Alqalam Journal of Medical and Applied Sciences. 2026;9(11):3827-3833
https://doi.org/10.54361/ajmas.261139

Original article

A Retrospective Trend Analysis on Structural Congenital Anomalies Patterns in Referral Hospitals in Dodoma, Tanzania (2015 – 2025)

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Abstract
Structural congenital anomalies (SCAs) are a major cause of neonatal morbidity, mortality, and lifelong disability, particularly in low- and middle-income countries. This hospital-based retrospective cross-sectional study reviewed live birth and congenital anomaly records from Dodoma Regional Referral Hospital (DRRH) and Benjamin Mkapa Hospital (BMH) between 2015 and 2025 to assess the SCA trends in central Tanzania. Of 32,641 live births analyzed (24,868 at DRRH and 7,773 at BMH), 3,294 (10.1%) newborns had SCAs, including 1,605 males (48.7%) and 1,689 females (51.3%). The incidence of congenital anomalies increased from 47.6 to 150.7 per 1,000 live births at DRRH and from 14.1 to 223.6 per 1,000 at BMH during the study period. The most common anomalies were gastroschisis (29.6%), spina bifida (25.2%), and atrial septal defects (12.5%). Male newborns showed a higher prevalence of neural tube defects, while females had a greater occurrence of other SCAs. The rising incidence observed at both facilities highlights the need for strengthened birth defect surveillance, improved early diagnosis, and enhanced preventive and clinical care services in the Centre Zone.
Keywords. Structural congenital anomalies, Live births, temporal trends, Dodoma.

Introduction

Structural congenital anomalies (SCA) are anatomical defects of organs or body parts that develop before birth and are present at birth, such as congenital heart defects, cleft lip, gastroschisis, abdominal wall defects, and spina bifida. These birth defects vary from mild to severe forms and mostly occur in the first three months of pregnancy, although some occur in later stages of pregnancy [1]. Approximately 50% of congenital anomalies are of unknown etiology, while the remaining cases are associated with genetic, environmental, and maternal risk factors [2]. About 94% of severe cases occur in low- and middle-income countries (LMIC's), where poor maternal nutrition, increased exposure to infections and alcohol, and limited access to healthcare and screening services contribute to the higher burden [3,4]. Consequently, mortality associated with SCA is less than 5% in high-income countries, where antenatal diagnosis is common, but may be as high as 100% in many LMIC's with limited prenatal diagnostic services [5,6,7]. The 2010 World Health Organization (WHO) World Health Assembly report on birth defects recommended prevention, screening, and ongoing support for affected children and their families [8].

In Sub-Saharan African countries, the true magnitude of congenital anomalies is often underestimated [6,8–11] due to inadequate surveillance systems, limited diagnostic facilities, and underreporting. In Tanzania, congenital anomalies continue to pose a major public health challenge [9,12], resulting in higher neonatal mortality rates, extended hospitalizations, and lasting health burdens on affected individuals and their families. Although considerable efforts have been made to strengthen maternal and child health services, data on the long-term trends and patterns of congenital anomalies remain scarce. This study, therefore, aimed at assessing the incidence, long-term temporal trends, types, and sex distribution of structural congenital anomalies observed among neonates born at Benjamin Mkapa Zonal Referral Hospital and Dodoma Regional Referral Hospital in central Tanzania from 2015 to 2025.

Methodology

Study design and setting

This hospital-based retrospective descriptive cross-sectional study design was conducted using hospital records of live births and congenital anomalies reported at Dodoma Regional Referral Hospital (DRRH) and Benjamin Mkapa Hospital (BMH) over an 11-year period from 2015 to 2025. The two facilities are Government tertiary referral and University teaching hospitals located in Dodoma Urban, Dodoma City, the capital city of the United Republic of Tanzania. The BMH hospital serves as a super referral hospital in the central zone regions: Dodoma, Singida, and Manyara, and neighbouring regions such as Morogoro, Iringa, and Tabora, making it a significant referral healthcare facility in the region (Figure 1). The DRRH serves as the main referral hospital in Dodoma Region, providing a longer baseline trend (11 years of continuous data from 2015–2025). BMH provides specialized tertiary-level data (8 years of continuous data from 2018–2025, following its 2017 establishment). The hospitals maintain delivery records, neonatal admission registers, and medical archives that served as data sources for this study.

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Received*: 12-09-2026 -* ***Accepted****: 11-11-2026 -* ***Published****: 18-11-2026*

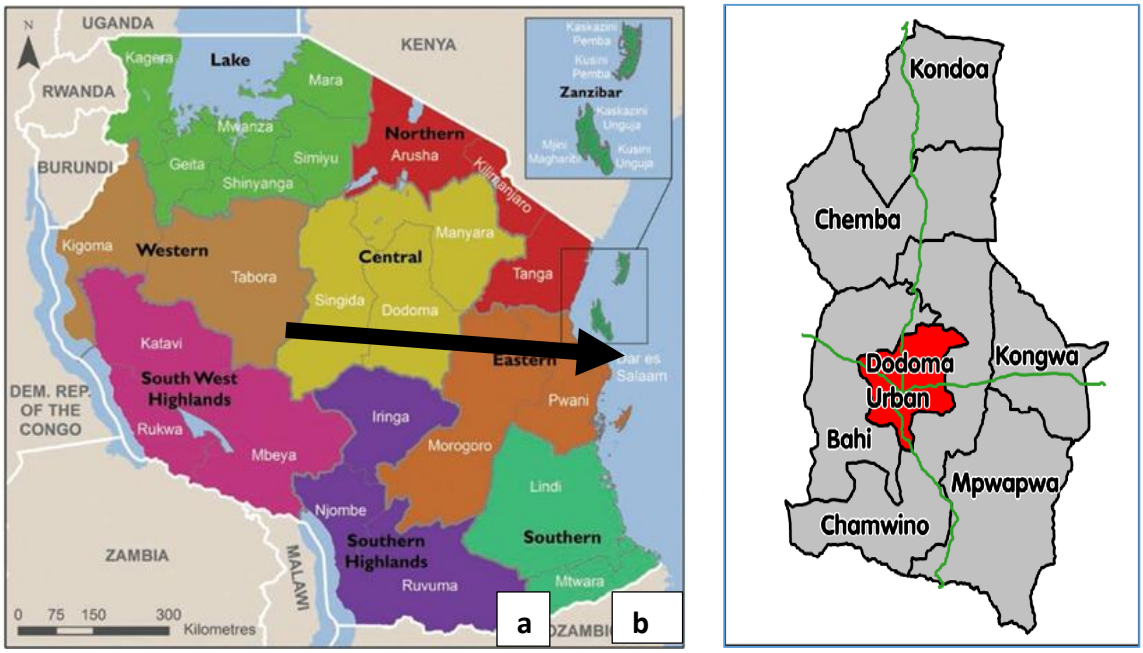


Figure 1. (a) Tanzania administrative zones (Map adopted from Mzee et al., 2021) [13]. The map display the area served by the BMH in Centre Zone (Dodoma, Manyara and Singida) and nearby regions. (b) Dodoma Region administrative districts displaying the location of the Benjamin Mkapa Zonal Referral Hospital and Dodoma Regional Referral Hospital.

Ethical approval

Ethical approval was obtained from the University of Dodoma Institutional Research Review Ethics Committee before commencement of the research, followed by permission from the relevant authorities at DRRH and BMH to access the retrospective records. Since the study involved secondary use of hospital data, no direct contact with newborns was required; therefore, confidentiality and privacy were maintained throughout data extraction, analysis, and reporting.

Inclusion/Exclusion criteria

The objective of the present retrospective study is to assess the incidence, temporal trends, types, and sex distribution of structural congenital anomalies observed among neonates born at Benjamin Mkapa Zonal Referral Hospital and Dodoma Regional Referral Hospital in central Tanzania from 2015 to 2025. To achieve this, all hospital records of live births and congenital anomalies reported at DRRH and BMH over an 11-year period from 2015 to 2025 were reviewed and included in the study. All records with missing information were excluded from the study.

Data Source, Tools, and Collection Method

Delivery registers for birth at BMH (between 2018 and 2025) and DRRH (between 2015 and 2025) served as the source of information on neonates with structural congenital anomalies. A structured data extraction form was used to retrieve delivery records for each year and to identify documented cases of neonates with congenital anomalies using a secure database. All data on congenital malformations were retrieved from the two facilities based on the classification system as described in ICD-10 Chapter XVII: Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99) code for diagnosis (ICD-10: version 2019) [14]; this made it easier to obtain the records from the databases of the two hospitals.

Data analysis

Data collected were entered into the Statistical Package for the Social Sciences (SPSS) for Windows (version 20, SPSS Inc., Chicago, IL, USA). Data were analysed using simple descriptive statistics.

Results

Statistical Overview

A combined dataset of 32,641 live births was retrieved from the two referral medical facilities for the 2015–2025 period. A total of 24,868 births were extracted from the DRRH system (2015–2025), and 7,773 were retrieved from the BMH database (2018–2025) (Figure 2). Yearly distributions are detailed in (Table 1). BMH records prior to 2018 were unavailable due to its establishment in 2017 and subsequent missing data for that year.

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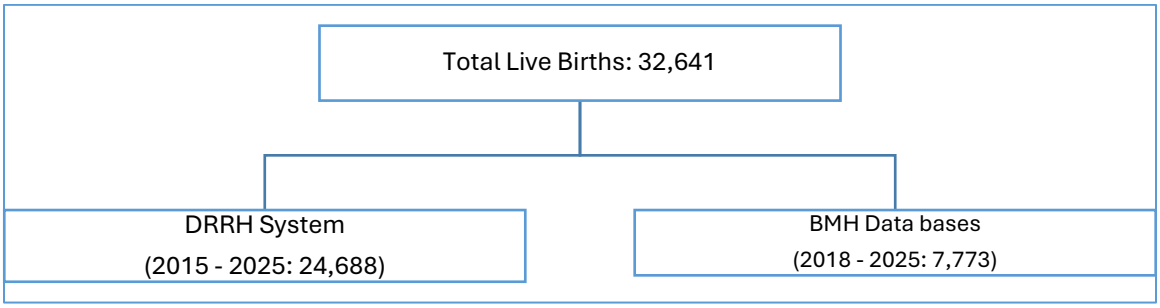


Figure 2. Retrieved study population (live births) data from the two facilities.

Table 1. Annual Distribution of Live Births at DRRH and BMH (2015 – 2025)

Year	Total number of live births		Annual Combined Total
	BMH live births	DRRH live births	
2015	-	1701	1701
2016	-	1837	1837
2017	-	1356	1356
2018	295	1813	2108
2019	316	2084	2400
2020	710	2522	3232
2021	1026	2493	3519
2022	1357	2605	3962
2023	1501	2748	4249
2024	1356	2810	4166
2025	1212	2899	4111

Annual trend of congenital anomalies at DRRH and BMH (2015 – 2025)

Retrospective data from both facilities reveal a rising trend in congenital anomalies (CAs) over time. As shown in Table 2, DRRH cases increased from 81 (4.8%) in 2015 to 437 (15.1%) in 2025, spiking noticeably after 2019, with a study-wide low of 68 cases (3.7%) in 2016. BMH began tracking data in 2018 but recorded no anomalies in 2018, 2019, and 2021. Still, BMH saw a sharp increase from 10 cases (1.4%) in 2020 to 292 (21.5%) in 2024, before reaching a peak of 271 cases (22.4%) in 2025 (Table 2).

Table 2. Annual trend of congenital anomalies among live births at DRRH and BMH

Year	DRRH (n = 24,868)			Year	BMH (n = 7,773)		
	CA	Non-CA	Total Live births		CA	Non-CA	Total Live births
	n (%)	n (%)			n (%)	n (%)	
2015	81 (4.8)	1620 (95.2)	1701	2015	-	-	-
2016	68 (3.7)	1769 (96.3)	1837	2016	-	-	-
2017	104 (7.7)	1252 (92.3)	1356	2017	-	-	-
2018	117 (6.5)	1696 (93.5)	1813	2018	0 (0.0)	295 (100.0)	295
2019	191 (9.2)	1893 (90.8)	2084	2019	0 (0.0)	316 (100.0)	316
2020	216 (8.6)	2306 (91.4)	2522	2020	10 (1.4)	700 (98.6)	710
2021	218 (8.7)	2275 (91.3)	2493	2021	0 (0.0)	1026 (100.0)	1026
2022	247 (9.5)	2358 (90.5)	2605	2022	30 (2.2)	1327 (97.8)	1357
2023	361 (13.1)	2387 (86.9)	2748	2023	279 (18.6)	1222 (81.4)	1501
2024	372 (13.2)	2438 (86.8)	2810	2024	292 (21.5)	1064 (78.5)	1356
2025	437 (15.1)	2462 (84.9)	2899	2025	271 (22.4)	941 (77.6)	1212

CA: Structural congenital anomalies

Prevalence of congenital anomalies among live births at DRRH and BMH (2015 – 2025)

Overall prevalence of congenital anomalies was 10.1% (3294/32641 live births). Of the 32,641 live births analyzed, 24,868 were delivered at DRRH and 7,773 at BMH. Structural congenital anomalies were identified in 3,294 newborns, including 1,605 (48.7%) males and 1,689 (51.3%) females. The prevalence of congenital anomalies was notably higher at BMH, reaching 11.4% (882/7,773 live births) compared to 9.7% at DRRH (2,412/24,868 live births) (Figure 3).

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Received: *12-09-2026 -* ***Accepted:*** *11-11-2026 -* ***Published:*** *18-11-2026*

https://doi.org/10.54361/ajmas.261139

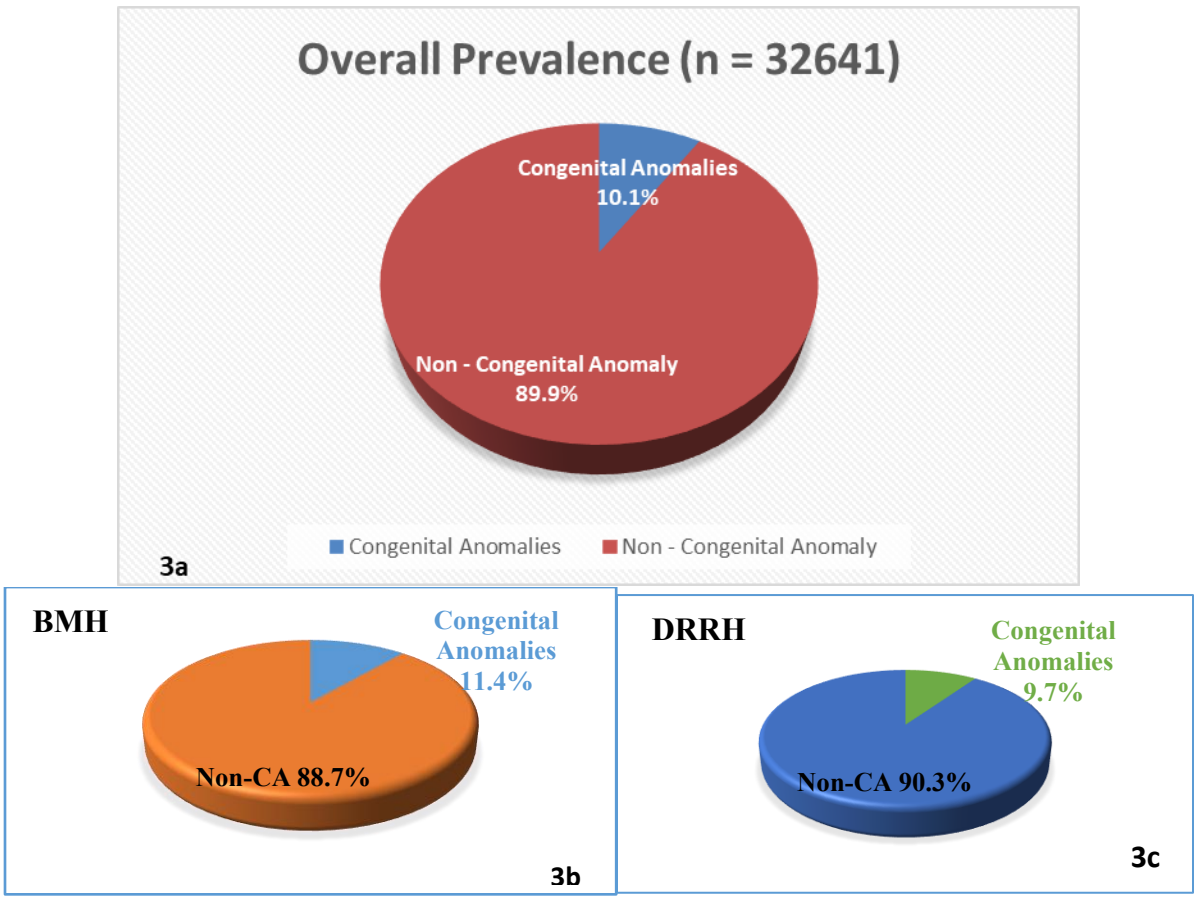
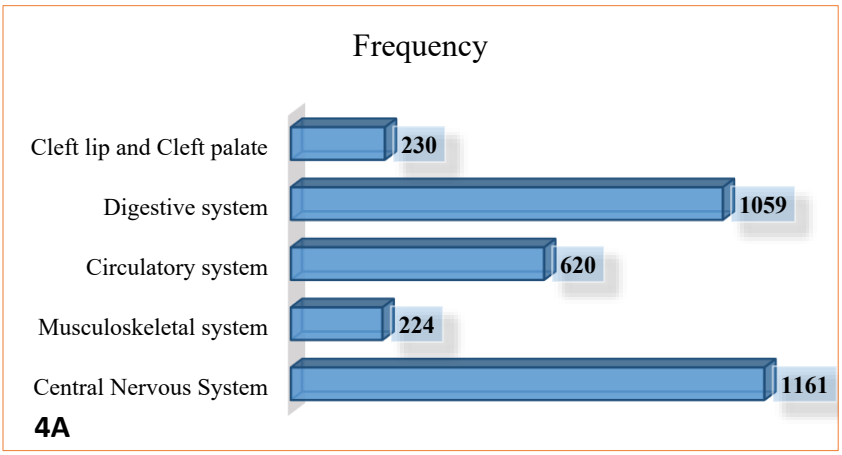


Figure 3. Prevalence of congenital anomalies observed among live births at DRRH and BMH. 3a: Displays the combined prevalence, while 3b and 3c represent individual prevalences at each facility. CA: congenital anomalies.

Congenital anomalies based on broad classification

A total of 3,294 neonates were diagnosed with congenital anomalies during the period under review. Description based on ICD-10 coding, the commonest broad classification of anomalies involved the central nervous system (1161; 35.2%) followed by those on digestive system (1059; 32.1%), while the musculoskeletal system (224; 6.8%) being the least observed (Figure 4).



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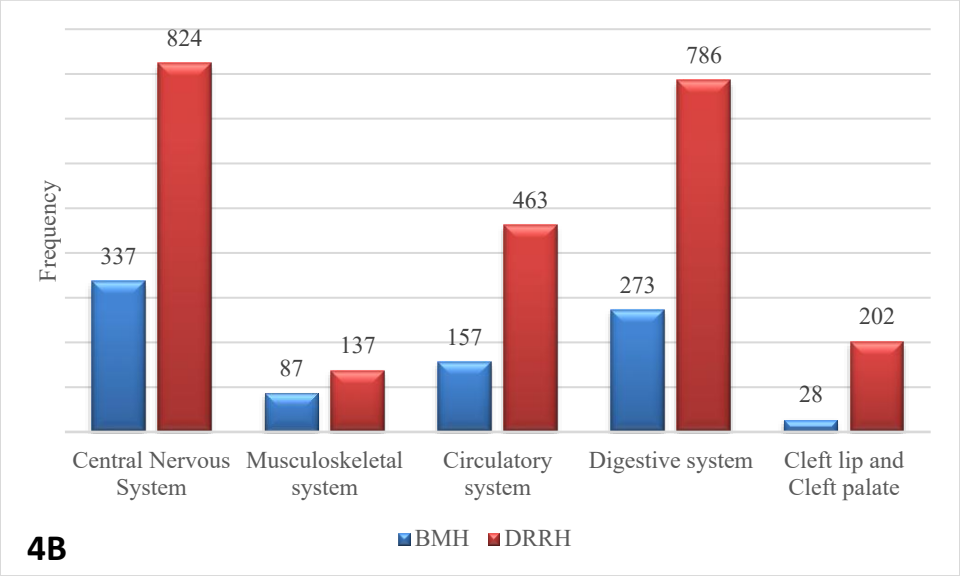


Figure 4. Congenital anomalies based on broad classification observed among live births at DRRH and BMH. 4a: Displays the combined frequency, while 4b represents the individual frequency at each facility.

Distribution of Congenital Anomalies based on broad classification and sex of the neonate

(Table 3) displays the broad classification of congenital anomalies based on ICD-10 coding as related to the sex of the neonate. Female neonates are more affected than males.

Table 3. Distribution of congenital anomaly findings based on broad classification and sex

Type of Congenital Anomaly	Frequencies	Percentages	Male, n (%)	Female, n (%)
Central Nervous System	1161	35.2	560(48.2)	601(51.8)
Musculoskeletal system	224	6.8	114(50.9)	110(49.1)
Circulatory system	620	18.8	300(48.4)	320(51.6)
Digestive system	1059	32.2	519(49)	540(51)
Cleft lip and Cleft palate	230	7	112(48.7)	118(51.3)
	3294		1605 (48.7%)	1689 (51.3%)

Distribution of Congenital Anomalies by Types and sex of the neonate

(Table 4) presents the distribution of specific types of congenital anomalies among affected neonates, categorized by sex.

Table 4. Distribution of congenital anomaly findings by type and sex

CA Type	Frequency	Percentages	Male, n (%)	Female, n (%)
Spina bifida	831	25.2	478 (57.5)	353 (42.5)
Hydrocephalus	204	6.2	105 (51.7)	99 (48.5)
Encephalocele	126	3.8	52 (41.2)	74 (58.7)
Club foot	224	6.8	105 (46.9)	119 (53.1)
AVSD	207	6.3	86 (41.5)	121 (58.5)
ASD	413	12.5	205 (49.6)	208 (50.4)
Gastroschisis	974	29.6	495 (50.8)	479 (49.2)
Omphalocele	85	2.6	37 (43.5)	48 (56.5)
Cleft lip	113	3.4	55 (48.7)	58 (51.3)
Cleft palate	117	3.6	51 (43.6)	66 (56.4)

CA=congenital anomaly, AVSD=Atrial ventricular septal defects, ASD=Atrial septal defects

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https://doi.org/10.54361/ajmas.261139

Distribution of congenital anomalies in girls versus boys (sex)(Table 5) details the distribution of congenital anomaly types across both facilities in relation to newborn sex. At both sites, spina bifida and gastroschisis were the most frequent anomalies recorded for both male and female neonates.

Table 5. The distribution of structural congenital anomalies across both facilities in relation to the newborn's sex

CA Type	DRRH				BMH			
	Frequency	Percentage	Male, n (%)	Female, n (%)	Frequency	Percentage	Male, n (%)	Female, n (%)
Spina bifida	573	23.8	307(53.6)	266(46.4)	258	29.3	171(66.3)	87(33.7)
Hydrocephalus	155	6.4	82(52.9)	73(47.1)	49	5.6	23(46.9)	26(53.1)
Encephalocele	96	4	40(41.7)	56(58.3)	30	3.4	12(40)	18(60)
Club foot	137	5.7	66(48.2)	71(51.8)	87	9.9	39(44.8)	48(55.2)
AVSD	138	5.7	54(39.1)	84(60.9)	69	7.8	32(46.4)	37(53.6)
ASD	325	13.5	163(50.2)	162(49.8)	88	10	42(47.7)	46(52.3)
Gastroschisis	714	29.6	359(50.3)	355(49.7)	260	29.5	136(52.3)	124(47.7)
Omphalocele	72	3	30(41.7)	42(58.3)	13	1.5	7(53.8)	6(46.2)
Cleft lip	107	4.4	52(48.6)	55(51.4)	6	0.7	3(50)	3(50)
Cleft palate	95	3.9	43(45.3)	52(54.7)	22	2.5	8(36.3)	14(63.6)

CA=congenital anomaly

Discussion

The present study aimed to track the annual and decade- long trends in structural congenital anomalies in neonates based on data from 11 years, which included a total of 32641 live births. The results showed that the overall combined prevalence of CA was 10.1% (4.9% males: 5.2% females), with CNS being the dominant type followed by digestive system anomalies. However, the trend of CA incidence tends to correlate with the population increase over time attending the two referral hospitals. This observation comes from the fact that the population (live births) has tremendously increased due to doubling of live births over this decade, surging from 1701 in 2015 to a peak of 32641 in 2025. This may also be contributed to by improved health services provided by the two referral facilities and the availability of advanced health equipment and specialists (paediatrics, surgeons, obstetricians), although this association was not measured in the current report.

The annual incidence in this study is considerably higher than in earlier studies from Tanzania and other African settings [15,16,17,18,19,20]. The higher annual incidences partly reflect differences in anomalies reported, case-finding method, diagnostic capacity, referral patterns, and record completeness, particularly since this study used retrospective records from two referral-level facilities where complicated pregnancies and births with suspected anomalies are more likely to be concentrated than in community-based populations.

The current study revealed a rising trend in congenital anomalies among newborns of both sexes at DRRH, with a significant increase in female cases during 2021, 2024, and 2025. These results mirror broader national trends in Tanzania; specifically, Kishimba et al. [15] observed a comparable sex distribution for selected structural birth defects, though they noted a higher prevalence of neural tube defects in females. Moreover, BMH recorded higher prevalence compared to DRRH, largely contributed to the highly specialization of BMH which is the super referral hospital, that mean it also receive more complicated referral birth cases from DRRH. However, the measure of association was not measured in the present study. During the decade-long study period, gastroschisis (29.6%) contributed a higher proportion of SCA followed by spina bifida (25.2%) among the neonates. This is slightly different from the report by Mashuda et al [21]. Furthermore, in both facilities, boys (male neonates) recorded higher spina bifida anomalies than girls, while cleft palate and omphalocele were more commonly observed in girls than boys. These discrepancies may stem from variations in specific congenital anomalies recorded, as sex-specific susceptibility fluctuates across different defects [22,23,24]

Conclusion

This study confirms that congenital anomalies are a critical and growing public health concern, evidenced by increasing annual incidences at BMH and DRRH, showing a pronounced spike in documented cases from 2015 to 2025. Gastroschisis, spina bifida, and atrial septal defects led the reported cases, alongside various neural tube, cardiovascular, musculoskeletal, and orofacial malformations. Anomalies displayed distinct sex-specific patterns that varied between the two medical facilities. The findings highlight the need to strengthen birth defect tracking and optimize early diagnostic tools and strengthen both preventative and clinical health services within the central zone regions.

Acknowledgement

We sincerely thank the staff of the neonatal units at DRRH and BMH for their invaluable support throughout this study. We also extend our appreciation to the management of both hospitals for granting permission and facilitating the conduct of this research within their facilities.

Conflict of Interest

The authors declare no conflicts of interest.

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Received*: 12-09-2026 -* ***Accepted****: 11-11-2026 -* ***Published****: 18-11-2026*

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Received*: 12-09-2026 -* ***Accepted****: 11-11-2026 -* ***Published****: 18-11-2026*