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Congenital anomalies matters: An analysis of data from the Kersa Health and Demographic Surveillance System in Eastern Ethiopia, a seven-year open cohort study.

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Abstract

Background: Congenital anomalies, which are structural or functional abnormalities present at birth, were the fourth leading cause of death among children under 5 years. However, there is a lack of community-based studies on the trends and factors associated with congenital anomalies in Eastern Oromia. This study aimed to investigate the trends and factors associated with congenital anomalies among newborns in Eastern Ethiopia.

Methods: A study was conducted among newborns in an open cohort using data from the Kersa Health and Demographic Surveillance System from 2015 to 2022. The system tracks demographic and health changes in the community. Data extraction was done using a checklist based on the study objectives and analyzed using SPSS version 26.0. The prevalence of congenital anomalies was determined, and associated factors were identified through binary logistic regression. Statistical significance was set at a p-value of < 0.05 with a 95% confidence interval for the adjusted odds ratio.

Results: Between 2015 and 2022, a total of 27,350 newborns were documented in the Kersa HDSS, with 104 of them having congenital anomalies. The overall rate of congenital anomalies was 3.83 per 1000 live births (95% CI: 3.19-4.61). Over the study period, there was a rising trend in the prevalence of congenital anomalies. Factors significantly associated with congenital anomalies included maternal age over 35 years (AOR: 1.68, 95% CI: 1.07, 2.62), place of birth (AOR: 2.04, 95% CI: 1.04, 4.02), and normal birth weight (AOR=0.14, 95% CI: 0.04, 0.47).

Conclusion: The data from the Kersa Health and Demographic Surveillance system revealed a rising trend in congenital anomalies. This trend was associated with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on these factors to reduce the prevalence of congenital anomalies.

Keywords: Congenital anomalies, associated factors, prevalence, new-borns

WHAT IS ALREADY KNOWN ON THIS TOPIC

Congenital anomalies can lead to long-term disability, creating physical, financial, and emotional challenges for families.

Research on congenital anomalies in Ethiopia is often limited to health facilities, lacking appropriate denominators and representative samples.

WHAT THIS STUDY ADDS

Community-based Demographic and Health Surveys (HDSS) provide longitudinal data on a known and stable target population, enhancing its representativeness and application.

There is evidence of significant variation in CA in specific locations.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

To enhance the assessment of congenital anomalies, incorporating genetic tests and ultrasound could offer a more comprehensive evaluation for better intervention strategies.

Introduction

Congenital anomalies (CAs) are structural or functional abnormalities that occur during fetal development [1 2]. They can range from minor to major anomalies, with major CAs being a leading cause of death in children under 5 [3]. Common types of CAs include neural tube defects, congenital heart disease, cleft lip/palate, and limb defects [4 5]. Causes of CAs include genetic factors, chromosomal disorders, environmental teratogens, and nutrient deficiencies. Early detection and intervention are crucial in managing these conditions [6].

Globally, the prevalence of major congenital anomalies is approximately 6% [5]. Studies in different countries have reported varying rates, with China showing rates of 245.95 to 304.36 per 10,000 live births, Iran at 112.89 per 10,000 births, and India at 230.51 per 10,000 births [7-12]. The majority of congenital anomalies occur in low- and middle-income countries and are a significant contributor to neonatal mortality, with about 240,000 neonates and 170,000 children aged 1 month to 5 years dying each year. [13 14]. Congenital anomalies also contribute to long-term disability and pose physical, financial, and emotional challenges for families [15 16].

Congenital anomalies can be caused by genetic factors, chromosomal disorders, multifactorial inheritance, environmental teratogens, and micronutrient deficiencies [6]. Previous studies in Ethiopia have shown that the likelihood of developing congenital anomalies is higher in mothers under 20 or over 35 years old [17 18], those who use medication during early pregnancy [16 17 19], consume alcohol or chew Khat during pregnancy [19], are exposed to chemicals [18], have chronic diseases during pregnancy or before conception [17], have inadequate antenatal care follow-up [20], have gestational age below 28 weeks or above 40 weeks. Conversely, a history of iron folate use before and during pregnancy [18], and living in urban areas were associated with a lower risk of congenital anomalies.

High-quality antenatal care, skilled birth attendance, and care for small and sick newborns can help reduce birth defects and neonatal mortality [11]. Some congenital anomalies can be prevented through vaccination, folic acid intake, and iodine supplementation [1 21] Integrating prevention and care for congenital anomalies into existing maternal, reproductive, and child health services is crucial. [22].

Health and demographic surveillance systems (HDSS) have become a crucial source of representative data for evidence generation, particularly in rural areas and countries with weak vital registration systems. Unlike facility-based studies or Demographic and Health Surveys, HDSS offers longitudinal data on a known and stable target population, allowing for the analysis of trends and changes in mortality determinants for tailored interventions. Unfortunately, research on CA in Ethiopia are often limited to health facilities and lack appropriate denominators, reducing their applicability [4 16-19]. Therefore, there is a pressing need for more comprehensive evidence that can illustrate the evolution of CA and identify the related factors. This study aims to analyze trends and associated factors of CA in Kersa HDSS from 2015 to 2022.

Methods and materials

Study area

The data for this study was obtained from the Kersa Health and Demographic Surveillance System (HDSS) in eastern Ethiopia, affiliated with the College of Health and Medical Sciences at Haramaya University. The HDSS was established in 12 sub-districts in 2007 and has been updated every 6 months to record demographic and health events. Currently, the Kersa HDSS covers 24 kebeles in 38 sub-districts. The majority of communities in the area are farmers, with a smaller number engaged in small trade, government positions, or casual labor. Khat is a dominant cash crop in most of the sub-districts. In the highland regions, the main crops grown are wheat, barley, and vegetables, while in the lowland areas, sorghum, maize, and potatoes are commonly cultivated [23].

Study Population, design, and period

This study utilized a longitudinal population-based surveillance design. The study population included all newborns born in the study area and registered in the Kersa HDSS from January 1, 2015, to December 31, 2022.

Sample Size and Sampling Techniques

All women of newborn born in the study area from from January 1, 2015, to December 31, 2022, were included

Data collection procedure

Data collection in the HDSS involves biannual visits to all residents, with updates recorded and entered into the database system [23]. Trained HDSS staff use ODK for data collection through face-to-face interviews. Field supervisors ensure data quality by checking GPS coordinates, consistency, and validity of responses before sending it to the Open HDSS database. If any issues are found, data collectors are supervised in making corrections. The collected data is temporarily stored on ODK aggregate and then reviewed by the data manager before being migrated to the final Open HDSS database. In this study, we tracked pregnant women and their pregnancy outcomes from 2015 to 2022. Data on congenital anomalies (CA) and normal births in the follow-up population were retrived

annually, along with socio-demographic characteristics, household information, prenatal care, obstetric details, and birth outcomes of CA or normal births.

Measurement and variables

The study focused on congenital anomalies (CAs) as the dependent variable. The independent variables included socio-demographic factors (marital status of the mother, age of the mother, sex of the neonate, educational status of the mother, educational status of the father, occupation of the father, occupation of the mother), maternal factors (antenatal care visits, parity, place of delivery), and neonatal factors (gestational age, birth weight). Women who had given birth were interviewed every six months to determine the outcome of their pregnancy (whether there was a congenital anomaly or a normal birth) and to gather information on any congenital anomalies in household members. Congenital anomalies are anatomical, structural, and functional defects present at birth that originate during prenatal development [19]. If a congenital anomaly was reported, detailed information on functional and structural abnormalities was collected through physical examinations and detailed interviews conducted by trained data collectors using a standard questionnaire with the mother or caregiver within four weeks of delivery. The outcome variable was then categorized as either 'congenital anomaly' or 'normal birth', with 'congenital anomaly' assigned a value of "1" and 'normal birth' a value of "0". Various factors such as socio-demographic (place of residence, mother's education level, wealth index), maternal (age at first birth), and obstetric (parity, place of delivery, ANC visits) were considered as explanatory variables for the presence of congenital anomalies.

Data processing and analysis

Data from the HDSS database was exported to SPSS version 26 for analysis. Descriptive statistics were used to summarize the explanatory variables by frequency and percentage. The prevalence of congenital anomalies (CAs) was calculated as the proportion of newborns with CAs in the HDSS population. Binary logistic regression analysis was conducted to select explanatory variables for the final model with a p-value of 0.25 and a 95% confidence interval. Variables with a p-value less than 0.25 in the bivariate analysis were included in the multivariate analysis to control for confounders.

Factors associated with CA were identified using multivariable logistic regression analysis, and adjusted odds ratios (AOR) with a 95% confidence interval were calculated. A P-value of <0.05 was considered statistically significant. Multi-collinearity was assessed using the variance inflation factor (VIF), for all independent variables. The model's goodness of fit was assessed using the Hosmer and Lemeshow test, with a p-value >0.05 indicating a good fit.

Results

Socio-demographic, Maternal, and neonatal characteristics by congenital anomalies

In this study, a total of 27,350 newborns from the KHDSS dataset were analyzed. Among the mothers, 17,186 (62.84%) were in the age group of 20-34 years, while 6,946 (25.39%) were above 35 years old. The majority of mothers, 18,967 (69.34%), had no formal education. Additionally, 24,351 (89.03%) of the community members in the study area had a family size of six or more. In this study, 12,630 (46.34%) mothers were multipara at the time of giving birth, 17,534 (64.33%) did not receive antenatal care, and 20,010 (73.44%) gave birth at home. Among the newborns studied, more than half (14,386 or 52.60%) were males. Furthermore, 25,234 (92.26%) of the neonates were born at a gestational age of 37-42 completed weeks, and 23,996 (87.73%) had a normal birth weight (Table 1).

Table 1: Sociodemographic, maternal, and newborn characteristics of study participants by congenital anomalies at KHDSS from January 2015, to December 2022, eastern Ethiopia (n=27,350).

Variable	Characteristics	Congenital anomalies	
		Yes (%)	No (%)
Age of the mother in years	<20	10(0.31)	3,208 (99.59)
	20-34	58 (0.34)	17,128 (99.66)
	≥35	36 (0.52)	6, 910(99.48)

Maternal educational status	No formal education	73 (0.40)	18,894 (99.6)
	Elementary	30(0.4)	7263 (99.6)
	Secondary and above	1(0.1)	1089 (99.9)
Maternal marital status	Married	86 (0.4)	22,993 (99.6)
	Divorced	2 (0.8)	247 (99.2)
	Single	16 (0.4)	3869 (99.6)
	Widowed	0 (0)	137(100)
Maternal occupational status	Farmer	3 (0.4)	834 (99.6)
	Housewife	83 (0.4)	22157 (99.6)
	Student	7 (0.4)	1936(99.6)
	Unemployed	8 (0.5)	1540 (99.5)
	Others	3 (0.4)	779 (99.6)
Educational status of the father	No formal education	70 (0.4)	18, 522(99.6)
	Elementary (1-8)	33 (0.4)	7595 (99.6)
	Highschool (9-12)	1 (0.1)	1, 129(99.9)
	College and above	0 (0)	147 (100)
Occupational status of the father	Farmer	80 (0.4)	20, 519 (99.6)
	Merchant	1 (0.2)	406 (99.8)
	Employed	1 (0.1)	709 (99.9)
	Student	13 (0.3)	4, 079 (99.7)
	Unemployed	7(0.6)	1, 098 (99.4)
	Other	2 (0.5)	435 (99.5)
Family size	≤2	0 (0)	104 (100)
	3-5	10 (0.3)	2, 885 (99.7)
	≥6	94 (0.4)	24, 257 (99.6)
Parity	Primipara	27 (0.4)	6, 345 (99.6)
	Multi-para (2-5)	45 (0.4)	12, 630 (99.6)

	Grand multipara (>5)	32 (0.4)	8, 271 (99.6)
Antenatal care	Yes	44 (0.5)	9, 712 (99.5)
	No	60 (0.3)	17, 534 (99.7)
Place of delivery	Home	77 (0.4)	20, 010(99.6)
	Health center	16 (0.3)	6, 062 (99.7)
	Hospital	10 (0.9)	1, 098 (99.1)
	Other$^{\pi}$	1 (1.3)	76 (98.7)
Newborn Sex	Male	51 (0.4)	14335 (99.6)
	Female	53 (0.4)	12911 (99.6)
Birth weight	Very small	3(2.1)	142 (97.9)
	Small	61 (1)	1621 (99)
	Normal	72 (0.3)	23, 924 (99.7)
	Big	13(0.8)	1559 (99.2)
Gestational age	<37 weeks	2(0.8)	258 (99.2)
	37-42 weeks	94 (4)	25, 140 (99.6)
	>42 weeks	8 (0.4)	1848 (99.6)

$^{\pi}$-private health facilities, trained traditional birth attendants, Health post

Prevalence of Congenital anomalies

From 2015 and 2022, a total of 27,350 newborns were recorded in the Kersa HDSS, among whom 104 were having congenital anomalies. The overall rate of congenital anomalies was 3.83 per 1000 live births (95% CI: 3.19-4.61).

Trend analysis of congenital anomalies

The trend analysis shows a high prevalence of CAs in 2020. with lower prevalence in 2015. The number of delivery was found to be highest in 2018 (4, 440), and 2021 (4, 425) (Figure 1A). the

trend line (red line) indicates a consistent increase in congenital anomalies from 2015 to 2022 (Figure 1B).

Prevalence of congenital anomalies in each kebele

The prevalence of CAs was found to be highest in two kebeles (Yabeta Lencha (1.80%) and Rameta (1.70%)). Whereas, zero prevalence was observed in Burka water, Gola Belina, and Metakoma kebeles (Figure 2). Whereas, the number of deliveries was relatively higher in Sodu (2, 439), Bala langey (1,860), and Handura Kosum (1,623) kebeles (Figure 2).

Factors associated with Congenital anomalies

In bivariable binary logistic regression, seven variables; antenatal care follow-up status, educational status of the father and mother, place of birth, age of the mother, occupational status of the mother, and birth weight were found to be candidates for multivariable binary logistic regression. On the other hand, after adjusted analysis in multivariable binary logistic regression, three variables; place of birth at a hospital home (AOR: 2.04, 95% CI: 1.04, 4.02) , having normal birth weight (AOR=0.14, 95% CI: 0.04, 0.47), and born from a mother older than 35 years (AOR: 1.68, 95% CI: 1.07, 2.62) were were significantly associated with the congenital anomalies. The Hosmer and Lemeshow test indicates the model fits the data well (p-value=0.100) (Table 2).

Table 2: Factors associated with congenital anomalies among newborns at KHDSS- 2015-2022. Bivariable and multivariable binary logistic regression analysis eastern Ethiopia.

Variables	Characteristics	Congenital anomalies		COR (95% CI)	p-value	AOR (95% CI)	p-value
		Yes (%)	No (%)				
Age of the mother	<20	10(0.31)	3,208 (99.59)	1.61 (0.95,2.73)	.076*	0.79 (0.39, 1.58)	.510
	20-34	58 (0.34)	17,128(99.66)	1			
	≥35	36 (0.52)	6, 910(99.48)	1.56 (0.98,2.48)	.063*	**1.68(1.07, 2.62)**	.023**

Place of delivery	Home	77 (0.4)	20010(99.6)	1		1	
	Health center	16 (0.3)	6062 (99.7)	0.69(0.40,1.18)	.171*	0.68 (0.39,1.18)	.174
	Hospital	10 (0.9)	1098 (99.1)	2.37 (1.22)	.011*	**2.04 (1.04, 4.02)**	.039**
	Other	1 (1.3)	76 (98.7)	3.42 (0.47)	.225*	3.34 (0.45,24.65)	.236
Educational status of the father	No formal education	70 (0.4)	18, 522(99.6)	1		1	
	Elementary (1-8)	33 (0.4)	7595 (99.6)	1.15 (0.76,1.74)	.510	2.44 (0.76, 7.88)	.133
	Highschool (9-12)	1 (0.1)	1129(99.9)	0. 23(0.03,1.69)	.150*	0.32 (0.01,1456)	.826
Occupational status of the father	Farmer	80 (0.4)	20, 519 (99.6)	1		1	
	Merchant	1 (0.2)	406 (99.8)	0.63 (0.09,4.55)	.648	0.49 (0.66, 3.64)	.485
	Employed	1 (0.1)	709 (99.9)	0.36 (0.05,2.60)	.313	0.48 (0.06, 3.64)	.480
	Student	13 (0.3)	4079 (99.7)	0.82 (0.45,1.47)	.501	1.01 (0.53, 1.88)	.997
	Unemployed	7(0.6)	1098 (99.4)	1.64 (0.75,3.55)	.214*	1.93 (0.86, 4.34)	.111
	Other	2 (0.5)	435 (99.5)	1.18 (0.29,4.81)	.818	3.34 (0.45,24.65)	.236
Antenatal care	Yes	44 (0.5)	9712 (99.5)			1	
	No	60 (0.3)	17534 (99.7)	0.76 (0.51,1.12)	.158	0.69 (0.46, 1.03)	0.069
Birth weight	Very small	3(2.1)	142 (97.9)	1			
	Small	61 (1)	1621 (99)	0.48 (0.14,1.66)	.231*	0.48 (0.14,1.67)	.248
	Normal	72 (0.3)	23924 (99.7)	0.15 (0.05,0.47)	.001*	**0.14 (0.04, 0.47)**	.001**
	Big	13(0.8)	1559 (99.2)	0.44 (0.12,1.56)	.150*	0.42 (0.12, 1.50)	.183
Educational status of mother	No formal education	73 (0.40)	18,894 (99.6)	1			
	Elementary	30(0.4)	7263 (99.6)	1.07(0.70,1.64)	.759	.52(0.16,1.71)	.284
	Secondary and above	1(0.1)	1089 (99.9)	0.24 (0.03,1.71)	.154*	.93 (0.01, 4159)	.986

*** significant at 0.05, *-significant at 0.25, KHDSS-Kersa Health and Demographic Surveillance system*

Discussion

In this study, 27,350 newborns were included, with a prevalence of congenital anomalies at 0.38%. From 2015 to 2022, there was an increasing trend in the prevalence of congenital anomalies. Factors significantly associated with congenital anomalies included maternal age over 35 years, place of birth, and normal birth weight.

The prevalence of congenital anomalies at birth was 3.83 per 1000 live births, which is lower than rates reported in studies from China [7]. This difference could be attributed to variations in inclusion criteria. In China, all births, including live births, early fetal losses, stillbirths, and early neonatal deaths, are recorded. The prevalence of congenital anomalies in this study was also lower compared to studies conducted in Latvia [24]. This discrepancy may be due to differences in screening criteria, in Lativia ultrasound screeing was done.

The study revealed an increase in the prevalence of congenital anomalies (CAs) from 2015 to 2022, reaching a peak of 1.4% in 2020. This increase is consistent with a study in China where the live birth rate of infants with CAs born before 28 gestational weeks rose significantly [7]. In contrast, a study in Latvia showed a decreasing trend in CAs [24], attributed to early pregnancy ultrasound surveillance and intervention measures in place. The higher prevalence of CAs in 2020 may be linked to the impact of the Covid-19 pandemic on healthcare services, including maternal healthcare [25]. Strengthening maternal health services during epidemics can help reduce neonatal morbidity [26]. Despite lower numbers of deliveries, two kebeles (Yabeta Lencha and Rameta) had higher rates of CAs, indicating the need for further research to understand the causes of this disparity.

In this study, neonates born to mothers over 35 years old were 1.68 times more likely to have congenital anomalies compared to those born to mothers aged 20-34 years. Similar findings have been reported in studies from different countries, showing a higher risk of congenital anomalies with increased maternal age. However, a systematic review and meta-analysis in 2021 found weak evidence of this association [27]. A population-based case-control study in Hungary also supported the link between maternal age ≥35 years and congenital anomalies [28]. In contrast, a study in Nigeria

did not find a significant association between maternal age and congenital anomalies [29]. On the other hand, a study in the Tigray region and another at Bishoftu General Hospital in Ethiopia found that maternal age ≤20 years and >35 years were significantly associated with congenital anomalies [17 18]. The increased risk of congenital anomalies after 35 years of age may be due to the higher likelihood of chromosomal anomalies and accumulated environmental exposures over time [28]. Therefore, it is important to enhance screening services for pregnant women over 35 years old to reduce the risk of congenital anomalies and related complications.

Furthermore, a study in India found that neonates with normal birth weight were 86% less likely to have congenital anomalies compared to low birth weight neonates [27]. However, a study in Nigeria did not find a significant association between birth weight and congenital anomalies [29]. The relationship between birth weight and congenital malformations is complex and influenced by various factors such as maternal medical conditions like hypertension, diabetes, and infections. Previous studies in Ethiopia have shown that factors like maternal age under 20 years, inter-pregnancy interval under 24 months, low body mass index, gestational age under 37 weeks, maternal educational status, and parity are associated with low birth weight [30 31]. Other factors for low birth weight include pregnancy-induced hypertension, lack of antenatal care follow-up, and prematurity [13]. Improving women's empowerment through education and socioeconomic status can reduce the risk of both low birth weight and congenital anomalies [30]. Strengthening quality antenatal care is also important.

Many congenital anomalies can be diagnosed before birth through prenatal screening using ultrasound. This screening has been a standard part of routine prenatal care for many years. Detecting these anomalies before birth allows for better management of the pregnancy and the baby's health [32 33]. In Ethiopia, there is currently no widespread ultrasound-based screening for congenital anomalies, but implementing such screening could greatly improve the management of these conditions.

The study offered insights on congenital anomalies in newborns in the community with a large sample size, but has limitations. Unaccounted and residual confounding factors may have influenced the associations found. The study did not specify the types of congenital anomalies observed. Additionally, relying solely on physical examinations and maternal interviews for diagnosis may have underestimated the true prevalence. Incorporating genetic tests and ultrasound could have provided a more thorough assessment of congenital anomalies.

Conclusion

The data from the Kersa Health and Demographic Surveillance system revealed a rising trend in congenital anomalies. This trend was associated with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on developing strategies that target these factors to reduce the prevalence of congenital anomalies effectively.

Abbreviations

ANC: Antenatal care

AOR: Adjusted odds ratio

CAs: Congenital anomalies

COR: crude odds ration

EDHS: Ethiopian Demographic Health Survey

HDSS: Health and demographic surveillance systems

KHDSS: Kersa Health and Demographic Survillance System

PNC: postnatal score

WHO: World health organization

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Author's contribution

The study was conceived and designed by MKD, YB, ET, and TAY. The statistical methods were developed by MKD, YB, ET, GM, LKS, and TAY. MKD led the drafting of the manuscript and interpretation of the results. MKD and TAY verified the data. All authors contributed to interpreting the results and the final version of the manuscript. MKD, YB, ET, GM, LKS, and TAY had full access to the data and were responsible for submitting the paper for publication.

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Data availability

The authors are unable to share the data, but it can be obtained from the Kersa HDSS Agency for Shared Services in Education and Research according to the institution's data request and sharing policy.

Declarations

Ethical consideration

The Kersa HDSS has recieved ethical clearance from the national ethical review committees of the Science and Technology Minister of the Federal Democratic Republic of Ethiopia (Ref No. EPHA/OG/1861/15) and the Institutional Health Research Ethical Review Committee (IHRERC) of the College of Health and Medical Sciences, Haramaya University (Ref No. IHRERC/271/2014). Data anonymity was maintained throughout the research process. All study participants provided informed written consent before being included in the HDSS. The study protocol was approved by the Institutional Research Ethics Review Committee (IRERC) at the College of Health and Medical Sciences. A support letter was issued by Haramaya University College of Health and Medical Sciences to the Kersa HDSS administrative office, and an agreement was reached between the

investigators and the organization. Personal information such as names of the mother, father, and children were not collected during data extraction. The extracted data will only be shared with third parties upon reasonable and legal request.

Consent of publication

Not applicable

Competing interest

The authors declare no competing interests.

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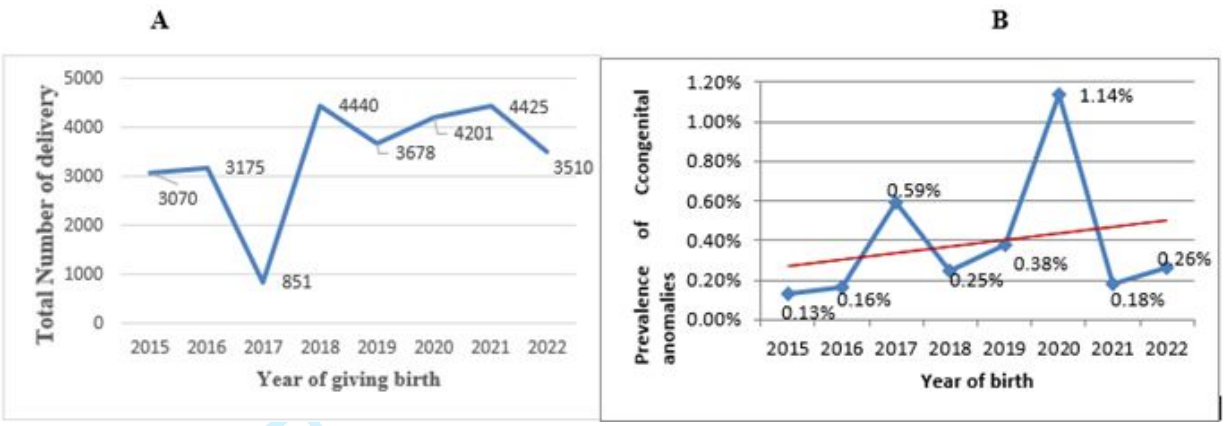

Figure 1: Time trend analysis of the number of deliveries versus the prevalence of congenital anomalies at KHDSS from 2015 to 2022, eastern Ethiopia.

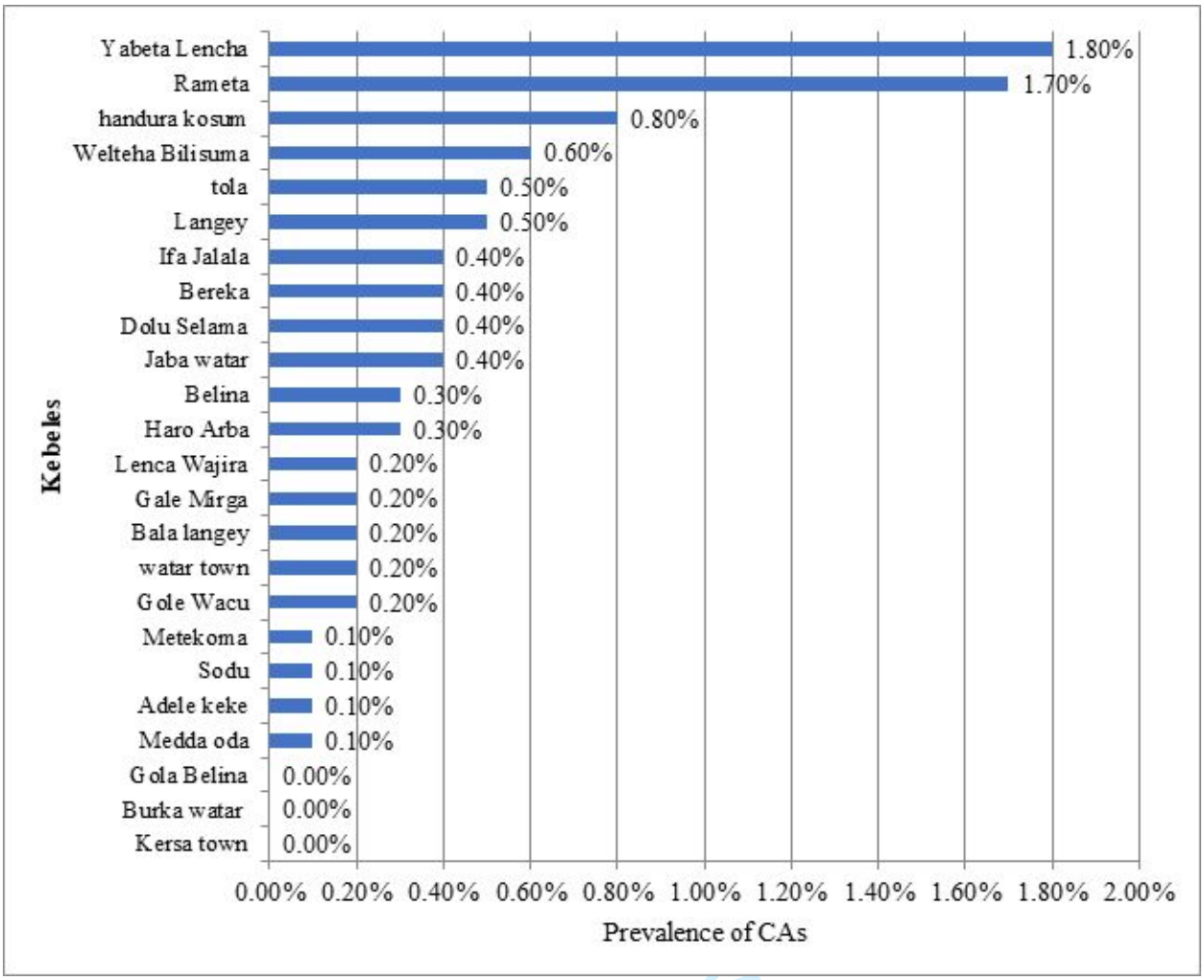

Figure 2: Prevalence of congenital anomalies among Kebeles in KHDSS from 2015 to 2022, eastern Ethiopia.

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Congenital Anomalies Trends and Associated Factors Among Newborns at the Kersa Health and Demographic Surveillance System in Eastern Ethiopia: An Eight-Year Open Cohort Study Analysis.

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Abstract

Objectives: This study aimed to investigate the trends and factors associated with congenital anomalies (CA) among newborns in Eastern Ethiopia.

Design: an open cohort study

Setting: Kersa Health and Demographic Surveillance System (KHDSS) is located in Eastern Ethiopia.

Population: Newborns registered at birth in the database of the Kersa Health and Demographic Surveillance System site in Eastern Ethiopia.

Methods: The Kersa Health and Demographic Surveillance System monitors demographic and health changes in the community. Newborn data at birth was extracted using a checklist. Trends in congenital anomalies over time (measured in years) were analyzed, and associated factors were identified through logistic regression.

Outcome: Newborn congenital anomalies, which are structural or functional abnormalities present at birth, were assessed through thorough physical examinations and detailed interviews conducted by trained data collectors using a standardized questionnaire.

Results: Between 2015 and 2022, a total of 27,350 newborns were recorded in the KHDSS, with 104 of them having congenital anomalies (CA). The overall rate of CA was 3.83 per 1000 live births (95% CI: 3.19-4.61). There was a significant increase in the trends of CA over the study period, with a Mantel-Haenszel $\chi 2 = 82.76$ ($p = 0.001$). Factors associated with CA included maternal age over 35 years (Adjusted Odds Ratio (AOR): 1.68, 95% CI: 1.07, 2.62), place of birth (AOR: 2.04, 95% CI: 1.04, 4.02), and normal birth weight (AOR=0.14, 95% CI: 0.04, 0.47).

Conclusion: The data from the Kersa Health and Demographic Surveillance system revealed a rising trend in congenital anomalies. The CA was associated with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare providers and stakeholders to focus on these factors to reduce the prevalence of congenital anomalies.

Keywords: Congenital anomalies, associated factors, prevalence, new-borns

Strength and Limitations of this Study

- This community-based study with a large sample size provided valuable insights into congenital anomalies in newborns.
- The study provides evidence that has been recorded over a long period of time.
- Unaccounted and residual confounding factors may have influenced the associations found.
- The study did not specify the specific types of congenital anomalies that were observed.

- The true prevalence may have been underestimated by relying only on physical examinations and maternal interviews for diagnosis.

Introduction

Congenital anomalies (CAs) are structural or functional abnormalities that occur during fetal development.[1,2] They can range from minor to major anomalies, with major CAs being a leading cause of death in children under 5.[3] Common types of CAs include neural tube defects, congenital heart disease, cleft lip/palate, and limb defects.[4,5] Causes of CAs include genetic factors, chromosomal disorders, environmental teratogens, and nutrient deficiencies. Early detection and intervention are crucial in managing these conditions.[6]

Globally, the prevalence of major congenital anomalies is approximately 6%.[5] More han 90% are of congenital anomalies occur in low- and middle-income countries and are a significant contributor to neonatal mortality, with about 240,000 neonates dying each year.[7-9] A systematic review of community-based studies on congenital anomalies in eastern Africa showed a prevalence of 4.54 per 1000 children. The range of congenital anomalies varied from 3.97 to 6.08 per 1000 children in the studies included in the review.[10] In South Africa in 2021, the incidence of congenital anomalies was reported to be 2.60 per 1,000 live births.[11]

Congenital anomalies contribute to 20–30% of infant mortality,[12] and 20% of stillbirth.[13] According to the 2015 World Health Statistics, approximately 303,000 newborns die each year globally due to CA before they reach 1 month of age.[14] Apart from stillbirth and neonatal death, CA can lead to lifelong mental and physical disabilities for survivors, affecting not only the community but also individuals and families.[15] Families dealing with congenital anomalies may face psychological challenges like stress and guilt, economic difficulties, and caregiving challenges due to the high level of care and support needed.[16]

A study found that mothers under 20 or over 35 years old [17,18], those who use medication during early pregnancy,[17,19,20] consume alcohol or chew Khat,[19] are exposed to chemicals,[18] have chronic diseases during pregnancy or before conception,[17] have inadequate antenatal care follow-up,[21] have gestational age below 28 weeks or above 40 weeks are at higher risk of congenital anomalies. Conversely, a history of iron folate use before and during pregnancy, and living in urban areas were associated with a lower risk of congenital anomalies.[18]

Ensuring high-quality antenatal care, skilled birth attendance, and proper care for small and sick newborns can help reduce birth defects and neonatal mortality.[22] Certain congenital anomalies can be prevented through measures such as vaccination, folic acid intake, and iodine supplementation.[1,23]

It is essential to integrate prevention and care for congenital anomalies into existing maternal, reproductive, and child health services.[24]

Health and demographic surveillance systems (HDSS) have become a crucial source of representative data for evidence generation, particularly in rural areas and countries with weak vital registration systems. Unlike facility-based studies or Demographic and Health Surveys, HDSS offers longitudinal data on a known and stable target population, allowing for the analysis of trends and changes in mortality determinants for tailored interventions. Unfortunately, research on CA in Ethiopia are often limited to health facilities and lack appropriate denominators, reducing their applicability.[4,17-20] Therefore, there is a pressing need for more comprehensive evidence that can illustrate the evolution of CA and identify the related factors. This study aims to analyze trends and associated factors of CA in Kersa HDSS from 2015 to 2022.

Methods

This paper is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE; online supplemental appendix A) [25]

Study setting, design, and period

An open cohort study design was conducted using data from the Kersa Health and Demographic Surveillance System (KHDSS) in eastern Ethiopia, which is affiliated with the College of Health and Medical Sciences at Haramaya University. The KHDSS is located in the Kersa district of eastern Ethiopia, which consists of 38 Kebeles, including 36 rural Kebeles and two small towns. The Kersa HDSS was established in 12 Kebeles in 2007 and expanded to include another 12 Kebeles in 2015. A Kebele is the smallest administrative unit in Ethiopia, typically consisting of around 1500 households, and is responsible for providing basic services such as education, healthcare, agriculture, water, and rural infrastructure. Currently, the Kersa HDSS covers 24 Kebeles and collects updated data every 6 months on demographic and health events. The majority of the population in the area are farmers, with some engaged in small trade, government roles, or casual labor. Khat is a prominent cash crop in the region, with wheat, barley, and vegetables being common crops in the highland areas, and sorghum, maize, and potatoes in the lowland areas.[26] This study analyzed trends and associated factors of CA in Kersa HDSS from 2015 to 2022.

Study Population and eligibility ciritera

The Kersa HDSS is a cohort study that collects health and demographic data to monitor changes in a stable population. It tracks demographic and health events at regular intervals and updates information every six months. The study includes all newborns registered in the Kersa HDSS area

between January 1, 2015, and December 31, 2022. Temporary visitors or those residing in the area for less than 6 months are not considered residents and are excluded from the study.

Study variables

This study examines newborn congenital anomalies as outcome variables, with independent variables including socio-demographic factors (marital status, age, sex, education, and occupation of parents), maternal factors (antenatal care, parity, place of delivery), and neonatal factors (gestational age, birth weight).

Measurement and data collection method

The KHDSS questionnaire covers a wide range of information, including morbidity surveillance, mortality registration, child immunization records, economic details, housing conditions, migration history, pregnancy monitoring, and pregnancy outcomes. The variables for this study were selected based on a literature review. Data is collected twice a year using Omicron Delta Kappa (ODK) by trained staff through face-to-face interviews, physical examinations, and electronic birth weight measurements.[26] Field supervisors ensure data quality by checking GPS coordinates, response consistency, and validity before transferring it to the Open HDSS database. Any errors are corrected by supervised data collectors. The collected data is initially stored on ODK aggregate, reviewed by the data manager, and then migrated to the final Open HDSS database. The study focused on congenital anomalies (CAs) as the outcome variable. Congenital anomalies are structural or functional defects present at birth that originate during prenatal development. In this study, the diagnosis of congenital anomalies was based on physical examination and interviews with the mother or caregiver. If a congenital anomaly was reported, detailed information on functional and structural abnormalities was collected through physical examinations and interviews conducted by trained data collectors using a standard questionnaire within four weeks of delivery. The CAs variable was categorized as 'congenital anomaly' or 'no congenital anomalies', with 'congenital anomaly' assigned a value of "1" and 'no congenital anomalies' a value of "0". Birth weight was measured using an electronic scale immediately after birth..

Data processing and analysis

The data from the HDSS database was exported to SPSS version 26 for analysis. The study aimed to track changes in congenital anomalies over time (measured in years) by analyzing data from January 1, 2015, to December 31, 2022. Descriptive statistics and a chi-square test were used to compare observed and expected trends in congenital anomalies each year. The Mantel-Haenszel chi-square test was used to assess linear trends in the proportion of newborns with congenital anomalies. Participant characteristics such as the mother's age, place of delivery, father's educational and

occupational status, antenatal care, birth weight, and mother's educational status were considered in the analysis. Binary logistic regression analysis was conducted to select explanatory variables for the final model with a p-value of 0.25 and a 95% confidence interval. Variables with a p-value less than 0.25 in the bivariate analysis were included in the multivariate analysis to control for confounders. Factors associated with congenital anomalies were identified using multivariable logistic regression analysis, and adjusted odds ratios (AOR) with a 95% confidence interval were calculated. A p-value of <0.05 was considered statistically significant. Multi-collinearity was assessed using the variance inflation factor (VIF) for all independent variables. The model's goodness of fit was evaluated using the Hosmer and Lemeshow test, with a p-value >0.05 indicating a good fit.

Patient and public involvement

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

Results

Socio-demographic, Maternal, and neonatal characteristics by congenital anomalies

In this study, a total of 27,350 newborns from the KHDSS dataset were analyzed. Among the mothers, 17,186 (62.84%) were in the age group of 20-34 years, while 6,946 (25.39%) were above 35 years old. The majority of mothers, 18,967 (69.34%), had no formal education. Additionally, 24,351 (89.03%) of the community members in the study area had a family size of six or more. In this study, 12,630 (46.34%) mothers were multipara at the time of giving birth, 17,534 (64.33%) did not receive antenatal care, and 20,010 (73.44%) gave birth at home. Among the newborns studied, more than half (14,386 or 52.60%) were males. Furthermore, 25,234 (92.26%) of the neonates were born at a gestational age of 37-42 completed weeks, and 23,996 (87.73%) had a normal birth weight (Table 1).

Table 1: Sociodemographic, maternal, and newborn characteristics of study participants by congenital anomalies at KHDSS from January 2015, to December 2022, eastern Ethiopia (n=27,350).

Variable	Characteristics	Congenital anomalies	
		Yes (%)	No (%)
Age of the mother in years	<20	10(0.41)	3,208 (99.59)
	20-34	58 (0.34)	17,128 (99.66)
	≥35	36 (0.52)	6, 910(99.48)
Maternal educational status	No formal education	73 (0.40)	18,894 (99.6)
	Elementary	30(0.4)	7263 (99.6)
	Secondary and above	1(0.1)	1089 (99.9)

Maternal marital status	Married	86 (0.4)	22,993 (99.6)
	Divorced	2 (0.8)	247 (99.2)
	Single	16 (0.4)	3869 (99.6)
	Widowed	0 (0)	137(100)
Maternal occupational status	Farmer	3 (0.4)	834 (99.6)
	Housewife	83 (0.4)	22157 (99.6)
	Student	7 (0.4)	1936(99.6)
	Unemployed	8 (0.5)	1540 (99.5)
	Others	3 (0.4)	779 (99.6)
Educational status of the father	No formal education	70 (0.4)	18, 522(99.6)
	Elementary (1-8)	33 (0.4)	7595 (99.6)
	Highschool (9-12)	1 (0.1)	1, 129(99.9)
	College and above	0 (0)	147 (100)
Occupational status of the father	Farmer	80 (0.4)	20, 519 (99.6)
	Merchant	1 (0.2)	406 (99.8)
	Employed	1 (0.1)	709 (99.9)
	Student	13 (0.3)	4, 079 (99.7)
	Unemployed	7(0.6)	1, 098 (99.4)
	Other	2 (0.5)	435 (99.5)
Family size	≤2	0 (0)	104 (100)
	3-5	10 (0.3)	2, 885 (99.7)
	≥6	94 (0.4)	24, 257 (99.6)
Parity	Primipara	27 (0.4)	6, 345 (99.6)
	Multi-para (2-5)	45 (0.4)	12, 630 (99.6)
	Grand multipara (>5)	32 (0.4)	8, 271 (99.6)
Antenatal care	Yes	44 (0.5)	9, 712 (99.5)
	No	60 (0.3)	17, 534 (99.7)
Place of delivery	Home	77 (0.4)	20, 010(99.6)
	Health center	16 (0.3)	6, 062 (99.7)
	Hospital	10 (0.9)	1, 098 (99.1)
	Other[π]	1 (1.3)	76 (98.7)
Newborn Sex	Male	51 (0.4)	14335 (99.6)
	Female	53 (0.4)	12911 (99.6)
Birth weight	Very small	3(2.1)	142 (97.9)
	Small	61 (1)	1621 (99)
	Normal	72 (0.3)	23, 924 (99.7)
	Big	13(0.8)	1559 (99.2)

Gestational age	<37 weeks	2(0.8)	258 (99.2)
	37-42 weeks	94 (4)	25, 140 (99.6)
	>42 weeks	8 (0.4)	1848 (99.6)
π-private health facilities, trained traditional birth attendants, Health post			

Trends and test for linear trend of Congenital anomalies

The Mantel-Haenszel test was used to determine a linear trend. Between 2015 and 2022, there were 27,350 newborns recorded in the Kersa HDSS, with 104 of them having congenital anomalies. The overall rate of congenital anomalies was 3.83 per 1000 live births (95% CI: 3.19-4.61). The proportion of congenital anomalies among newborns increased from 0.0013 (95% CI: 0.0002–0.002) in 2015 to 0.0025 (95% CI: 0.001–0.004) in 2022. The trend of congenital anomalies was statistically significant with a Mantel-Haenszel $\chi2 = 82.76$ ($p = 0.001$), and the number of congenital anomalies varied over the 8-year period (Table 2).

Table 2. Trends in congenital anomalies adjusted for birth year at the Kersa Health and Demographic Surveillance System in Eastern Ethiopia from January 2015 to December 2022.

Birth Year	CA	Non-CA	Proportion	Mantel-Haenszel (OR)	CI Lower	CI Upper
2015	4	3066	0.001302932	1	0.000214	0.002391
2016	5	3170	0.001574803	1.209925	0.000305	0.00286
2017	5	846	0.005875441	4.5101	0.001934	0.010941
2018	11	4429	0.002477477	1.905086	0.000757	0.004197
2019	14	3664	0.003806417	2.932127	0.001452	0.006938
2020	48	4153	0.011425851	8.803371	0.00702	0.016256
2021	8	4417	0.00180791	1.389308	0.000344	0.003553
2022	9	3501	0.002564103	1.97218	0.001034	0.00462
Total	104	27246	0.003817074	$\chi2=82.76$ ($p=0.0001$)	0.002115	0.005401

$\chi2$: Chi-square; OR: Odds Ratio; p: p-value; CI: Confidence interval

Trend analysis of congenital anomalies

The trend analysis shows a high prevalence of CAs in 2020. with lower prevalence in 2015. The number of delivery was found to be highest in 2018 (4, 440), and 2021 (4, 425) (Figure 1).

Prevalence of congenital anomalies in each kebele

The prevalence of CAs was found to be highest in two kebeles (Yabeta Lencha (1.80%) and Rameta (1.70%)). Whereas, zero prevalence was observed in Burka water, Gola Belina, and Metakoma

kebeles (Figure 2). Whereas, the number of deliveries was relatively higher in Sodu (2, 439), Bala langey (1,860), and Handura Kosum (1,623) kebeles (Figure 2).

Factors associated with Congenital anomalies

In bivariable binary logistic regression, seven variables had a p-value less than 0.25 in the bivariate analysis and were identified as potential factors for multivariable binary logistic regression. These variables include antenatal care follow-up status, educational status of the father and mother, place of birth, age of the mother, occupational status of the mother, and birth weight. The Adjusted Odds Ratios (AOR) were calculated to determine the relative contribution of each factor to congenital anomalies. The analysis revealed that newborns with normal birth weight had a 86% lower risk of developing congenital anomalies compared to those with low birth weight (AOR=0.14, 95% CI: 0.04, 0.47). Additionally, newborns born to mothers older than 35 years had a 68% higher odds of having congenital anomalies compared to those born to mothers aged 20-24 (AOR: 1.68, 95% CI: 1.07, 2.62). Furthermore, newborns born in hospitals had a 2.04 times higher odds of having congenital anomalies compared to those born at home (AOR: 2.04, 95% CI: 1.04, 4.02). The model was found to fit the data well based on the Hosmer and Lemeshow test (p-value=0.100) (Table 3).

Table 3: Bivariable and multivariable logistic regression analysis to identify factors associated with congenital anomalies in newborns at KHDSS, eastern Ethiopia from January 2015 to December 2022.

Variables	Characteristics	Congenital anomalies		COR (95% CI)	p-value	AOR (95% CI)	p-value
		Yes (%)	No (%)				
Age of the mother	<20	10(0.31)	3,208 (99.59)	1.61 (0.95,2.73)	.076	0.79 (0.39, 1.58)	.510
	20-34	58 (0.34)	17,128(99.66)	1			
	≥35	36 (0.52)	6, 910(99.48)	1.56 (0.98,2.48)	.063	**1.68(1.07, 2.62)**	.023*
Place of delivery	Home	77 (0.4)	20010(99.6)	1		1	
	Health center	16 (0.3)	6062 (99.7)	0.69(0.40,1.18)	.171	0.68 (0.39,1.18)	.174
	Hospital	10 (0.9)	1098 (99.1)	2.37 (1.22)	.011*	**2.04 (1.04, 4.02)**	.039*
	Other	1 (1.3)	76 (98.7)	3.42 (0.47)	.225	3.34 (0.45,24.65)	.236
Educational status of the father	No formal education	70 (0.4)	18, 522(99.6)	1		1	
	Elementary (1-8)	33 (0.4)	7595 (99.6)	1.15 (0.76,1.74)	.510	2.44 (0.76, 7.88)	.133
	Highschool (9-12)	1 (0.1)	1129(99.9)	0. 23(0.03,1.69)	.150	0.32 (0.01,1456)	.826
Occupational status of the father	Farmer	80 (0.4)	20, 519 (99.6)	1		1	
	Merchant	1 (0.2)	406 (99.8)	0.63 (0.09,4.55)	.648	0.49 (0.66, 3.64)	.485
	Employed	1 (0.1)	709 (99.9)	0.36 (0.05,2.60)	.313	0.48 (0.06, 3.64)	.480
	Student	13 (0.3)	4079 (99.7)	0.82 (0.45,1.47)	.501	1.01 (0.53, 1.88)	.997

	Unemployed	7(0.6)	1098 (99.4)	1.64 (0.75,3.55)	.214	1.93 (0.86, 4.34)	.111
	Other	2 (0.5)	435 (99.5)	1.18 (0.29,4.81)	.818	3.34 (0.45,24.65)	.236
Antenatal care	Yes	44 (0.5)	9712 (99.5)			1	
	No	60 (0.3)	17534 (99.7)	0.76 (0.51,1.12)	.158	0.69 (0.46, 1.03)	0.069
Birth weight	Very small	3(2.1)	142 (97.9)	1			
	Small	61 (1)	1621 (99)	0.48 (0.14,1.66)	.231	0.48 (0.14,1.67)	.248
	Normal	72 (0.3)	23924 (99.7)	0.15 (0.05,0.47)	.001*	**0.14 (0.04, 0.47)**	.001*
	Big	13(0.8)	1559 (99.2)	0.44 (0.12,1.56)	.150	0.42 (0.12, 1.50)	.183
Educational status of mother	No formal education	73 (0.40)	18,894 (99.6)	1			
	Elementary	30(0.4)	7263 (99.6)	1.07(0.70,1.64)	.759	.52(0.16,1.71)	.284
	Secondary and above	1(0.1)	1089 (99.9)	0.24 (0.03,1.71)	.154	.93 (0.01, 4159)	.986

**AOR significant at p<0.05.*

AOR, adjusted OR; COR, crude OR; CI: Confidence interval

Discussion

This study analyzed 27,350 newborns at Kersa Health and Demographic Surveillance System in eastern Ethiopia revealed a prevalence of congenital anomalies at 0.38%. The study also observed a significant increasing trend in congenital anomalies from 2015 to 2022 (Mantel-Haenszel $\chi 2 = 82.76$, $p = 0.001$). Factors such as maternal age over 35 years, place of birth, and birth weight showed statistically significant associations with congenital anomalies.

The prevalence of congenital anomalies in newborns was 3.83 per 1000 live births, which is lower than rates reported in studies from China,[27] and worldwide.[28] This difference may be due to variations in inclusion criteria. In China, all births, including live births, early fetal losses, stillbirths, and early neonatal deaths, are recorded. Additionally, differences in screening criteria may also contribute to the discrepancy. Physical examination and interviews are used for diagnosis, but only around 30% of congenital malformations can be reliably diagnosed this way.[29,30] This study did not include stillbirths and terminated pregnancies, the assessment only covers the first few weeks of life, and physical examination and interviews were used for diagnosis limiting the prevalence rate estimates.

The study found a rise in the prevalence of congenital anomalies (CAs) from 2015 to 2022, peaking at 1.4% in 2020. This increase aligns with a study in China showing a significant increase in the live birth rate of infants with CAs born before 28 gestational weeks.[27] The study also indicated that the

prevalence of chromosomal abnormalities, which can cause congenital anomalies in newborns, has been increasing in recent years.[31] Factors such as increasing in maternal age,[32,33] and increased exposure to environmental factors are believed to contribute to this upward trend in CA prevalence. Improving the accessibility of maternity care mainly preconception,[34] and antenatal care,[35] could reduce the rates of CAs.

The increased prevalence of CAs in 2020 may be attributed to the impact of the Covid-19 pandemic on healthcare services, particularly maternal healthcare.[36] Strengthening maternal health services during epidemics can help reduce neonatal morbidity.[37] One possible contributing factor could be the distance of residency from health facilities, as previous studies in Ethiopia have shown that kebeles far from healthcare facilities have limited access to maternity care.[38] Consanguinity may also be a significant factor in the high rates of malformations and should be considered in genetic counseling.[39] Despite lower overall delivery numbers, two kebeles (Yabeta Lencha and Rameta) had higher rates of CAs, highlighting the need for further research to investigate the underlying causes of this disparity.

In this study, neonates born to mothers over 35 years old were 1.68 times more likely to have congenital anomalies compared to those born to mothers aged 20-34 years. Similar findings have been reported in studies from different countries, indicating a higher risk of congenital anomalies with increased maternal age.[17,18,40] The increased risk of congenital anomalies after 35 years of age may be attributed to the higher likelihood of chromosomal anomalies and accumulated environmental exposures over time.[40] Therefore, it is crucial to improve screening services for pregnant women over 35 years old to mitigate the risk of congenital anomalies and associated complications.

This study also found a correlation between birth weight and newborn congenital anomalies. The findings of this study are consistent with research conducted in different parts of the world.[41] Monitoring birth weight is a simple way to assess prenatal health in a population.[42] Women born with low birth weight are more likely to give birth to low birth weight infants, perpetuating a cycle of malnutrition and poverty across generations.[43] Maternal malnutrition, particularly micronutrient deficiencies, is believed to be a significant factor in intrauterine growth restriction (IUGR).[44] Another study reported that 71.04% of patients with congenital anomalies had a birth weight less than 2.5 kg.[45] The relationship between birth weight and congenital malformations is complex and influenced by factors such as maternal medical conditions like hypertension, diabetes, and infections. Previous studies in Ethiopia have identified factors such as maternal age under 20 years, inter-pregnancy interval under 24 months, low body mass index, gestational age under 37 weeks, maternal educational status, parity as associated with low birth weight, and lack of antenatal care follow-up.[7,46,47]

Enhancing women's empowerment through education and socioeconomic status, and quality maternal care can help decrease the likelihood of low birth weight and congenital anomalies.[46]

This study found that hospital deliveries are linked to congenital anomalies, but this association may not be directly related to the risk of hospitals causing congenital anomalies. Women with complicated pregnancies are more likely to give birth in a hospital due to the presence of specialists and equipment to monitor and treat complications.[48] Factors such as maternal history of previous congenital anomalies, parental consanguinity, and history of medical disorders were important factors associated with congenital anomalies, [49] which may also influence the decision to opt for hospital deliveries.

Congenital anomalies can lead to long-term disability, creating physical, financial, and emotional burdens for families. In high-income countries, approximately 70% of congenital disorders can be prevented or effectively treated. [50,51] However, low-income countries require a comprehensive set of interventions to address these issues. Prevention strategies include vaccinations, folic acid or iodine supplementation, and adequate prenatal care. Preconception and peri-conception healthcare, including genetic screening and counseling, are crucial for identifying and managing congenital anomalies. Screening during the neonatal period is also essential for early detection and treatment.

It is crucial to improve the quality of antenatal care to reduce the incidence of congenital anomalies. By providing high-quality antenatal care, healthcare professionals and stakeholders can advise pregnant women on maintaining proper nutrition, following recommended supplementation, monitoring maternal weight regularly, and taking necessary actions for high-risk individuals [52]. Prenatal screening using ultrasound can help diagnose congenital anomalies before birth. This screening is a common practice in routine prenatal care and has been used for many years. Detecting these anomalies early on can lead to better management of the pregnancy and the baby's health.[53,54] In Ethiopia, widespread ultrasound-based screening for congenital anomalies is not currently in place, but implementing such screening could significantly enhance the management of these conditions.

Community-based HDSS provide valuable longitudinal data on a stable population, improving representativeness. Research on congenital anomalies in Ethiopia is often limited to health facilities, lacking representative samples. This study examined congenital anomalies in newborns within the community with a large sample size, aligning with world health organization (WHO) recommendations to strengthen surveillance systems. However, the study is observational and cannot establish causality. There may be unaccounted confounding factors contributing to congenital anomalies, and the types of anomalies observed were not specified. Relying solely on physical examinations and maternal interviews for diagnosis may have underestimated the true prevalence of congenital anomalies. Incorporating genetic tests and ultrasound alongside physical examinations

and interviews could enhance the assessment of congenital anomalies for more effective intervention strategies.

Conclusion

The data from the Kersa Health and Demographic Surveillance system revealed a rising trend in congenital anomalies. This trend was associated with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on developing strategies that target these factors to reduce the prevalence of congenital anomalies effectively.

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Ethical approval: The Kersa HDSS has recieved ethical clearance from the national ethical review committees of the Science and Technology Minister of the Federal Democratic Republic of Ethiopia (Ref No. EPHA/OG/1861/15) and the Institutional Health Research Ethical Review Committee (IHRERC) of the College of Health and Medical Sciences, Haramaya University (Ref No. IHRERC/271/2014). Data anonymity was maintained throughout the research process. All study participants provided informed written consent before being included in the HDSS. The study protocol was approved by the Institutional Research Ethics Review Committee (IRERC) at the College of Health and Medical Sciences. A support letter was issued by Haramaya University College of Health and Medical Sciences to the Kersa HDSS administrative office, and an agreement was reached between the investigators and the organization. Personal information such as names of the

mother, father, and children were not collected during data extraction. The extracted data will only be shared with third parties upon reasonable and legal request.

Data availability: The authors are unable to share the data, but it can be obtained from the Kersa HDSS Agency for Shared Services in Education and Research according to the institution's data request and sharing policy.

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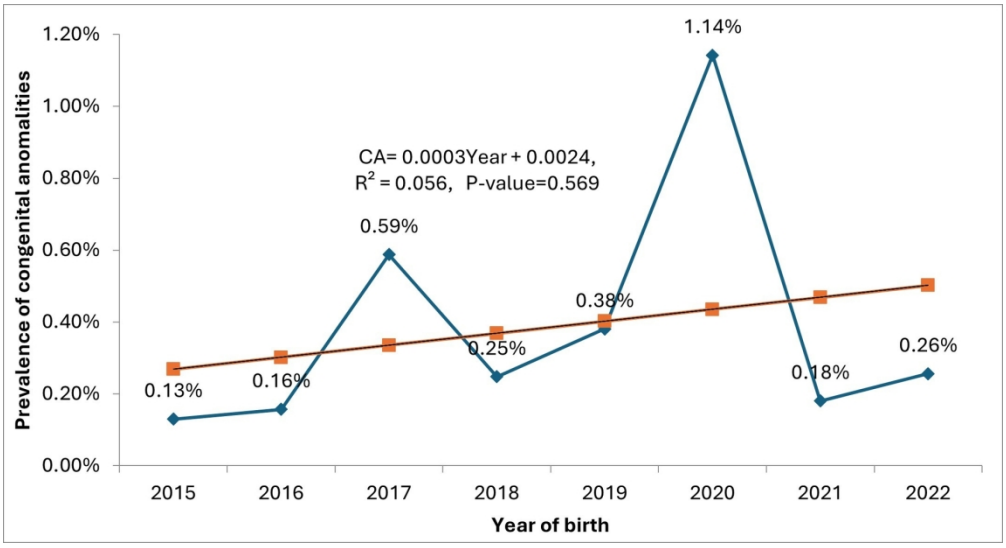
Figure 1. Trend of congenital anomalies in newborns at Kersal Health and Demographic Surveillance System in Eastern Ethiopia: an eight-year open cohort analysis from January 2015 to December 2022.

552 Figure 2. Prevalence of congenital anomalies in newborns in Kebeles found at Kersal Health and
553 Demographic Surveillance System in Eastern Ethiopia: an eight-year open cohort analysis from
554 January 2015 to December 2022.



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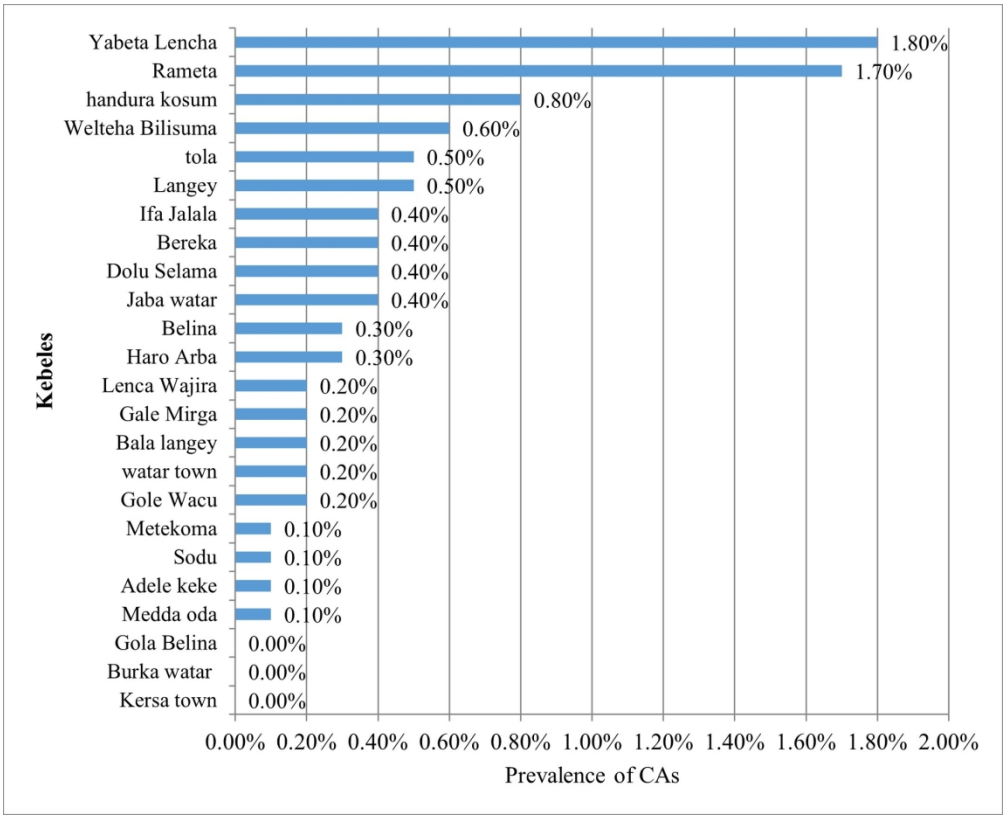

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Trends in congenital anomalies and associated factors among newborns in Eastern Ethiopia: an 8-year open cohort analysis of the Kersa Health and Demographic Surveillance System

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Abstract

Objectives: This study aimed to investigate the trends and factors associated with congenital anomalies (CAs) among newborns in Eastern Ethiopia, from 2015 to 2022.

Design: Open cohort study

Setting: The Kersa Health and Demographic Surveillance System (KHDSS), which is located in the Kersa district of the Oromia region in Eastern Ethiopia, covering 24 kebeles.

Population: Newborns registered at birth in the database of the KHDSS site in Eastern Ethiopia.

Methods: The KHDSS tracks demographic and health changes in the community. Newborn data at birth was extracted using a checklist. Trends in CAs over time (in years) were analyzed, and associated factors were identified through logistic regression analysis.

Outcome measure: Newborn CAs, which are structural or functional abnormalities present at birth, were assessed through thorough physical examinations and detailed interviews conducted by trained data collectors using a standardized questionnaire.

Results: Between 2015 and 2022, a total of 27,350 newborns were recorded in the KHDSS, 104 with CAs. The overall rate of CAs was 3.83 per 1000 live births (95% CI: 3.19-4.61). There was a significant increase in the trends of CA over the study period, with a Mantel-Haenszel $\chi 2$ of 82.76 ($p = 0.001$). Factors associated with CA included maternal age over 35 years (adjusted odds ratio [AOR]: 1.68, 95% CI: 1.07, 2.62), place of birth (AOR: 2.04, 95% CI: 1.04, 4.02), and normal birth weight (AOR=0.14, 95% CI: 0.04, 0.47).

Conclusion: The data from the KHDSS revealed a rising trend in CAs. CA was associated with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare providers and stakeholders to consider these factors in efforts to reduce the prevalence of CAs.

Keywords: Congenital anomalies, associated factors, prevalence, new-borns

Strengths and limitations of this study

- This community-based study with a large sample size provides valuable insights into congenital anomalies in newborns.
- The study provides evidence covering a substantial time period.
- Unaccounted and residual confounding factors may have influenced the associations found.
- The study did not specify the specific types of congenital anomalies that were observed.
- The true prevalence may have been underestimated by relying only on physical examinations and maternal interviews for diagnosis.

INTRODUCTION

Congenital anomalies (CAs) are structural or functional abnormalities that occur during fetal development.[1,2] They can vary in severity, with major CAs being a leading cause of death in children under 5.[3] Common types of CAs include neural tube defects, congenital heart disease, cleft lip/palate, and limb defects.[4,5] Causes of CAs include genetic factors, chromosomal disorders, environmental teratogens, and nutrient deficiencies. Early detection and intervention are crucial in managing these conditions effectively.[6]

Globally, the prevalence of major congenital anomalies is approximately 6%.[5] More han 90% of congenital anomalies occur in low- and middle-income countries and are a significant contributor to neonatal mortality, with about 240,000 neonates dying each year.[7-9] A systematic review of community-based studies on congenital anomalies in eastern Africa showed a prevalence of 4.54 per 1000 children. The range of congenital anomalies varied from 3.97 to 6.08 per 1000 children in the studies included in the review.[10] In South Africa in 2021, the incidence of congenital anomalies was reported to be 2.60 per 1,000 live births.[11]

Congenital anomalies contribute to 20–30% of infant mortality,[12] and 20% of stillbirth.[13] According to the 2015 World Health Statistics, approximately 303,000 newborns die each year globally due to CA before they reach 1 month of age.[14] These anomalies can also result in lifelong mental and physical disabilities for survivors, affecting not only the community but also individuals and families.[15] Families dealing with congenital anomalies may experience psychological challenges such as stress and guilt, economic difficulties, and caregiving challenges due to the high level of care and support required.[16]

A study found that mothers who are under 20 or over 35 years old [17,18], use medication during early pregnancy,[17,19,20] consume alcohol or chew Khat,[19] are exposed to chemicals,[18] have chronic diseases during pregnancy or before conception,[17] have inadequate antenatal care follow-up,[21] have gestational age below 28 weeks or above 40 weeks are at higher risk of congenital anomalies. On the other hand, a history of iron folate use before and during pregnancy, and living in urban areas were associated with a lower risk of congenital anomalies.[18]

High-quality antenatal care, skilled birth attendance, and proper care for small and sick newborns are crucial in reducing birth defects and neonatal mortality.[22] Certain congenital anomalies can be prevented through measures such as vaccination, folic acid intake, and iodine supplementation.[1,23] It

is essential to integrate prevention and care for congenital anomalies into existing maternal, reproductive, and child health services.[24]

Health and demographic surveillance systems (HDSS) have become a crucial source of representative data for evidence generation, particularly in rural areas and countries with weak vital registration systems. Unlike facility-based studies or Demographic and Health Surveys, HDSS offers longitudinal data on a known and stable target population, allowing for the analysis of trends and changes in mortality determinants for tailored interventions. Unfortunately, research on CA in Ethiopia are often limited to health facilities and lack appropriate denominators, reducing their applicability.[4,17-20] Therefore, there is a pressing need for more comprehensive evidence that can illustrate the evolution of CA and identify the related factors. This study aims to analyze trends and factors associated with CA in the Kersa HDSS from 2015 to 2022.

METHODS

This paper is follows the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE; online supplemental appendix A) [25]

Study design and setting

An open cohort study design was conducted using data from the Kersa Health and Demographic Surveillance System (KHDSS) in eastern Ethiopia, which is affiliated with the College of Health and Medical Sciences at Haramaya University. The KHDSS is located in the Kersa district of the Oromia region in Eastern Ethiopia. The district consists of 38 Kebeles, with 36 being rural and two small towns. The KHDSS was established in 12 Kebeles in 2007 and later expanded to include an additional 12 Kebeles in 2015. A Kebele is the smallest administrative unit in Ethiopia, typically consisting of around 1500 households, and is responsible for providing basic services such as education, healthcare, agriculture, water, and rural infrastructure. Currently, the KHDSS covers 24 Kebeles and collects updated data every 6 months on demographic and health events. The majority of the population in the area are farmers, with some engaged in small trade, government roles, or casual labor. Khat is a prominent cash crop in the region, with wheat, barley, and vegetables being common crops in the highland areas, and sorghum, maize, and potatoes in the lowland areas.[26] This study analyzed trends and associated factors of CA in KHDSS from 2015 to 2022.

Study population and eligibility ciritera

The KHDSS is a cohort study that collects health and demographic data to monitor changes in a stable population. It tracks demographic and health events at regular intervals and updates

information every six months. The study includes all newborns registered in the KHDSS area between January 1, 2015, and December 31, 2022. Temporary visitors or those residing in the area for less than 6 months are not considered residents and are excluded from the study.

Study variables

This study examines newborn congenital anomalies as outcome variables, with independent variables including socio-demographic factors (marital status, age, sex, education, and occupation of parents), maternal factors (antenatal care, parity, place of delivery), and neonatal factors (gestational age, birth weight).

Measurements and data collection

The KHDSS questionnaire covers a wide range of information, including morbidity surveillance, mortality registration, child immunization records, economic details, housing conditions, migration history, pregnancy monitoring, and pregnancy outcomes. The variables for this study were selected based on a literature review. Data is collected twice a year using Omicron Delta Kappa (ODK) by trained staff through face-to-face interviews, physical examinations, and electronic birth weight measurements.[26] Field supervisors ensure data quality by checking GPS coordinates, response consistency, and validity before transferring it to the Open HDSS database. Any errors are corrected by supervised data collectors. The collected data is initially stored on ODK aggregate, reviewed by the data manager, and then migrated to the final Open HDSS database. The study focused on congenital anomalies (CAs) as the outcome variable. Congenital anomalies are structural or functional defects present at birth that originate during prenatal development. In this study, the diagnosis of congenital anomalies was based on physical examination and interviews with the mother or caregiver. If a congenital anomaly was reported, detailed information on functional and structural abnormalities was collected through physical examinations and interviews conducted by trained data collectors using a standard questionnaire within four weeks of delivery. The CAs variable was categorized as 'congenital anomaly' or 'no congenital anomalies', with 'congenital anomaly' assigned a value of "1" and 'no congenital anomalies' a value of "0". We measured the newborn's birth weight using a WHO-recommended calibrated digital scale with a precision of 10g within the first hour of life. The newborn was placed on the scale on a stable surface, covered with a cleaned cloth, and zeroed before placing the undressed baby on it. The weight was recorded in grams once it stabilized. For analysis, birth weight was categorized according to the WHO classification into four groups: normal birth weight (≥2500 g to <4000 g), low birth weight (1500 g to <2500 g), very low birth weight (<1500 g), and big birth weight (≥4.0 kg) .

Data processing and analysis

The data from the HDSS database was exported to SPSS version 26 for analysis. The study aimed to track changes in congenital anomalies over time (measured in years) by analyzing data from January 1, 2015, to December 31, 2022. Descriptive statistics and a chi-square test were used to compare observed and expected trends in congenital anomalies each year. The Mantel-Haenszel chi-square test was used to assess linear trends in the proportion of newborns with congenital anomalies. Participant characteristics such as the mother's age, place of delivery, father's educational and occupational status, antenatal care, birth weight, and mother's educational status were considered in the analysis. Binary logistic regression analysis was conducted to select explanatory variables for the final model with a p-value of 0.25 and a 95% confidence interval. In the multivariate analysis, only variables or categories with a p-value less than 0.25, as identified in the bivariate analysis, were included to control for confounders. Factors associated with congenital anomalies were identified using multivariable logistic regression analysis, and adjusted odds ratios (AOR) with a 95% confidence interval were calculated. A p-value of <0.05 was considered statistically significant. Multi-collinearity was assessed using the variance inflation factor (VIF) for all independent variables. The model's goodness of fit was evaluated using the Hosmer and Lemeshow test, with a p-value >0.05 indicating a good fit.

Patient and public involvement

None.

RESULTS

Sociodemographic, maternal, and neonatal characteristics

In this study, a total of 27,350 newborns from the KHDSS dataset were analyzed. Among the mothers, 17,186 (62.84%) were in the age group of 20-34 years, while 6,946 (25.39%) were above 35 years old. The majority of mothers, 18,967 (69.34%), had no formal education. Additionally, 24,351 (89.03%) of the community members in the study area had a family size of six or more. In this study, 12,630 (46.34%) mothers were multipara at the time of giving birth, 17,534 (64.33%) did not receive antenatal care, and 20,010 (73.44%) gave birth at home. Among the newborns studied, 23,996 (87.73%) had a normal birth weight (Table 1).

Table 1. Sociodemographic, maternal, and newborn characteristics of study participants with and without congenital anomalies at the KHDSS in Eastern Ethiopia from January 2015, to December 2022 (n=27,350)

Variable	Characteristics	Congenital anomalies	
		Yes (%)	No (%)
	<20	10(0.31)	3,208 (99.59)

Age of the mother in years	20-34	58 (0.34)	17,128 (99.66)
	≥35	36 (0.52)	6, 910(99.48)
Maternal educational status	No formal education	73 (0.40)	18,894 (99.6)
	Elementary	30(0.4)	7263 (99.6)
	Secondary and above	1(0.1)	1089 (99.9)
Maternal marital status	Married	86 (0.4)	22,993 (99.6)
	Divorced	2 (0.8)	247 (99.2)
	Single	16 (0.4)	3869 (99.6)
	Widowed	0 (0)	137(100)
Maternal occupational status	Farmer	3 (0.4)	834 (99.6)
	Housewife	83 (0.4)	22157 (99.6)
	Student	7 (0.4)	1936(99.6)
	Unemployed	8 (0.5)	1540 (99.5)
	Others	3 (0.4)	779 (99.6)
Educational status of the father	No formal education	70 (0.4)	18, 522(99.6)
	Elementary (1-8)	33 (0.4)	7595 (99.6)
	Secondary and above	1 (0.1)	1, 129(99.9)
Occupational status of the father	Farmer	80 (0.4)	20, 519 (99.6)
	Merchant	1 (0.2)	406 (99.8)
	Employed	1 (0.1)	709 (99.9)
	Student	13 (0.3)	4, 079 (99.7)
	Unemployed	7(0.6)	1, 098 (99.4)
	Other	2 (0.5)	435 (99.5)
Family size	≤2	0 (0)	104 (100)
	3-5	10 (0.3)	2, 885 (99.7)
	≥6	94 (0.4)	24, 257 (99.6)
Parity	Primipara	27 (0.4)	6, 345 (99.6)
	Multi-para (2-5)	45 (0.4)	12, 630 (99.6)
	Grand multipara (>5)	32 (0.4)	8, 271 (99.6)
Antenatal care	Yes	44 (0.5)	9, 712 (99.5)
	No	60 (0.3)	17, 534 (99.7)
Place of delivery	Home	77 (0.4)	20, 010(99.6)
	Health center	16 (0.3)	6, 062 (99.7)
	Hospital	10 (0.9)	1, 098 (99.1)
	Other$^{\pi}$	1 (1.3)	76 (98.7)
Newborn Sex	Male	51 (0.4)	14335 (99.6)
	Female	53 (0.4)	12911 (99.6)
Birth weight	Very low	3(2.1)	142 (97.9)
	Low	16 (1)	1621 (99)
	Normal	72 (0.3)	23, 924 (99.7)
	Big	13(0.8)	1559 (99.2)
Gestational age	<37 weeks	2(0.8)	258 (99.2)
	37-42 weeks	94 (4)	25, 140 (99.6)
	>42 weeks	8 (0.4)	1848 (99.6)

$^{\pi}$-private health facilities, trained traditional birth attendants, Health post

Trends and test for linear trend of congenital anomalies

The Mantel-Haenszel test was used to determine a linear trend. Between 2015 and 2022, there were 27,350 newborns recorded in the KHDSS, with 104 of them having congenital anomalies. The overall rate of congenital anomalies was 3.83 per 1000 live births (95% CI: 3.19-4.61). The proportion of congenital anomalies among newborns increased from 0.0013 (95% CI: 0.0002–0.002) in 2015 to

0.0025 (95% CI: 0.001–0.004) in 2022. The trend of congenital anomalies was statistically significant with a Mantel-Haenszel $\chi2 = 82.76$ ($p = 0.001$), and the number of congenital anomalies varied over the 8-year period (Table 2).

Table 2. Trends in congenital anomalies adjusted for birth year at the KHDSS in Eastern Ethiopia from January 2015 to December 2022

Birth Year	CA	Non-CA	Proportion	CI Lower	CI Upper	Mantel-Haenszel (OR)
2015	4	3066	0.001302932	0.000214	0.002391	1
2016	5	3170	0.001574803	0.000305	0.00286	1.209925
2017	5	846	0.005875441	0.001934	0.010941	4.5101
2018	11	4429	0.002477477	0.000757	0.004197	1.905086
2019	14	3664	0.003806417	0.001452	0.006938	2.932127
2020	48	4153	0.011425851	0.00702	0.016256	8.803371
2021	8	4417	0.00180791	0.000344	0.003553	1.389308
2022	9	3501	0.002564103	0.001034	0.00462	1.97218
Total	104	27246	0.003817074	0.002115	0.005401	$\chi2$=82.76 (p=0.0001)

$\chi2$: Chi-square; OR: Odds Ratio; p: p-value; CI: Confidence interval

Trend analysis of congenital anomalies

The trend analysis shows a high prevalence of CAs in 2020. with lower prevalence in 2015. The number of delivery was found to be highest in 2018 (4, 440), and 2021 (4, 425) (Figure 1).

Prevalence of congenital anomalies in each kebele

The prevalence of CAs was found to be highest in two kebeles (Yabeta Lencha (1.80%) and Rameta (1.70%)). Whereas, zero prevalence was observed in Burka water, Gola Belina, and Metakoma kebeles (Figure 2). Whereas, the number of deliveries was relatively higher in Sodu (2, 439), Bala langey (1,860), and Handura Kosum (1,623) kebeles (Figure 2).

Factors associated with congenital anomalies

In bivariable binary logistic regression, seven variables had a p-value less than 0.25 in the bivariate analysis and were identified as potential factors for multivariable binary logistic regression. These variables include antenatal care follow-up status, educational status of the father and mother, place of birth, age of the mother, occupational status of the mother, and birth weight. The Adjusted Odds Ratios (AOR) were calculated to determine the relative contribution of each factor to congenital anomalies. The analysis revealed that newborns with normal birth weight had a 86% lower risk of

developing congenital anomalies compared to those with low birth weight (AOR=0.14, 95% CI: 0.04, 0.47). Additionally, newborns born to mothers older than 35 years had a 68% higher odds of having congenital anomalies compared to those born to mothers aged 20-24 (AOR: 1.68, 95% CI: 1.07, 2.62). Furthermore, newborns born in hospitals had a 2.04 times higher odds of having congenital anomalies compared to those born at home (AOR: 2.04, 95% CI: 1.04, 4.02). The model was found to fit the data well based on the Hosmer and Lemeshow test (p-value=0.100) (Table 3).

Table 3. Bivariable and multivariable logistic regression analysis to identify factors associated with congenital anomalies in newborns at the KHDSS, Eastern Ethiopia, from January 2015 to December 2022

Variables	Characteristics	Congenital anomalies		COR (95% CI)	p-value	AOR (95% CI)	p-value
		Yes (%)	No (%)				
Age of the mother	<20	10(0.31)	3,208 (99.59)	1.61 (0.95,2.73)	0.076	0.79 (0.39, 1.58)	0.510
	20-34	58 (0.34)	17,128(99.66)	1			
	≥35	36 (0.52)	6, 910(99.48)	1.56 (0.98,2.48)	0.063	**1.68 (1.07, 2.62)**	0.023*
Place of delivery	Home	77 (0.4)	20010(99.6)	1		1	
	Health center	16 (0.3)	6062 (99.7)	0.69 (0.40,1.18)	0.171	0.68 (0.39,1.18)	0.174
	Hospital	10 (0.9)	1098 (99.1)	2.39 (1.29,4.43)	0.011*	**2.04 (1.04, 4.02)**	0.039*
	Other	1 (1.3)	76 (98.7)	3.42 (0.47,24.44)	0.225	3.34 (0.45,24.65)	0.236
Educational status of the father	No formal education	70 (0.4)	18, 522(99.6)	1		1	
	Elementary (1-8)	33 (0.4)	7595 (99.6)	1.15 (0.76,1.74)	0.510	2.44 (0.76, 7.88)	0.133
	Secondary and above	1 (0.1)	1129(99.9)	0. 23 (0.03,1.69)	0.150	0.32 (0.01,1.45)	0.826
Occupational status of the father	Farmer	80 (0.4)	20, 519 (99.6)	1		1	
	Merchant	1 (0.2)	406 (99.8)	0.63 (0.09,4.55)	0.648	0.49 (0.66, 3.64)	0.485
	Employed	1 (0.1)	709 (99.9)	0.36 (0.05,2.60)	0.313	0.48 (0.06, 3.64)	0.480
	Student	13 (0.3)	4079 (99.7)	0.82 (0.45,1.47)	0.501	1.01 (0.53, 1.88)	0.997
	Unemployed	7(0.6)	1098 (99.4)	1.64 (0.75,3.55)	0.214	1.93 (0.86, 4.34)	0.111
	Other	2 (0.5)	435 (99.5)	1.18 (0.29,4.81)	0.818	3.34 (0.45,24.65)	0.236
Antenatal care	Yes	44 (0.5)	9712 (99.5)			1	
	No	60 (0.3)	17534 (99.7)	0.76 (0.51,1.12)	0.158	0.69 (0.46, 1.03)	0.069
Birth weight	Very low	3(2.1)	142 (97.9)	1			
	Low	16 (1)	1621 (99)	0.48 (0.14,1.66)	0.231	0.48 (0.14,1.67)	0.248
	Normal	72 (0.3)	23924 (99.7)	0.15 (0.05,0.47)	0.001*	**0.14 (0.04, 0.47)**	0.001*
	Big	13(0.8)	1559 (99.2)	0.44 (0.12,1.56)	0.150	0.42 (0.12, 1.50)	0.183
Educational status of mother	No formal education	73 (0.40)	18,894 (99.6)	1			
	Elementary	30(0.4)	7263 (99.6)	1.07 (0.70,1.64)	0.759	0.52 (0.16,1.71)	0.284

	Secondary and above	1(0.1)	1089 (99.9)	0.24 (0.03,1.71)	0.154	0.93 (0.01, 4.15)	0.986

**AOR significant at p<0.05.*

AOR, adjusted OR; COR, crude OR; CI: Confidence interval.

DISCUSSION

This study analyzed data from 27,350 newborns from the KHDSS in Eastern Ethiopia revealed a prevalence of congenital anomalies at 0.38%. The study also observed a significant increasing trend in congenital anomalies from 2015 to 2022 (Mantel-Haenszel $\chi 2 = 82.76$, $p = 0.001$). Factors such as maternal age over 35 years, place of birth, and birth weight showed statistically significant associations with congenital anomalies.

The prevalence of congenital anomalies in newborns was 3.83 per 1000 live births, which is lower than rates reported in studies from China,[27] and worldwide.[28] This difference may be due to variations in inclusion criteria. In China, all births, including live births, early fetal losses, stillbirths, and early neonatal deaths, are recorded. Additionally, differences in screening criteria may also contribute to the discrepancy. Physical examination and interviews are used for diagnosis, but only around 30% of congenital malformations can be reliably diagnosed this way.[29,30] This study did not include stillbirths and terminated pregnancies, the assessment only covers the first few weeks of life, and physical examination and interviews were used for diagnosis limiting the prevalence rate estimates.

The study found a rise in the prevalence of congenital anomalies (CAs) from 2015 to 2022, peaking at 1.4% in 2020. This increase aligns with a study in China showing a significant increase in the live birth rate of infants with CAs born before 28 gestational weeks.[27] The study also indicated that the prevalence of chromosomal abnormalities, which can cause congenital anomalies in newborns, has been increasing in recent years.[31] Factors such as increasing in maternal age,[32,33] and increased exposure to environmental factors are believed to contribute to this upward trend in CA prevalence. The critical role of folic acid supplementation in preventing neural tube defects is well-established [34]. However, low coverage of folic acid supplementation[35] and contraceptive utilization, along with high fertility rates[36], may also contribute to an increase in CAs. Improving the accessibility of maternity care mainly preconception,[37] and antenatal care,[38] could reduce the rates of CAs.

The increased prevalence of CAs in 2020 may be attributed to the impact of the Covid-19 pandemic on healthcare services, particularly maternal healthcare.[39] Strengthening maternal health services during epidemics can help reduce neonatal morbidity.[40] One possible contributing factor could be the

distance of residency from health facilities, as previous studies in Ethiopia have shown that kebeles far from healthcare facilities have limited access to maternity care.[41] Consanguinity may also be a significant factor in the high rates of malformations and should be considered in genetic counseling.[42] Despite lower overall delivery numbers, two kebeles (Yabeta Lencha and Rameta) had higher rates of CAs, highlighting the need for further research to investigate the underlying causes of this disparity.

In this study, neonates born to mothers over 35 years old were 1.68 times more likely to have congenital anomalies compared to those born to mothers aged 20-34 years. Similar findings have been reported in studies from different countries, indicating a higher risk of congenital anomalies with increased maternal age.[17,18,43] The increased risk of congenital anomalies after 35 years of age may be attributed to the higher likelihood of chromosomal anomalies and accumulated environmental exposures over time.[43] Therefore, it is crucial to improve screening services for pregnant women over 35 years old to mitigate the risk of congenital anomalies and associated complications.

This study also found a correlation between birth weight and newborn congenital anomalies. The findings of this study are consistent with research conducted in different parts of the world.[44] Monitoring birth weight is a simple way to assess prenatal health in a population.[45] Women born with low birth weight are more likely to give birth to low birth weight infants, perpetuating a cycle of malnutrition and poverty across generations.[46] Maternal malnutrition, particularly micronutrient deficiencies, is believed to be a significant factor in intrauterine growth restriction (IUGR).[47] Another study reported that 71.04% of patients with congenital anomalies had a birth weight less than 2.5 kg.[48] The relationship between birth weight and congenital malformations is complex and influenced by factors such as maternal medical conditions like hypertension, diabetes, and infections. Previous studies in Ethiopia have identified factors such as maternal age under 20 years, inter-pregnancy interval under 24 months, low body mass index, gestational age under 37 weeks, maternal educational status, parity as associated with low birth weight, and lack of antenatal care follow-up.[7,49,50] Enhancing women's empowerment through education and socioeconomic status, and quality maternal care can help decrease the likelihood of low birth weight and congenital anomalies.[49]

This study found that hospital deliveries are linked to congenital anomalies, but this association may not be directly related to the risk of hospitals causing congenital anomalies. Women with complicated pregnancies are more likely to give birth in a hospital due to the presence of specialists and equipment to monitor and treat complications.[51] Factors such as maternal history of previous congenital anomalies, parental consanguinity, and history of medical disorders were important factors associated with congenital anomalies, [52] which may also influence the decision to opt for hospital deliveries.

Congenital anomalies can lead to long-term disability, creating physical, financial, and emotional burdens for families. In high-income countries, approximately 70% of congenital disorders can be prevented or effectively treated. [53,54] However, low-income countries require a comprehensive set of interventions to address these issues. Prevention strategies include vaccinations, folic acid or iodine supplementation, and adequate prenatal care. Preconception and peri-conception healthcare, including genetic screening and counseling, are crucial for identifying and managing congenital anomalies. Screening during the neonatal period is also essential for early detection and treatment.

It is crucial to improve the quality of antenatal care to reduce the incidence of congenital anomalies. By providing high-quality antenatal care, healthcare professionals and stakeholders can advise pregnant women on maintaining proper nutrition, following recommended supplementation, monitoring maternal weight regularly, and taking necessary actions for high-risk individuals [55]. Prenatal screening using ultrasound can help diagnose congenital anomalies before birth. This screening is a common practice in routine prenatal care and has been used for many years. Detecting these anomalies early on can lead to better management of the pregnancy and the baby's health.[56,57] In Ethiopia, widespread ultrasound-based screening for congenital anomalies is not currently in place, but implementing such screening could significantly enhance the management of these conditions.

Community-based HDSS provide valuable longitudinal data on a stable population, improving representativeness. Research on congenital anomalies in Ethiopia is often limited to health facilities, lacking representative samples. This study examined congenital anomalies in newborns within the community with a large sample size, aligning with world health organization (WHO) recommendations to strengthen surveillance systems. However, the study is observational and cannot establish causality. There may be unaccounted confounding factors contributing to congenital anomalies, and the types of anomalies observed were not specified. Relying solely on physical examinations and maternal interviews for diagnosis may have underestimated the true prevalence of congenital anomalies. Incorporating genetic tests and ultrasound alongside physical examinations and interviews could enhance the assessment of congenital anomalies for more effective intervention strategies.

CONCLUSION

The data from the KHDSS revealed a rising trend in congenital anomalies. This trend was associated with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on developing strategies that consider these factors to reduce the prevalence of congenital anomalies effectively.

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Ethical approval: The Kersa HDSS has recieved ethical clearance from the national ethical review committees of the Science and Technology Minister of the Federal Democratic Republic of Ethiopia (Ref No. EPHA/OG/1861/15) and the Institutional Health Research Ethical Review Committee (IHRERC) of the College of Health and Medical Sciences, Haramaya University (Ref No. IHRERC/271/2014). Data anonymity was maintained throughout the research process. All study participants provided informed written consent before being included in the HDSS. The study protocol was approved by the Institutional Research Ethics Review Committee (IRERC) at the College of Health and Medical Sciences. A support letter was issued by Haramaya University College of Health and Medical Sciences to the Kersa HDSS administrative office, and an agreement was reached between the investigators and the organization. Personal information such as names of the mother, father, and children were not collected during data extraction. The extracted data will only be shared with third parties upon reasonable and legal request.

Data availability statement: The authors are unable to share the data, but it can be obtained from the Kersa HDSS Agency for Shared Services in Education and Research according to the institution's data request and sharing policy.

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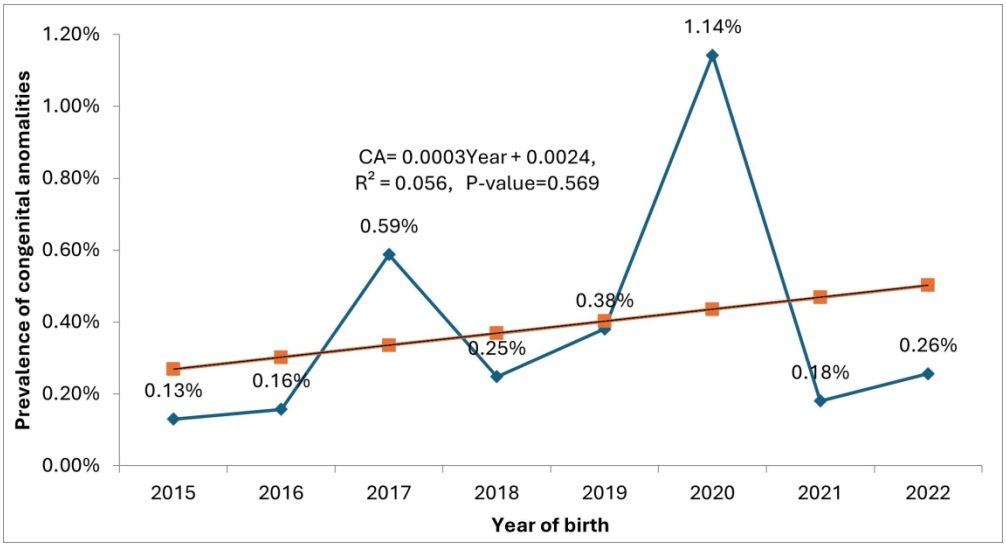
FIGURE TITLES

Figure 1. Trends of congenital anomalies in newborns at Kersal Health and Demographic Surveillance System in Eastern Ethiopia, January 2015 to December 2022

Figure 2. Prevalence of congenital anomalies in newborns by kebele



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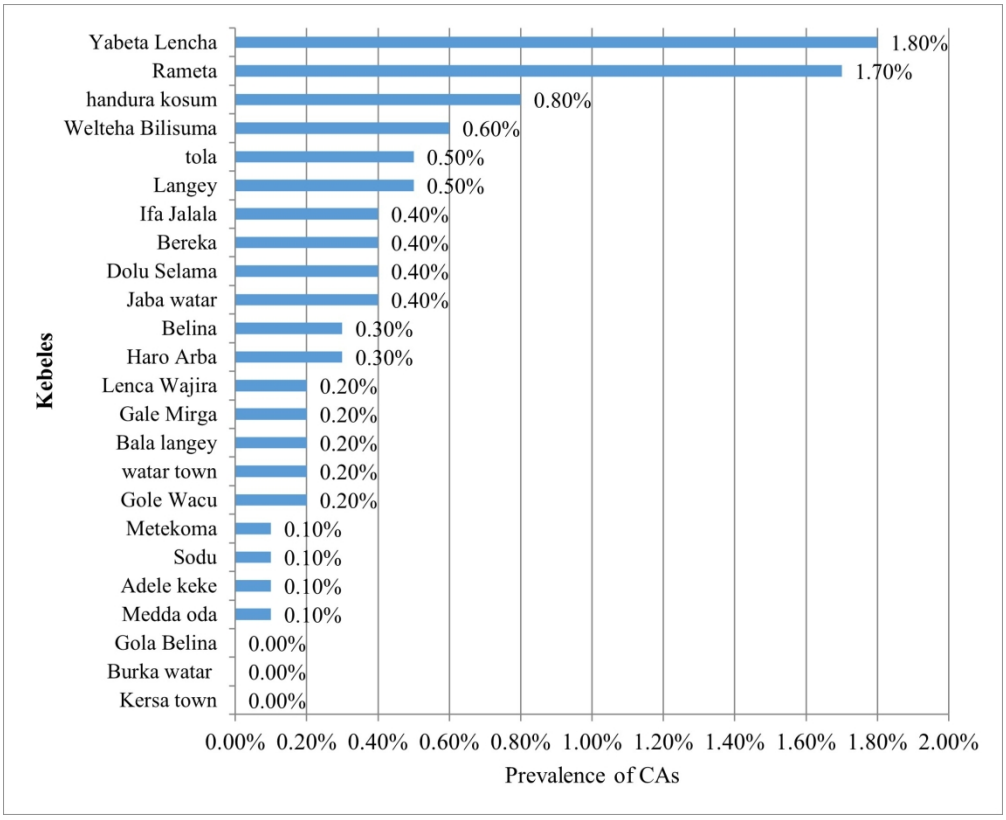

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