the paediatric cardiologist and the neonate's family.

POS was conducted by a trained research assistant who also obtained both oral and written parental consent and completed the standardised data collection form. This form included details on birth history, demographic characteristics and maternal risk factors associated with CHD (eg, maternal diabetes). The paediatricians performing newborn examinations documented their findings on the same form. Echocardiogram results were recorded and subsequently entered into REDCap by a trained data entry team. Consent forms and the complete study questionnaire are provided in the online supplemental materials.

Data analysis

Collected data were analysed using STATA V.18. Sociodemographic and clinical characteristics were summarised using descriptive statistics. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means or medians, as appropriate.

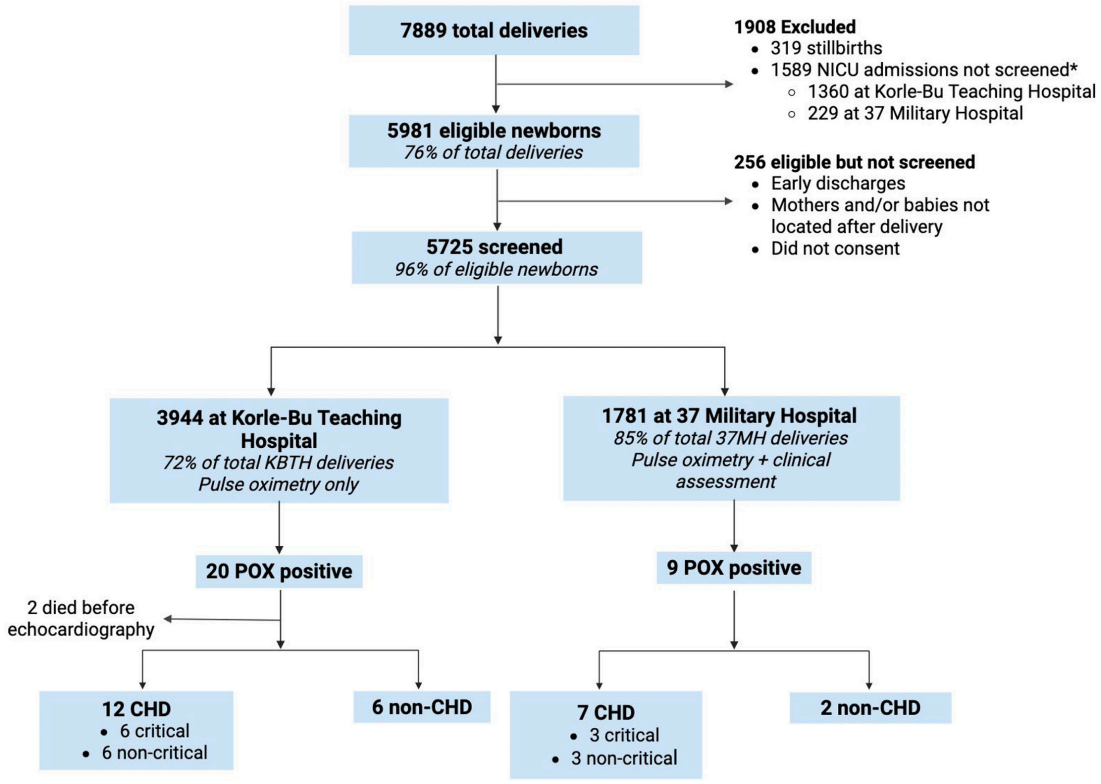


Figure 2 Screening profile. *Most neonates admitted to the NICU were on supplemental oxygen, excluding them from the study. Newborns in the NICU who were not on oxygen supplementation within the screening window were enrolled. CHD, congenital heart disease; NICU, neonatal intensive care unit.

RESULTS

For consecutive 12 months, 7889 births were documented at the KBTH and the 37MH. Roughly a quarter of deliveries (1908), consisting of stillbirths and newborns placed on supplemental oxygen support in the NICU, were excluded from enrolment (figure 2). Of the eligible newborns, 96% were screened by POS alone at KBTH or POS and clinical assessment at 37MH (figure 2).

Screening occurred within 24 hours of life in 74% of the entire cohort. The average hour of life at the time of screening for this majority was 15 hours as compared with 31 hours of life for the >24-hour subgroup (table 1).

Baseline neonatal and maternal characteristics are summarised in table 2. Newborns with diagnosed CHDs had lower newborn dimensions and higher parental ages on average (maternal age; p=0.015) than those who passed screening. Premature newborns less than 34 weeks comprised approximately 2.3% of all screenings (data available from authors). Differences in maternal medical

Table 1 Comparison of ages at which babies were screened

Variable	<24 hours	≥24 hours
n (per cent)	4236 (74)	1489 (26)
Korle-Bu Teaching Hospital	3026 (76.7)	918 (23.3)
37 Military Hospital	1210 (67.93)	571 (32.1)
Average age in hours, median (IQR)	16 (9)	29 (11)
Preductal oxygen saturation, median (IQR)	98 (2)	98 (2)
Postductal oxygen saturation, median (IQR)	99 (2)	98 (2)

Table 2 Baseline neonatal characteristics

Variable (n)	non-CHD Median (IQR)	All CHD, N=19 Median (IQR)
Sex (percent ratio M:F)	53:47	32:68
General		
Gestational age in weeks (n=5678)	38 (3)	38 (2.5)
Age in hours at screening (n=5608)	19 (11)	21 (11.5)
Newborn measurements		
Birth weight in kg (n=5680)	3.10 (0.69)	2.77 (0.74)
Length in cm (n=5640)	50 (3)	48 (3.75)
Head circumference in cm (n=5634)	34 (2)	33 (2.5)
Apgar scores		
First (n=5684)	7 (1)	7 (1)
Second (n=5678)	9 (1)	8 (2)

CHD, congenital heart disease.

Table 3 Characterisation of failed cases

Patient	Site	Diagnosis	Age screened (hours)	Saturations (R-arm/leg)	6-week mortality
		Critical			
1	37MH	Mitral atresia, fenestrated atrial septum, VSD	25	78/80	Died
2	37MH	Dextrocardia, large VSD, large secundum ASD, malposed great vessels, moderate sized PDA	38	81/80	Alive
3	KBTH	TGA	13	51/46	Died
4	KBTH	Supramitral membrane, common atrium, hypoplastic left ventricle	16	90/87	Alive
5	KBTH	Tricuspid atresia, large atrial communication, large PDA	22	47/41	Died
6	37MH	TOF with severe pulmonary stenosis, PDA	41	88/90	Alive
7	37MH	TGA, VSD, moderate pulmonary stenosis, small PDA, ASD	20	81/80	Died
8	KBTH	Hypoplastic left heart syndrome	44	88/91	Died
9	KBTH	TOF and CAVSD	13	92/91	Alive
		Non-critical			
10	37MH	Complete atrioventricular septal defect	4	89/92	Alive
11	37MH	Patent ductus arteriosus	15	96/91	Alive
12	KBTH	Moderate sized PDA	28	90/90	Alive
13	KBTH	CAVSD, PDA	26	90/90	Alive
14	KBTH	Dextrocardia, common atrium, common AV junction	39	81/--	Died
15	KBTH	Large ostium secundum ASD, moderate-large PDA, severe Tricuspid regurgitation	21	70/64	Died
16	37MH	Small ASD, PDA	16	71/92	Alive
17	KBTH	Large inlet VSD	17	89/88	Alive
18	KBTH	CAVSD, large primum ASD	25	88/87	Died
19	KBTH	Large PDA	14	91/87	Alive

ASD, atrial septal defect; CAVSD, complete atrioventricular septal defect; KBTH, Korle-Bu Teaching Hospital; 37MH, 37 Military Hospital; PDA, patent ductus arteriosus; TGA, transposition of the great arteries; TOF, tetralogy of Fallot; VSD, ventricular septal defect.

history, maternal infection screen results and drug use during pregnancy across the CHD and non-CHD groups were notable for an association with maternal thyroid disease and the use of herbal medicines (online supplemental table two).

A total of 29 neonates failed POS screening and underwent echocardiography; two died before imaging was able to be obtained and were excluded from further analysis. Echocardiographic evaluation confirmed CHD in 19/27 cases (0.33% of total number screened). POS positive cases of CHD and 6-week mortality are described in table 3. Nine cases of CCHD (0.16% of total number screened) and 10 non-CCHD (0.17% of total number screened) were identified. The remaining eight cases were false positives. A more detailed profile of all failed cases, including false positives, cardiovascular examination findings, dysmorphic features and survival status at the end of the study, is provided in online supplemental table one.

DISCUSSION

High-quality epidemiological data on the prevalence of CHD and CCHD in Africa remains extremely limited. A recent meta-analysis of 260 studies published between 1970 and 2017 reported an increase in the global birth prevalence of CHD to a maximum of 9.4/1000 live births during the epoch of 2010–2017 and noted regional heterogeneity with Asia reporting the highest and Africa reporting the lowest rates.[1] The authors of that review cautioned that the lower African prevalence was at least in part a function of lower detection rates and only four regional studies of the 260 analysed met inclusion criteria.[1] Similarly, the 2017 Global Burden of Diseases Study attributing greater than 260 000 worldwide deaths to CHD with the highest mortality in low sociodemographic index countries emphasised a massive data gap for the continent of Africa.[21] An accompanying expert commentary in the Lancet Child and Adolescent issue noted, “Although the challenges of collecting these data from many parts of the world are vast and not easily overcome, improved data on vital statistics should improve the accuracy of the models and the understanding of the true burden of congenital heart disease.”[22]

To our knowledge, this report is the first of its kind to prospectively capture the birth prevalence of CCHD

in Ghana, although imperfectly. The systems-level challenges to operationalise this type of pilot implementation were substantial and will be reported in a separate manuscript. Nevertheless, 5725 neonates were screened in one full year at two high volume delivery institutions in the capital, Accra, and 19 of those screened were found to have some form of CHD. This approximates 3 in 1000 live births and is almost certainly an underestimate as POS is not an effective screening tool for the most common non-CCHDs. Nine of 19 identified cases were found to have CCHD, approximating 1.5 in 1000 live births. We note that two of the POS positive neonates died before a confirmatory CHD/CCHD diagnosis could be made with echocardiography and therefore were excluded from our analysis. However, the index of suspicion that both neonates had severe CCHD was very high. Our CCHD prevalence data are slightly lower than what is commonly reported in the literature. A reasonable explanation for this difference resides in the high number of neonates (>20%) excluded from our study due to the perceived clinical need for early supplemental oxygen in the NICU; it is plausible that some of these neonates' early oxygen requirement resulted from an underlying congenital cardiac rather than pulmonary condition.

We are aware of only one prior study in Ghana describing a single institutional experience of CHD in a paediatric outpatient setting.[23] In their retrospective chart review over a 10-month period in 2018, the investigators detected 79 cases out of approximately 10 000 clinic visits. 77.2% of the diagnoses were made in children below 5 years with a median age of 1.9 years, and the earliest diagnosis was reported at around 3 months. Ventricular septal defect (31%) was the most common acyanotic lesion found and Tetralogy of Fallot (25%) was the most common complex CHD. A 2020 prospective report from Morocco provides a more relevant comparison to the current study.[18] Investigators there aimed to test the feasibility of implementing a CCHD screening programme at a single high-volume delivery centre in Marrakesh as well as improve early detection. Over a 10-month period, 8013 neonates out of 10 451 live births (76.7%) were screened, 15 (1.8/1000) tested positive, and of those, 10 were found to have CHD, with 5 identified as CCHD and 5 false positives.[18] Similar to the Ghanaian context, the authors noted the impracticality of conducting screening for a majority of neonates after 24 hours due to standard early discharge practices for normal deliveries.[18] Preliminary results published in 2022 from a large, prospective POS study in Dar es Salaam, Tanzania reported that of the 1592 neonates screened, 1032 (65%) were born via caesarean section due to the routine practice in non-operative, uncomplicated deliveries of discharging mothers and babies within 12 hours, despite hospital protocols calling for a minimum of 24 hours observation after delivery.[10] Of the 1592 neonates screened, 14 were positive, with 4 found to have CCHD (yielding a 2.5/1000 live birth detection rate), 1 died before an echocardiogram could be obtained, and 7 were found to have PPHN, 1 with sepsis and 1 with normal findings.[10]

The main limitation of this study was our inability to screen a substantial portion of live births, thereby affecting the precision of our reported prevalence. As previously mentioned, excluding neonates placed on supplemental oxygen prior to having an opportunity to conduct POS likely reduced our ability to capture the actual number of babies born in these two institutions with CCHD. Additionally, 256 eligible neonates were unable to be screened due to early discharge, lack of consent or an inability to locate the patient. We note observationally that locating mothers and babies presented a frequent logistical challenge, particularly at KBTH, stemming from a lack of access to a unified, regularly updated registry of patients/births. Some parents/babies were never found even with researchers going from bed to bed on every floor to check for new deliveries. This phenomenon is not unique to the Ghanaian context and is routinely experienced in other under-resourced clinical settings.[10 18 19] A further limitation of our study was the inability to assess the false negative rate, as no procedural mechanism existed to follow up discharged neonates who passed POS, and no formal database currently exists to continue to track their health status as infants and children.

Our false positive rate was ~0.14% which is on the lower end of some reported estimates. Increases in the false-positive rate have been documented in studies when pulse oximetry was performed before 24 hours, and the sensitivity of delaying POS beyond that time is apparent in settings where hospital discharges reliably occur after one full day. However, for many neonates born globally, particularly in LMICs with under-resourced health systems, delaying POS beyond 24 hours is an unrealistic goal at least in the short to medium term. Furthermore, as noted in the introduction, the potential diagnostic value of POS is not narrowly limited to the detection of CCHD, as treatable common non-cardiac neonatal pathologies such as sepsis and PPHN can be picked up with routinised screening.[11–14] In this study, two of the false positives revealed a case of myocarditis and a case of PPHN (see online supplemental table one for complete characterisation of the eight false positives). Future studies are needed to more accurately estimate the risk of false positive screens in such contexts when POS is intentionally and necessarily undertaken within the first 24 hours of life, and to further elucidate the utility POS offers to detect earlier non-cardiac causes of hypoxaemia. We note that in our study, 6 of the 8 false positive neonates and 11 of the 19 neonates identified with CHD were screened less than or at 24 hours of life.

This limitation was compounded by the inability to conduct routine newborn physical examinations by paediatricians at Korle-Bu due to the extremely high birth volume overwhelming available personnel. A meta-analysis including over 800 000 screened newborns showed that combining physical examination with pulse oximetry increased detection sensitivity for CCHDs

to approximately 93%, substantially improving early recognition compared with physical exam (69%) and pulse oximetry (78%) independently.[24] This highlights that while pulse oximetry is a valuable tool, expanding the capacity for newborn physical examination in high-volume, resource-limited hospitals remains an essential step towards improving early CHD detection. It is also important to acknowledge that concerns have been raised that pulse oximetry may overestimate arterial oxygen saturation in darker pigmented patients, which raises the theoretical possibility of underdetection of CCHD when deployed as the sole diagnostic tool to screen newborns in settings where melanin levels might potentially be anticipated to affect light absorption.[9 25]

Although not an aim of our study, we think it is important to emphasise the persistently high mortality seen in neonates and infants born with CHD/CCHD in countries such as Ghana. Eight of the 19 babies identified with CHD (5 with CCHD and 3 with CHD) were dead at the time of study conclusion. It is likely that some of the remaining survivors will also have died in the intervening time. These deaths serve as a direct reminder of the stubborn and massive healthcare equity gap that persists between economically advantaged (and therefore advanced) healthcare systems and those operating with far less resources across the board. Neonates born in places like Boston with CCHD, barring exceptional circumstances, are guaranteed to obtain life-saving services at the cost of sometimes hundreds of thousands of USD per patient. Neonates born in Accra with CCHD, barring exceptional circumstances such as having families with financial means to obtain care abroad, are destined for death.

One (too frequently voiced) pessimistic reaction to this grim reality is to question the utility (or cost-effectiveness) of investing in POS in LMICs when very little can be offered by way of therapeutic intervention. As a principled matter, those of us in the global health community must firmly reject that perhaps seductive line of thinking. While it is true that for many LMICs, access to paediatric cardiac surgery is quite limited and system-level barriers (unavailability of equipment, infrastructure, transport and critical care services, trained medical personnel) are commonplace, these conditions define what is present—not—what is possible with deliberate advocacy and sustained local stakeholder engagement.

Healthcare providers and parents in Accra want neonates born with treatable CHD/CCHD to receive proven high-quality care just as much as their counterparts in Los Angeles; that they currently cannot is not a 'their problem' but rather our collective responsibility to help solve. With support from collaborators from high-income countries, paediatric cardiac surgery on simple CHDs has been taking place for the past several years in Accra under the stewardship of one of this study's authors (first author Yao) and dedicated efforts are ongoing to continue its local advancement. Implementing standardised POS and investing the resources into its effective institutional implementation are equally necessary components on the clinical road to advancing healthcare equity for children born with all forms of CHD in Ghana.

CONCLUSIONS

From a holistic care perspective, identifying neonates with CCHD enables healthcare providers to better counsel families to prepare for a sudden or insidious neonatal or infant demise and further offer ongoing psychological support in the coming days and weeks. Families everywhere and anywhere deserve to understand the why and how of their children's life-threatening conditions, even if little can be done in the short term to prevent death. Identifying neonates at high risk for early demise due to CCHD creates an opportunity to craft contextually appropriate approaches to palliative care with families.[26]

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study was approved by the Korle Bu Teaching Hospital Scientific and Technical Committee (Approval number: KBTH-STC000243/2023) and the IRB of the 37 Military Hospital (Approval number: 37MH-IRB/NFP/IPN/819/24). Participants gave informed consent to participate in the study before taking part.

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REFERENCES

1 Liu Y, Chen S, Zühlke L, *et al*. Global birth prevalence of congenital heart defects 1970-2017: updated systematic review and meta-analysis of 260 studies. *Int J Epidemiol* 2019;48:455–63.
2 Zimmerman MS, Smith AGC, Sable CA, *et al*. Global, regional, and national burden of congenital heart disease, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet Child Adolesc Health* 2020;4:185–200.
3 Zhang L, Liu B, Li H, *et al*. Epidemiology of Congenital Heart Disease in Jinan, China From 2005 to 2020: A Time Trend Analysis. *Front Cardiovasc Med* 2022;9:815137.
4 Abdelrahman O, Diab R. Prevalence and Pattern of Congenital Heart Disease Among Children in Khartoum State, Sudan: A Reflection of the Current Cardiac Profile. *Cureus* 2022;14:e21196.
5 Lawrenson J. The prevalence of congenital heart disease: we need to work towards getting more data. *Cardiovasc J Afr* 2020;31:225–6.
6 Ossa Galvis MM, Bhakta RT, Tarmahomed A, *et al*. Cyanotic heart disease. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing, 2025. Available: http://www.ncbi.nlm.nih.gov/books/NBK500001/
7 AlAql F, Khaleel H, Peter V. Universal Screening for CCHD in Saudi Arabia: The Road to a “State of the Art” Program. *Int J Neonatal Screen* 2020;6:13.
8 Kemper AR, Mahle WT, Martin GR, *et al*. Strategies for Implementing Screening for Critical Congenital Heart Disease. *Pediatrics* 2011;128:e1259–67.
9 Oster ME, Pinto NM, Pramanik AK, *et al*. Newborn Screening for Critical Congenital Heart Disease: A New Algorithm and Other Updated Recommendations: Clinical Report. *Pediatrics* 2025;155:e2024069667.
10 Majani N, Chillo P, Slieker MG, *et al*. Newborn Screening for Critical Congenital Heart Disease in a Low-Resource Setting; Research Protocol and Preliminary Results of the Tanzania Pulse Oximetry Study. *Glob Heart* 2022;17:32.
11 Thangaratinam S, Brown K, Zamora J, *et al*. Pulse oximetry screening for critical congenital heart defects in asymptomatic newborn babies: a systematic review and meta-analysis. *Lancet* 2012;379:2459–64.
12 Abbas A, Ewer AK. New born pulse oximetry screening: A global perspective. *Early Hum Dev* 2021;162:105457.
13 Meberg A, Brügmann-Pieper S, Due R, *et al*. First day of life pulse oximetry screening to detect congenital heart defects. *J Pediatr* 2008;152:761–5.
14 Riede FT, Wörner C, Dähnert I, *et al*. Effectiveness of neonatal pulse oximetry screening for detection of critical congenital heart disease in daily clinical routine--results from a prospective multicenter study. *Eur J Pediatr* 2010;169:975–81.
15 Singh A, Rasiah SV, Ewer AK. The impact of routine predischarge pulse oximetry screening in a regional neonatal unit. *Arch Dis Child Fetal Neonatal Ed* 2014;99:F297–302.
16 Hom LA, Martin GR. Newborn Critical Congenital Heart Disease Screening Using Pulse Oximetry: Value and Unique Challenges in Developing Regions. *Int J Neonatal Screen* 2020;6:74.
17 Kumar RK. Screening for congenital heart disease in India: Rationale, practical challenges, and pragmatic strategies. *Ann Pediatr Cardiol* 2016;9:111–4.
18 El Idrissi Slitine N, Bennaoui F, Sable CA, *et al*. Pulse Oximetry and Congenital Heart Disease Screening: Results of the First Pilot Study in Morocco. *Int J Neonatal Screen* 2020;6:53.
19 Van Niekerk AM, Cullis RM, Linley LL, *et al*. Feasibility of Pulse Oximetry Pre-discharge Screening Implementation for detecting Critical Congenital heart Lesions in newborns in a secondary level maternity hospital in the Western Cape, South Africa: The “POPSICLe” study. *S Afr Med J* 2016;106:817–21.
20 Ghana demographic and health survey 2022. Ghana Statistical Service; 2023. Available: https://dhsprogram.com/pubs/pdf/PR149/PR149.pdf [Accessed 10 Nov 2025].
21 Dai H, Much AA, Maor E, *et al*. Global, regional, and national burden of ischaemic heart disease and its attributable risk factors, 1990–2017: results from the Global Burden of Disease Study 2017. *Eur Heart J Qual Care Clin Outcomes* 2022;8:50–60.
22 Rossano JW. Congenital heart disease: a global public health concern. *Lancet Child Adolesc Health* 2020;4:168–9.
23 Thomford NE, Biney RP, Okai E, *et al*. Clinical Spectrum of congenital heart defects (CHD) detected at the child health Clinic in a Tertiary Health Facility in Ghana: a retrospective analysis. *J Congenit Heart Dis* 2020;4.
24 van Vliet JT, Majani NG, Chillo P, *et al*. Diagnostic Accuracy of Physical Examination and Pulse Oximetry for Critical Congenital Cardiac Disease Screening in Newborns. *Children (Basel)* 2023;11:47.
25 Ruppel H, Makeneni S, Faerber JA, *et al*. Evaluating the Accuracy of Pulse Oximetry in Children According to Race. *JAMA Pediatr* 2023;177:540–3.
26 Entsua-Mensah K, Tetteh J, Ekem-Ferguson G, *et al*. Psychological Distress and Its Associated Factors Among Parents of Children With Congenital Heart Disease: A Cross-Sectional Mixed Method Study at the National Cardiothoracic Center, Ghana. *World J Pediatr Congenit Heart Surg* 2024;15:755–65.