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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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Congenital anomalies matters: An analysis of data from the Kersa Health and Demographic Surveillance System in Eastern Ethiopia, a seven-year open cohort study. Muluken Kumera Didisa¹, Yohannes Baye², Eyerusalem Tamiru², Gezaheng Mengesha³, Lencho Kajela Solbana⁴, Tesfaye Assebe Yadeta^{*2} Affiliation and correspondence ¹Hiwot Fana Specialized Hospital, Haramaya, Harar, Ethiopia ²School of Nursing and Midwifery, Haramaya University, Harar, Ethiopia ³Hararghe Health and Demographic Surveillance Systems, Harar, Ethiopia ⁴Department of Nursing, College of Health Sciences, Assosa University, Ethiopia **Authors Email** MkD: didissamuluken@gmail.com YB: yohannesbaye21@gmail.com ET: eyerusalemtamiru9@gmail.com GM: gmange2004@gmail.com LKS: lejch7@gmail.com TAY: tesfaye.assb@gmail.com **Corresponding author** Tesfaye Assebe Yadeta, School of Nursing and Midwifery, College of Health and Medical Sciences,

Haramaya University, Harar, Ethiopia, E-mail tesfaye.assb@gmail.com, P.O. Box. 235, Harar,

Ethiopia

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 33 Health and Demographic Surveillance System from 2015 to 2022. The system tracks demographic 34 and health changes in the community. Data extraction was done using a checklist based on the study 35 objectives and analyzed using SPSS version 26.0. The prevalence of congenital anomalies was 36 determined, and associated factors were identified through binary logistic regression. Statistical 37 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).

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44 Conclusion: The data from the Kersa Health and Demographic Surveillance system revealed a rising 45 trend in congenital anomalies. This trend was associated with factors such as the mother's age, place 46 of birth, and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on 47 these factors to reduce the prevalence of congenital anomalies.

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

49 WHAT IS ALREADY KNOWN ON THIS TOPIC

Page 4 of 20

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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].

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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].

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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

99 Study area

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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 Haramava 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 16 106 18 107 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, 26 110 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 36 114

39 115 **Data collection procedure**

Data collection in the HDSS involves biannual visits to all residents, with updates recorded and 44 117 entered into the database system [23]. Trained HDSS staff use ODK for data collection through face-46 118 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 53 121 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

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

126 **Measurement and variables**

The study focused on congenital anomalies (CAs) as the dependent variable. The independent 127 10 11 12 128 variables included socio-demographic factors (marital status of the mother, age of the mother, sex of 13 ¹⁴ 129 the neonate, educational status of the mother, educational status of the father, occupation of the father, 15 16 130 occupation of the mother), maternal factors (antenatal care visits, parity, place of delivery), and 17 18 19 131 neonatal factors (gestational age, birth weight). Women who had given birth were interviewed every 20 21 132 six months to determine the outcome of their pregnancy (whether there was a congenital anomaly or 22 23 133 a normal birth) and to gather information on any congenital anomalies in household members. 24 25 26 134 Congenital anomalies are anatomical, structural, and functional defects present at birth that originate 27 28 135 during prenatal development [19]. If a congenital anomaly was reported, detailed information on 29 30 functional and structural abnormalities was collected through physical examinations and detailed 136 31 32 137 interviews conducted by trained data collectors using a standard questionnaire with the mother or 33 34 caregiver within four weeks of delivery. The outcome variable was then categorized as either 35 138 36 ³⁷ 139 'congenital anomaly' or 'normal birth', with 'congenital anomaly' assigned a value of "1" and 'normal 38 39 140 birth' a value of "0". Various factors such as socio-demographic (place of residence, mother's 40 41 42 141 education level, wealth index), maternal (age at first birth), and obstetric (parity, place of delivery, 43 44 142 ANC visits) were considered as explanatory variables for the presence of congenital anomalies.

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143 Data processing and analysis 47

49 144 Data from the HDSS database was exported to SPSS version 26 for analysis. Descriptive statistics 50 51 145 were used to summarize the explanatory variables by frequency and percentage. The prevalence of 52 53 146 congenital anomalies (CAs) was calculated as the proportion of newborns with CAs in the HDSS 54 55 56 147 population. Binary logistic regression analysis was conducted to select explanatory variables for the 57 58 148 final model with a p-value of 0.25 and a 95% confidence interval. Variables with a p-value less than 59 60 149 0.25 in the bivariate analysis were included in the multivariate analysis to control for confounders.

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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	<20	10(0.31)	3,208 (99.59)
years	20-34	58 (0.34)	17,128 (99.66)
	≥35	36 (0.52)	6, 910(99.48)

Maternal educational	No formal education	73 (0.40)	18,894 (99.6)
status	Elementary	30(0.4)	7263 (99.6)
	Secondary and above	1(0.1)	1089 (99.9)
Maternal marital	Married	86 (0.4)	22,993 (99.6)
status	Divorced	2 (0.8)	247 (99.2)
	Single	16 (0.4)	3869 (99.6)
	Widowed	0 (0)	137(100)
Maternal	Farmer	3 (0.4)	834 (99.6)
occupational status	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	No formal education	70 (0.4)	18, 522(99.6)
the father	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	Farmer	80 (0.4)	20, 519 (99.6)
of the father	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)

42 170 Prevalence of Congenital anomalies

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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).

5253 174 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 for

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

Prevalence of congenital anomalies in each kebele

10 180 The prevalence of CAs was found to be highest in two kebeles (Yabeta Lencha (1.80%) and Rameta 12 181 (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 17 183 langey (1,860), and Handura Kosum (1,623) kebeles (Figure 2).

Factors associated with Congenital anomalies 25 186

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 32 189 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, 39 192 95% CI: 0.04, 0.47), and born from a mother older than 35 years (AOR: 1.68, 95% CI: 1.07, 2.62) 41 193 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		haracteristics Congenital anomalies COR (95% CI) p-		p-	p- AOR (95% CI)	p-
		Yes (%)	No (%)		value		value	
Age of the	<20	10(0.31)	3,208 (99.59)	1.61 (0.95,2.73)	.076*	0.79 (0.39, 1.58)	.510	
mother	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	Home	77 (0.4)	20010(99.6)	1		1	
delivery	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	No formal	70 (0.4)	18, 522(99.6)	1		1	
status of the	education						
father	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-	1 (0.1)	1129(99.9)	0. 23(0.03,1.69)	.150*	0.32 (0.01,1456)	.826
	12)						
Occupational	Farmer	80 (0.4)	20, 519 (99.6)	1		1	
status of the	Merchant	1 (0.2)	406 (99.8)	0.63 (0.09,4.55)	.648	0.49 (0.66, 3.64)	.485
father	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	Yes	44 (0.5)	9712 (99.5)			1	
care	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	No formal	73 (0.40)	18,894 (99.6)	1			
status of	education						
mother	Elementary	30(0.4)	7263 (99.6)	1.07(0.70,1.64)	.759	.52(0.16,1.71)	.284
	Secondary and	1(0.1)	1089 (99.9)	0.24 (0.03,1.71)	.154*	.93 (0.01, 4159)	.986
	above						

Discussion

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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.

12 203 The prevalence of congenital anomalies at birth was 3.83 per 1000 live births, which is lower than 13 14 204 rates reported in studies from China [7]. This difference could be attributed to variations in inclusion 15 16 17 205 criteria. In China, all births, including live births, early fetal losses, stillbirths, and early neonatal 18 19 206 deaths, are recorded. The prevalence of congenital anomalies in this study was also lower compared 20 21 207 to studies conducted in Latvia [24]. This discrepancy may be due to differences in screening criteria, 22 23 24 208 in Lativia ultrasound screeing was done.

26 27 209 The study revealed an increase in the prevalence of congenital anomalies (CAs) from 2015 to 2022, 28 29 210 reaching a peak of 1.4% in 2020. This increase is consistent with a study in China where the live 30 31 211 birth rate of infants with CAs born before 28 gestational weeks rose significantly [7]. In contrast, a 32 33 212 study in Latvia showed a decreasing trend in CAs [24], attributed to early pregnancy ultrasound 34 35 surveillance and intervention measures in place. The higher prevalence of CAs in 2020 may be linked 36 213 37 ³⁸ 214 to the impact of the Covid-19 pandemic on healthcare services, including maternal healthcare [25]. 39 40 41 215 Strengthening maternal health services during epidemics can help reduce neonatal morbidity [26]. 42 43 216 Despite lower numbers of deliveries, two kebeles (Yabeta Lencha and Rameta) had higher rates of 44 45 217 CAs, indicating the need for further research to understand the causes of this disparity. 46

⁴⁸ 218 In this study, neonates born to mothers over 35 years old were 1.68 times more likely to have 49 50 50 51 219 congenital anomalies compared to those born to mothers aged 20-34 years. Similar findings have 52 been reported in studies from different countries, showing a higher risk of congenital anomalies with 53 220 54 ⁵⁵ 221 increased maternal age. However, a systematic review and meta-analysis in 2021 found weak 56 57 222 57 evidence of this association [27]. A population-based case-control study in Hungary also supported 59 60 223 the link between maternal age \geq 35 years and congenital anomalies [28]. In contrast, a study in Nigeria

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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 232 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. 236 Previous studies in Ethiopia have shown that factors like maternal age under 20 years, interpregnancy 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 239 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 242 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.

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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 17 255

The data from the Kersa Health and Demographic Surveillance system revealed a rising trend in ₂₂ 257 congenital anomalies. This trend was associated with factors such as the mother's age, place of birth, 24 258 and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on ²⁶ 259 developing strategies that target these factors to reduce the prevalence of congenital anomalies effectively.

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Abbreviations 34 262

- ANC: Antenatal care
- 39 264 AOR: Adjusted odds ratio
- 41 265 CAs: Congenital anomalies
- COR: crude odds ration
- 46 267 EDHS: Ethiopian Demographic Health Survey
- ⁴⁸ 268 HDSS: Health and demographic surveillance systems
- KHDSS: Kersa Health and Demographic Survillance System
- 53 270 PNC: postnatal score
- WHO: World health organization

58 272 Acknowledgment

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9 Author's contribution 276 10 11 The study was conceived and designed by MKD, YB, ET, and TAY. The statistical methods were 277 12 13 278 developed by MKD, YB, ET, GM, LKS, and TAY. MKD led the drafting of the manuscript and 14 15 16 279 interpretation of the results. MKD and TAY verified the data. All authors contributed to interpreting 17 18 280 the results and the final version of the manuscript, MKD, YB, ET, GM, LKS, and TAY had full 19 20 281 access to the data and were responsible for submitting the paper for publication. 21 22 23 282 Funding 24 25 283 The authors received no funding for this study. 26 27 284 Data availability 28 29 30 285 The authors are unable to share the data, but it can be obtained from the Kersa HDSS Agency for 31 32 286 Shared Services in Education and Research according to the institution's data request and sharing 33 34 287 policy. 35 36 **Declarations** 37 288 38 39 40 289 **Ethical consideration** 41 42 290 The Kersa HDSS has recieved ethical clearance from the national ethical review committees of the 43 44 291 Science and Technology Minister of the Federal Democratic Republic of Ethiopia (Ref No. 45 46 47 292 EPHA/OG/1861/15) and the Institutional Health Research Ethical Review Committee (IHRERC) of 48 49 293 the College of Health and Medical Sciences, Haramaya University (Ref No. IHRERC/271/2014). 50 51 294 Data anonymity was maintained throughout the research process. All study participants provided 52 53 ₅₄ 295 informed written consent before being included in the HDSS. The study protocol was approved by 55 56 296 the Institutional Research Ethics Review Committee (IRERC) at the College of Health and Medical 57 ⁵⁸ 297 Sciences. A support letter was issued by Haramaya University College of Health and Medical 59 60 298 Sciences to the Kersa HDSS administrative office, and an agreement was reached between the 15

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investigators and the organization. Personal information such as names of the mother, father, and

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300 children were not collected during data extraction. The extracted data will only be sh 301 parties upon reasonable and legal request. 10 302 **Consent of publication** 12 303 Not applicable ¹⁴ 304 **Competing interest** 305 The authors declare no competing interests. 19 306 22 307 REFERENCES 25 308 1. World Health Organization. Congenital disorders; key fact: accesses on 27 Februar 26 309 https://www.hoint/news-room/fact-sheets/detail/birth-defects 20023 ²⁷ 310 2. Reece EA, Eriksson U. Congenital malformations: epidemiology, pathogenesis, an -0 29 311 experimental methods of induction and prevention. Diabetes in Women: Adol 30 312 Pregnancy and Menopause 3rd ed Philadelphia: Lippincott Williams & Wilking Philadelphia 2004:169-204 31 313 32 314 3. Kang L, Cao G, Jing W, et al. Global, regional, and national incidence and mortali 33 315 congenital birth defects from 1990 to 2019. European Journal of Pediatrics ³⁴ 316 2023;182(4):1781-92 317 4. Mekonnen AG, Hordofa AG, Kitila TT, et al. Modifiable risk factors of congenital 36 37 318 malformations in bale zone hospitals, Southeast Ethiopia: an unmatched case-38 319 BMC pregnancy and childbirth 2020;20:1-9 39 320 5. Seyoum G, Adane F. Prevalence and associated factors of birth defects among new 40 321 referral hospitals in Northwest Ethiopia. Ethiopian Journal of Health Develop 41 322 2018;32(3) ⁴² 323 6. World Health Organization. Congenital disorders. Retrieved December 19, 2023, f 44 324 https://www.who.int/news-room/fact-sheets/detail/birth-defects. 2023 45 325 7. Zhang X, Chen L, Wang X, et al. Changes in maternal age and prevalence of cong anomalies during the enactment of China's universal two-child policy (2013-2 46 326 47 327 Zhejiang Province, China: an observational study. PLoS medicine 2020;17(2) 48 328 8. Mashhadi Abdolahi H, Kargar Maher MH, Afsharnia F, et al. Prevalence of conger ⁴⁹ 329 anomalies: a community-based study in the Northwest of Iran. International S 50 330 Research Notices 2014;2014 52 331 9. Bhide P, Gund P, Kar A. Prevalence of congenital anomalies in an Indian maternal 53 332 healthcare, prevention, and surveillance implications. PloS one 2016;11(11):e 54 333 10. World Health Organization. Cardiovascular diseases (CVDs)[Internet]. 2021. Wo 55 334 Organization Available from: http://www.who.int/mediacentre/factsheets/fs3 56 335 11. UNICEF. Levels & Trends in Child Mortality Estimation Child Mortality. Un Igr ⁵⁷ 336 https://www.unicef.org/media/79371/file/UN-IGME-child-mortality-report-20 58 337 2020 59 ₆₀ 338 12. Tiedje LB. Neonatal Survival 1: 4 Million Neonatal Deaths: When? Where? Why 339 American Journal of Maternal/Child Nursing 2007;32(6):386 16

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1 2 340 13. Katiso NA, Kassa GM, Fekadu GA, et al. Prevalence and determinants of low birth weight in 3 341 Ethiopia: a systematic review and meta-analysis. Advances in Public Health 2020;2020:1-4 342 13 5 14. Liu L, Oza S, Hogan D. Global, regional, and national causes of under-5 mortality in 2000–15. 343 6 344 an updated systematic analysis with implications for the Sustainable Development 7 345 8 Goals:388:30273035 9 346 15. Cardoso-dos-Santos AC, Alves RSdM, Medeiros-de-Souza AC, et al. National congenital 10 3 4 7 anomaly registers in the world: historical and operational aspects. Epidemiologia e Serviços 11 348 de Saúde 2021;30:e2021075 12 349 16. Getachew B, Alemayehu T, Abebe S, et al. Prevalence of overt congenital anomalies and 13 14 350 associated factors among newborns delivered at Jimma University medical center, 15 351 Southwest Ethiopia, 2018: a cross-sectional study. International Journal of Africa Nursing Sciences 2023;18:100513 16 352 17 353 17. Mekonen HK, Berhe Y, Berihu BA, et al. A silent epidemic of major congenital malformations 18 3 5 4 in Tigray, northern Ethiopia: hospital-based study. Scientific Reports 2021;11(1):21035 ¹⁹ 355 18. Gedamu S, Sendo EG, Daba W. Congenital anomalies and associated factors among newborns 20 356 in Bishoftu General Hospital, Oromia, Ethiopia: a retrospective study. Journal of 21 22 357 Environmental and Public Health 2021;2021 23 358 19. Taye M, Afework M, Fantaye W, et al. Factors associated with congenital anomalies in Addis 24 3 5 9 Ababa and the Amhara Region, Ethiopia: a case-control study. BMC pediatrics 2018;18:1-25 360 11 ²⁶ 361 20. Birhanu K, Tesfaye W, Berhane M. Congenital anomalies in neonates admitted to a tertiary ²⁷ 362 hospital in Southwest Ethiopia: a cross sectional study. Ethiopian journal of health sciences 28 ²⁰₂₉ 363 2021;31(6) 30 364 21. Penchaszadeh VB. Preventing congenital anomalies in developing countries. Public Health 31 365 Genomics 2002;5(1):61-69 22. World Health Organization. Prevention and control of birth defects in South-East Asia Region: 32 366 33 367 strategic framework (2013-2017): WHO Regional Office for South-East Asia, 2013. ³⁴ 368 23. Assefa N, Oljira L, Baraki N, et al. HDSS profile: the Kersa health and demographic 35 369 surveillance system. International Journal of Epidemiology 2016;45(1):94-101 36 37 370 24. Zile-Velika I, Ebela I, Folkmanis V, et al. Prenatal ultrasound screening and congenital 38 371 anomalies at birth by region: Pattern and distribution in Latvia. European Journal of 39 372 Obstetrics & Gynecology and Reproductive Biology: X 2023:100242 40 373 25. Mebratie AD, Nega A, Gage A, et al. Effect of the COVID-19 pandemic on health service 41 374 utilization across regions of Ethiopia: an interrupted time series analysis of health ⁴² 375 information system data from 2019–2020. PLOS global public health 2022;2(9):e0000843 43 376 26. Tilahun B, Nigusie A, Zelalem M, et al. Effect of COVID-19 pandemic on maternal and child 44 45 377 health services and strategies for effective service implementation in Ethiopia. Journal of 46 378 Multidisciplinary Healthcare 2022:2781-95 47 379 27. Bhalerao A, Garg R. Pattern of congenital anomalies at birth. Int J Obstet Gynaecol Res 48 380 2016;3(7):420-6 ⁴⁹ 381 28. Pethő B, Mátrai Á, Agócs G, et al. Maternal age is highly associated with non-chromosomal 50 382 congenital anomalies: Analysis of a population-based case-control database. BJOG: An 51 52 383 International Journal of Obstetrics & Gynaecology 2023;130(10):1217-25 53 384 29. Ajao AE, Adeoye IA. Prevalence, risk factors and outcome of congenital anomalies among 54 385 neonatal admissions in OGBOMOSO, Nigeria. BMC pediatrics 2019;19:1-10 55 386 30. Kebede A, Kebede A, Belina S, et al. Trends and determinants of small birth weight in 56 387 Ethiopia: further analysis of Ethiopian Demographic and Health Surveys. Ethiopian Journal ⁵⁷ 388 of Health Sciences 2021:31(2) 59 389 31. Endalamaw A, Engeda EH, Ekubagewargies DT, et al. Low birth weight and its associated ₆₀ 390 factors in Ethiopia: a systematic review and meta-analysis. Italian journal of pediatrics 391 2018;44:1-12

2 392 3 393 4 394 5 395 7 396	 Boyle B, Addor M-C, Arriola L, et al. Estimating global burden of disease due to congenital anomaly: an analysis of European data. Archives of Disease in Childhood-Fetal and Neonatal Edition 2018;103(1):F22-F28 Bidondo MP, Groisman B, Duarte S, et al. Prenatal detection of congenital anomalies and related factors in Argentina. Journal of Community Genetics 2020;11(3):313-20
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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.



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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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Primary Subject Heading :	Public health
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Keywords:	Fetal medicine < OBSTETRICS, Postpartum Women < Postpartum Period, Pregnant Women, Pregnancy, Postpartum Period, PAEDIATRICS

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1 2	1	Congenital Anomalies Trends and Associated Factors Among Newborns at the Kersa Health and
3	1 2	Demographic Surveillance System in Eastern Ethionia: An Eight Veer Open Cohort Study Analysis
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6 7	5	Mulukan Kumara Didigal Nahannag Dava ² Evanyadam Tamim ² Carahang Mangasha ³ Lanaha
8	4	Muluken Kumera Didisa ² , Yonannes Baye ² , Eyerusalem Tamiru ² , Gezaneng Mengesna ² , Lencho
9 10	3	Kajela Solbana ⁺ , Testaye Assebe Yadeta ^{*2}
11 12	6	
13	7	Author affiliation
15	8	¹ Hiwot Fana Specialized Hospital, Haramaya University, Harar, Ethiopia
16 17	9	² School of Nursing and Midwifery, Haramaya University, Harar, Ethiopia
18 19	10	³ Hararghe Health and Demographic Surveillance Systems, Harar, Ethiopia
20	11	⁴ Department of Nursing, College of Health Sciences, Assosa University, Assosa, Ethiopia
21 22	12	
23 24	10	
25 26	13	Authors Email
20	14	MkD: <u>didissamuluken@gmail.com</u>
28 29	15	YB: <u>yohannesbaye21(@gmail.com</u>
30 31	16	ET: eyerusalemtamiru9@gmail.com
32	17	GM: <u>gmange2004@gmail.com</u>
33 34	18	LKS: <u>lejch7@gmail.com</u>
35 36	19	TAY: <u>tesfaye.assb@gmail.com</u>
37	20	
38 39	21	Corresponding author
40 41	22	Tesfaye Assebe Yadeta, School of Nursing and Midwifery, College of Health and Medical Sciences,
42 43	23	Haramaya University, Harar, Ethiopia, E-mail tesfaye.assb@gmail.com, P.O. Box. 235, Harar,
44	24	Ethiopia
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1 2 3	31	Abstract
4 5	32	Objectives: This study aimed to investigate the trends and factors associated with congenital
6 7 8 9 10 11 12	33	anomalies (CA) among newborns in Eastern Ethiopia.
	34	Design: an open cohort study
	35	Setting: Kersa Health and Demographic Surveillance System (KHDSS) is located in Eastern
	36	Ethiopia.
13 14	37	Population: Newborns registered at birth in the database of the Kersa Health and Demographic
15	38	Surveillance System site in Eastern Ethiopia.
16 17	39	Methods: The Kersa Health and Demographic Surveillance System monitors demographic and
18 19	40	health changes in the community. Newborn data at birth was extracted using a checklist. Trends in
20 21	41	congenital anomalies over time (measured in years) were analyzed, and associated factors were
22	42	identified through logistic regression.
23 24	43	Outcome: Newborn congenital anomalies, which are structural or functional abnormalities present
25 26	44	at birth, were assessed through thorough physical examinations and detailed interviews conducted by
27 28	45	trained data collectors using a standardized questionnaire.
29	46	Results: Between 2015 and 2022, a total of 27,350 newborns were recorded in the KHDSS, with 104
30 31	47	of them having congenital anomalies (CA). The overall rate of CA was 3.83 per 1000 live births
32 33	48	(95% CI: 3.19-4.61). There was a significant increase in the trends of CA over the study period, with
34 35	49	a Mantel-Haenszel $\chi 2 = 82.76$ (p = 0.001). Factors associated with CA included maternal age over
36	50	35 years (Adjusted Odds Ratio (AOR): 1.68, 95% CI: 1.07, 2.62), place of birth (AOR: 2.04, 95%
37 38	51	CI: 1.04, 4.02), and normal birth weight (AOR=0.14, 95% CI: 0.04, 0.47).
39 40	52	Conclusion: The data from the Kersa Health and Demographic Surveillance system revealed a rising
41 42	53	trend in congenital anomalies. The CA was associated with factors such as the mother's age, place of
43	54	birth, and the baby's birth weight. It is crucial for healthcare providers and stakeholders to focus on
44 45	55	these factors to reduce the prevalence of congenital anomalies.
46 47 48	56	Keywords: Congenital anomalies, associated factors, prevalence, new-borns
49 50	57	Strength and Limitations of this Study
51 52	58	• This community-based study with a large sample size provided valuable insights into
53	59	congenital anomalies in newborns.
54 55	60	• The study provides evidence that has been recorded over a long period of time.
56 57	61	• Unaccounted and residual confounding factors may have influenced the associations found.
58 59 60	62	• The study did not specify the specific types of congenital anomalies that were observed.
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The true prevalence may have been underestimated by relying only on physical examinations
 and maternal interviews for diagnosis.

65 Introduction

 66 Congenital anomalies (CAs) are structural or functional abnormalities that occur during fetal 67 development.^{1,2} They can range from minor to major anomalies, with major CAs being a leading 68 cause of death in children under 5.³ Common types of CAs include neural tube defects, congenital 69 heart disease, cleft lip/palate, and limb defects.^{4,5} Causes of CAs include genetic factors, 70 chromosomal disorders, environmental teratogens, and nutrient deficiencies. Early detection and 71 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}

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6 97 Health and demographic surveillance systems (HDSS) have become a crucial source of representative 7 8 98 data for evidence generation, particularly in rural areas and countries with weak vital registration 9 99 systems. Unlike facility-based studies or Demographic and Health Surveys, HDSS offers longitudinal 10 11 100 data on a known and stable target population, allowing for the analysis of trends and changes in 12 13 101 mortality determinants for tailored interventions. Unfortunately, research on CA in Ethiopia are often 14 15 102 limited to health facilities and lack appropriate denominators, reducing their applicability.^{4,17-20} 16 103 Therefore, there is a pressing need for more comprehensive evidence that can illustrate the evolution 17 18 104 of CA and identify the related factors. This study aims to analyze trends and associated factors of CA 19 20 105 in Kersa HDSS from 2015 to 2022. 21

²² 23 106 Methods

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

²⁹ 109 Study setting, design, and period ³⁰

31 110 An open cohort study design was conducted using data from the Kersa Health and Demographic 32 33 111 Surveillance System (KHDSS) in eastern Ethiopia, which is affiliated with the College of Health and 34 112 Medical Sciences at Haramaya University. The KHDSS is located in the Kersa district of eastern 35 36 113 Ethiopia, which consists of 38 Kebeles, including 36 rural Kebeles and two small towns. The Kersa 37 HDSS was established in 12 Kebeles in 2007 and expanded to include another 12 Kebeles in 2015. 38 114 39 40¹¹⁵ A Kebele is the smallest administrative unit in Ethiopia, typically consisting of around 1500 41 116 households, and is responsible for providing basic services such as education, healthcare, agriculture, 42 43 117 water, and rural infrastructure. Currently, the Kersa HDSS covers 24 Kebeles and collects updated 44 45 118 data every 6 months on demographic and health events. The majority of the population in the area 46 119 are farmers, with some engaged in small trade, government roles, or casual labor. Khat is a prominent 47 48 120 cash crop in the region, with wheat, barley, and vegetables being common crops in the highland areas, 49 and sorghum, maize, and potatoes in the lowland areas.²⁶ This study analyzed trends and associated 50 121 51 ₅₂ 122 factors of CA in Kersa HDSS from 2015 to 2022.

54 123 Study Population and eligibility ciritera 55

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

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

⁶₇ 129 **Study variables**

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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).

1516 134 Measurement and data collection method

17 135 The KHDSS questionnaire covers a wide range of information, including morbidity surveillance, 18 19 136 mortality registration, child immunization records, economic details, housing conditions, migration 20 21 137 history, pregnancy monitoring, and pregnancy outcomes. The variables for this study were selected 22 23 138 based on a literature review. Data is collected twice a year using Omicron Delta Kappa (ODK) by 24 139 trained staff through face-to-face interviews, physical examinations, and electronic birth weight 25 26 140 measurements.²⁶ Field supervisors ensure data quality by checking GPS coordinates, response 27 28 141 consistency, and validity before transferring it to the Open HDSS database. Any errors are corrected 29 ₃₀ 142 by supervised data collectors. The collected data is initially stored on ODK aggregate, reviewed by 31 143 the data manager, and then migrated to the final Open HDSS database. The study focused on 32 33 144 congenital anomalies (CAs) as the outcome variable. Congenital anomalies are structural or 34 35 145 functional defects present at birth that originate during prenatal development. In this study, the 36 146 diagnosis of congenital anomalies was based on physical examination and interviews with the mother 37 38 147 or caregiver. If a congenital anomaly was reported, detailed information on functional and structural 39 40 148 abnormalities was collected through physical examinations and interviews conducted by trained data 41 42 149 collectors using a standard questionnaire within four weeks of delivery. The CAs variable was 43 150 categorized as 'congenital anomaly' or 'no congenital anomalies', with 'congenital anomaly' assigned 44 45 151 a value of "1" and 'no congenital anomalies' a value of "0". Birth weight was measured using an 46 electronic scale immediately after birth.. 47 152

⁴⁹₅₀ 153 **Data processing and analysis**

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51 154 The data from the HDSS database was exported to SPSS version 26 for analysis. The study aimed to 52 ₅₃ 155 track changes in congenital anomalies over time (measured in years) by analyzing data from January 54 55 156 1, 2015, to December 31, 2022. Descriptive statistics and a chi-square test were used to compare 56 157 observed and expected trends in congenital anomalies each year. The Mantel-Haenszel chi-square 57 58 158 test was used to assess linear trends in the proportion of newborns with congenital anomalies. 59 ₆₀ 159 Participant characteristics such as the mother's age, place of delivery, father's educational and

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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 11 165 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. 16 168

Patient and public involvement

Patients and/or the public were not involved in the design, conduct, reporting, or dissemination plans of this research. 22 171

Results 25 172

27 173 Socio-demographic, Maternal, and neonatal characteristics by congenital anomalies

29 174 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 34 177 36³⁶178 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, 39 180 more than half (14,386 or 52.60%) were males. Furthermore, 25,234 (92.26%) of the neonates were 41 181 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). 46 184

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

Maternal marital	Married	86 (0.4)	22,993 (99.6)
status	Divorced	2 (0.8)	247 (99.2)
	Single	16 (0.4)	3869 (99.6)
	Widowed	0 (0)	137(100)
Maternal	Farmer	3 (0.4)	834 (99.6)
occupational status	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	No formal education	70 (0.4)	18, 522(99.6)
the father	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	Farmer	80 (0.4)	20, 519 (99.6)
of the father	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)	23 024 (00 7)
	Normai	12 (0.5)	23, 924 (99.7)

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2019

2020

2021

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Total

	Gestatio	onal age	<37 w	eeks	2(0.8)	258 (99.2)	
			37-42	weeks	94 (4)	25, 140 (99.6)
			>42 w	eeks	8 (0.4)	1848 (99.6)	
	^π -privat	e health f	acilities, trai	ned traditional birth	h attendants, Health j	post	
]	Frends and	test for	linear tren	d of Congenital a	nomalies		
]	The Mantel-	Haensze	l test was us	sed to determine a	linear trend. Betwe	een 2015 and 20	22, there were
2	27,350 newł	oorns rec	orded in the	e Kersa HDSS, wi	th 104 of them hav	ing congenital a	anomalies. The
C	overall rate	of cong	enital anon	nalies was 3.83 i	per 1000 live birt	hs (95% CI: 3.	.19-4.61). The
r	roportion	fcongen	ital anomali	es among newbor	ns increased from 0	0013 (05% CI:	
ł		or congen	ital alloillall	es among new our		.0013 (9570 CI.	0.0002-0.002
i	n 2015 to 0.	0025 (95	% CI: 0.001	-0.004) in 2022.	The trend of congen	ital anomalies w	vas statistically
s	significant w	vith a Ma	antel-Haensz	$\chi = 82.76 (p = $	= 0.001), and the nu	umber of conger	nital anomalie
varied over the 8-year period (Table 2).							
		-					
]	Table 2. Tre	nds in co	ngenital and	malies adjusted for	or birth year at the k	Kersa Health and	l Demographi
S	Surveillance	System	in Eastern F	Ethiopia from Janu	ary 2015 to Decem	ber 2022	
~		<i>by</i> stelli					
E	Birth Year	CA	Non-CA	Proportion	Mantel- Haenszel (OR)	CI Lower	CI Upper
2	2015	4	3066	0.001302932	1	0.000214	0.002391
2	2016	5	3170	0.001574803	1.209925	0.000305	0.00286
2	2017	5	846	0.005875441	4.5101	0.001934	0.010941
2	2018	11	4429	0.002477477	1.905086	0.000757	0.004197

(p=0.0001) χ^2 : Chi-square; OR: Odds Ratio; p: p-value; CI: Confidence interval 196

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50 197 Trend analysis of congenital anomalies 51

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52 198 The trend analysis shows a high prevalence of CAs in 2020. with lower prevalence in 2015. The 53 54 199 number of delivery was found to be highest in 2018 (4, 440), and 2021 (4, 425) (Figure 1).

0.003806417

0.011425851

0.00180791

0.002564103

0.003817074

2.932127

8.803371

1.389308

1.97218

 $\chi 2 = 82.76$

0.001452

0.00702

0.000344

0.001034

0.002115

0.006938

0.016256

0.003553

0.00462

0.005401

56 200 Prevalence of congenital anomalies in each kebele 57

58 201 The prevalence of CAs was found to be highest in two kebeles (Yabeta Lencha (1.80%) and Rameta 59 60 202 (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 10 207 analysis and were identified as potential factors for multivariable binary logistic regression. These ₁₂ 208 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 15 210 Ratios (AOR) were calculated to determine the relative contribution of each factor to congenital 17 211 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 22 214 congenital anomalies compared to those born to mothers aged 20-24 (AOR: 1.68, 95% CI: 1.07, 24 215 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 27 217 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-	AOR (95% CI)	p-
		Yes (%)	No (%)	4	value		value
Age of the	<20	10(0.31)	3,208 (99.59)	1.61 (0.95,2.73)	.076	0.79 (0.39, 1.58)	.510
mother	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	Home	77 (0.4)	20010(99.6)	1		1	
delivery	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	No formal	70 (0.4)	18, 522(99.6)	1		1	
status of the	education						
father	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-	1 (0.1)	1129(99.9)	0. 23(0.03,1.69)	.150	0.32 (0.01,1456)	.826
	12)						
Occupational	Farmer	80 (0.4)	20, 519 (99.6)	1		1	
status of the	Merchant	1 (0.2)	406 (99.8)	0.63 (0.09,4.55)	.648	0.49 (0.66, 3.64)	.485
father	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	Yes	44 (0.5)	9712 (99.5)			1	
care	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	No formal	73 (0.40)	18,894 (99.6)	1			
status of	education						
mother	Elementary	30(0.4)	7263 (99.6)	1.07(0.70,1.64)	.759	.52(0.16,1.71)	.284
	Secondary and	1(0.1)	1089 (99.9)	0.24 (0.03,1.71)	.154	.93 (0.01, 4159)	.986
	above						:

*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 36 226 significant increasing trend in congenital anomalies from 2015 to 2022 (Mantel-Haenszel $\chi 2 = 82.76$, 38 227 p = 0.001). Factors such as maternal age over 35 years, place of birth, and birth weight showed statistically significant associations with congenital anomalies.

42 229 The prevalence of congenital anomalies in newborns was 3.83 per 1000 live births, which is lower 44 230 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 47 232 neonatal deaths, are recorded. Additionally, differences in screening criteria may also contribute to 49 233 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 ⁵² 235 stillbirths and terminated pregnancies, the assessment only covers the first few weeks of life, and 54 236 physical examination and interviews were used for diagnosis limiting the prevalence rate estimates.

57 237 The study found a rise in the prevalence of congenital anomalies (CAs) from 2015 to 2022, peaking ⁵⁸ 238 at 1.4% in 2020. This increase aligns with a study in China showing a significant increase in the live 60 2 3 9 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.

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12¹¹245 11 The increased prevalence of CAs in 2020 may be attributed to the impact of the Covid-19 pandemic ¹³ 246 on healthcare services, particularly maternal healthcare.³⁶ Strengthening maternal health services 14 during epidemics can help reduce neonatal morbidity.³⁷ One possible contributing factor could be the 15 247 16 17 248 distance of residency from health facilities, as previous studies in Ethiopia have shown that kebeles 18 249 far from healthcare facilities have limited access to maternity care.³⁸ Consanguinity may also be a 19 20 250 significant factor in the high rates of malformations and should be considered in genetic counseling.³⁹ 21 Despite lower overall delivery numbers, two kebeles (Yabeta Lencha and Rameta) had higher rates 22 251 23 ²³₂₄ 252 of CAs, highlighting the need for further research to investigate the underlying causes of this ²⁵ 253 disparity.

In this study, neonates born to mothers over 35 years old were 1.68 times more likely to have 28 254 29 ²₃₀ 255 congenital anomalies compared to those born to mothers aged 20-34 years. Similar findings have 31 256 been reported in studies from different countries, indicating a higher risk of congenital anomalies 32 with increased maternal age.^{17,18,40} The increased risk of congenital anomalies after 35 years of age 33 257 34 35 258 may be attributed to the higher likelihood of chromosomal anomalies and accumulated environmental ³⁶ 37 259 exposures over time.⁴⁰ Therefore, it is crucial to improve screening services for pregnant women over ³⁸ 260 35 years old to mitigate the risk of congenital anomalies and associated complications. 39

40 41 261 This study also found a correlation between birth weight and newborn congenital anomalies. The 42 43 262 42 findings of this study are consistent with research conducted in different parts of the world.⁴¹ 44 263 Monitoring birth weight is a simple way to assess prenatal health in a population.⁴² Women born with 45 46 264 low birth weight are more likely to give birth to low birth weight infants, perpetuating a cycle of 47 48 265 malnutrition and poverty across generations.⁴³ Maternal malnutrition, particularly micronutrient 49 deficiencies, is believed to be a significant factor in intrauterine growth restriction (IUGR).⁴⁴ Another 266 50 51 267 study reported that 71.04% of patients with congenital anomalies had a birth weight less than 2.5 52 kg.⁴⁵ The relationship between birth weight and congenital malformations is complex and influenced 53 268 54 55 269 by factors such as maternal medical conditions like hypertension, diabetes, and infections. Previous ⁵⁶ 270 studies in Ethiopia have identified factors such as maternal age under 20 years, inter-pregnancy 58 271 interval under 24 months, low body mass index, gestational age under 37 weeks, maternal educational 59 60 272 status, parity as associated with low birth weight, and lack of antenatal care follow-up.7,46,47

Page 13 of 21

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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

⁶ 275 This study found that hospital deliveries are linked to congenital anomalies, but this association may ⁸ 276 not be directly related to the risk of hospitals causing congenital anomalies. Women with complicated ⁹ pregnancies are more likely to give birth in a hospital due to the presence of specialists and equipment ¹¹ 278 to monitor and treat complications.⁴⁸ Factors such as maternal history of previous congenital ¹³ 279 anomalies, parental consanguinity, and history of medical disorders were important factors associated ¹⁴ 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.

288 It is crucial to improve the quality of antenatal care to reduce the incidence of congenital anomalies. 32 289 By providing high-quality antenatal care, healthcare professionals and stakeholders can advise 34 290 pregnant women on maintaining proper nutrition, following recommended supplementation, 35 36 291 monitoring maternal weight regularly, and taking necessary actions for high-risk individuals ⁵². ³⁷ 292 Prenatal screening using ultrasound can help diagnose congenital anomalies before birth. This 39 293 screening is a common practice in routine prenatal care and has been used for many years. Detecting 40 41 294 these anomalies early on can lead to better management of the pregnancy and the baby's health.^{53,54} 42 43 295 In Ethiopia, widespread ultrasound-based screening for congenital anomalies is not currently in place, ⁴⁴ 296 but implementing such screening could significantly enhance the management of these conditions. 45

46 47 297 Community-based HDSS provide valuable longitudinal data on a stable population, improving 48 298 representativeness. Research on congenital anomalies in Ethiopia is often limited to health facilities, 49 ⁵⁰ 299 lacking representative samples. This study examined congenital anomalies in newborns within the 51 52 300 community with a large sample size, aligning with world health organization (WHO) 53 54 301 recommendations to strengthen surveillance systems. However, the study is observational and cannot ⁵⁵₅₆ 302 establish causality. There may be unaccounted confounding factors contributing to congenital 57 303 anomalies, and the types of anomalies observed were not specified. Relying solely on physical 58 59 304 examinations and maternal interviews for diagnosis may have underestimated the true prevalence of 60 305 congenital anomalies. Incorporating genetic tests and ultrasound alongside physical examinations

2 306 and interviews could enhance the assessment of congenital anomalies for more effective intervention 3 307 strategies. 4

6 Conclusion 308 7

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8 309 The data from the Kersa Health and Demographic Surveillance system revealed a rising trend in 10 310 congenital anomalies. This trend was associated with factors such as the mother's age, place of birth, 11 12 311 and the baby's birth weight. It is crucial for healthcare providers and stakholders to focus on 13 312 developing strategies that target these factors to reduce the prevalence of congenital anomalies 14 15 313 effectively. 16

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43 44 329 Patient consent for publication: Not applicable.

45 330 Ethical approval: The Kersa HDSS has recieved ethical clearance from the national ethical review 46 47 331 committees of the Science and Technology Minister of the Federal Democratic Republic of Ethiopia 48 49 332 (Ref No. EPHA/OG/1861/15) and the Institutional Health Research Ethical Review Committee 50 51 333 (IHRERC) of the College of Health and Medical Sciences, Haramava University (Ref No. ⁵² 334 IHRERC/271/2014). Data anonymity was maintained throughout the research process. All study 53 54 335 participants provided informed written consent before being included in the HDSS. The study 55 56 336 protocol was approved by the Institutional Research Ethics Review Committee (IRERC) at the 57 58 337 57 College of Health and Medical Sciences. A support letter was issued by Haramaya University College ⁵⁹ 338 of Health and Medical Sciences to the Kersa HDSS administrative office, and an agreement was 60 339 reached between the investigators and the organization. Personal information such as names of the

² 340	mother, father, and children were not collected during data extraction. The extracted data will only					
4 341	be shared with third parties upon reasonable and legal request.					
⁵ ₆ 342	Data availability: The authors are unable to share the data, but it can be obtained from the Kersa					
⁷ 343	HDSS Agency for Shared Services in Education and Research according to the institution's data					
° 9 344	request and sharing policy.					
10 11 345	ORCID iDs					
$^{12}_{12}346$	Muluken Kumera Didisa					
13 14 347	Yohannes Baye					
15 16 348	Everusalem Tamiru					
17 18 349	Gezaheng Mengesha https://orcid.org/0000-0001-6450-1806					
¹⁹ 350	Lencho Kajela Solbana, https://orcid.org/0000-0002-3155-9363					
20 ²⁰ 21 351	Tesfave Assebe Vadeta http://orcid.org/0000-0003-3015-8979					
22						
23 <i>332</i> 24						
25 26 353	REFERENCES					
27 28						
28 29 354	1. World Health Organization. Congenital disorders; key fact: accesses on 27 February 2023, .					
30 355	https://www.who.int/news-room/fact-sheets/detail/birth-defects. 20023.					
31 356	2. Reece EA, Eriksson U. Congenital malformations: epidemiology, pathogenesis, and					
32_{33} 357	experimental methods of induction and prevention. Diabetes in Women: Adolescence,					
₃₄ 358	Pregnancy and Menopause. 3rd ed. Philadelphia: Lippincott Williams & Wilkins					
35 359	Philadelphia. 2004:169-204.					
36 360	3. Kang L, Cao G, Jing W, Liu J, Liu M. Global, regional, and national incidence and					
37 361	mortality of congenital birth defects from 1990 to 2019. European Journal of Pediatrics.					
³⁸ 362	2023:182(4):1781-1792.					
³⁹ 363	4 Mekonnen AG Hordofa AG Kitila TT Say A Modifiable risk factors of congenital					
40 364	malformations in bale zone hospitals. Southeast Ethiopia: an unmatched case-control study					
41 365	BMC pregnancy and childbirth, 2020.20.1-9					
42 366	5 Sevoum G Adane F Prevalence and associated factors of birth defects among newborns at					
44 367	referral hospitals in Northwest Ethiopia <i>Ethiopian Journal of Health Development</i>					
45 368	2018·32(3)					
⁴⁶ 369	6. World Health Organization. Congenital disorders. Retrieved December 19, 2023. from					
47 370	https://www.who.int/news-room/fact-sheets/detail/birth-defects. 2023.					
48 371	7 Katiso NA Kassa GM Fekadu GA Kidanemariam Berhe A Muche AA Prevalence and					
49 ° 1 1 50 372	determinants of low birth weight in Ethiopia: a systematic review and meta-analysis					
51 373	Advances in Public Health 2020:2020:1-13					
52 374	8 Liu L Oza S Hogan D Global regional and national causes of under-5 mortality in 2000–					
53 375	15 an undated systematic analysis with implications for the Sustainable Development					
⁵⁴ 376	Goals 388:30273035					
55 377	9 Sitkin NA Ozgediz D Donkor P Farmer DL Congenital anomalies in low-and middle-					
56 378	income countries: the unborn child of global surgery World iournal of surgery 2015:30:36-					
50 370	40					
59						
60						

Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

 Neonatal Care [Internet]. 2020;10(2):43-50. Mayer MMM, Velaphi S. Incidence, types and outcomes of congenital anomalies i born at a public, tertiary hospital in South Africa. South African Journal of Child E. 2021;15(4):193-197. Ahmed AM, El-Kader S, El-Hamid A, Gaafar HM. Assessment of risk factors for the congenital anomalies among pregnant women at Cairo University Hospitals. 2011. Serra-Juhe C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy num variants to isolated human malformations. 2012. Organization WH. World health statistics 2010. World Health Organization; 2010. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children. 2005. 	in babies <i>Jealth</i> . fetal
 Mayer MMM, Velaphi S. Incidence, types and outcomes of congenital anomalies in born at a public, tertiary hospital in South Africa. South African Journal of Child E 2021;15(4):193-197. Ahmed AM, El-Kader S, El-Hamid A, Gaafar HM. Assessment of risk factors for the congenital anomalies among pregnant women at Cairo University Hospitals. 2011. Serra-Juhe C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy num variants to isolated human malformations. 2012. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children. 2005 	in babies <i>Iealth</i> . fetal
 born at a public, tertiary hospital in South Africa. South African Journal of Child F. born at a public, tertiary hospital in South Africa. South African Journal of Child F. 2021;15(4):193-197. Ahmed AM, El-Kader S, El-Hamid A, Gaafar HM. Assessment of risk factors for the congenital anomalies among pregnant women at Cairo University Hospitals. 2011. Serra-Juhe C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy num variants to isolated human malformations. 2012. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children. 2005 	Health. fetal
 8 385 2021;15(4):193-197. 9 386 12. Ahmed AM, El-Kader S, El-Hamid A, Gaafar HM. Assessment of risk factors for a congenital anomalies among pregnant women at Cairo University Hospitals. 2011. 11 388 13. Serra-Juhe C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy num variants to isolated human malformations. 2012. 13 389 14. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. 15 391 15. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children 2005. 	fetal
 9 386 12. Ahmed AM, El-Kader S, El-Hamid A, Gaafar HM. Assessment of risk factors for congenital anomalies among pregnant women at Cairo University Hospitals. 2011. 11 388 13. Serra-Juhe C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy num variants to isolated human malformations. 2012. 13 390 14. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children 2005. 	fetal
 10 387 10 387 11 388 13. 13. 14. 14 390 14. 15. 15. 16 392 10. 10. 10. 10. 11. 12. 13. 14. 15. 15. 16. 16.<td>han</td>	han
 Serra-Juhe C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy num variants to isolated human malformations. 2012. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children. 2005 	1. a.m.
 variants to isolated human malformations. 2012. variants to isolated human malformations. 2012. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det bidden toll of dving and disabled children. 2005. 	ider
 ¹³ 390 14. Organization WH. <i>World health statistics 2010</i>. World Health Organization; 2010. ¹⁵ 391 15. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det hidden toll of dving and disabled children 2005. 	
15 391 15. Christianson A, Howson CP, Modell B. March of Dimes: global report on birth det 16 392 hidden toll of dving and disabled children 2005	
16 392 hidden toll of dving and disabled children 2005	fects, the
10.372 Induction of using and usabled children, 2003 .	,
17 393 16 Dua'a F Kawafha MM Abdullah KL Shawish NS Kamel AMA Basyouni NR	
¹⁸ 394 Psychological problems among parents of children with congenital anomalies <i>Jou</i>	rnal of
¹⁹ 395 Neonatal Nursing 2023:29(6):846-850	indir og
²⁰ 396 17 Mekonen HK Berhe V Berihu BA et al. A silent enidemic of major congenital	
²¹ ³⁷⁰ ¹⁷¹ malformations in Tigray, northern Ethionia: hospital-based study. <i>Scientific Renor</i>	ts
22.397 induces in Figure , normerin Europha: hospital based study: betenilje Report 22.398 $2021\cdot11(1)\cdot21035$	<i>b</i> 0 .
23 390 18 Gedamu S Sendo EG Daha W Congenital anomalies and associated factors amor	ıα
25 400 newhorns in Bishoffu General Hospital Oromia Ethiopia: a retrospective study <i>L</i>	ng ournal of
26 A01 Environmental and Public Health 2021:2021	jurnui 0j
27 402 10 Taya M A fawark M Eantava W Dira E Warku A Easters associated with congo	mital
²⁸ 402 19. Taye M, Alework M, Fallaye W, Dilo E, Worku A. Factors associated with conge	
²⁹ ⁴⁰⁵ anomalies in Addis Adada and the Annara Region, Ethiopia. a case-control study.	DMC
30404 pediatrics. 2018;18:1-11.	· 1
31 405 20. Getachew B, Alemayenu I, Abebe S, et al. Prevalence of overt congenital anomali	les and
32406 associated factors among newborns delivered at Jimma University medical center,	NT ·
Southwest Ethiopia, 2018: a cross-sectional study. International Journal of Africa	Nursing
35 408 Sciences. 2023;18:100513.	, , .
$36 \frac{409}{110}$ 21. Birnanu K, Testaye W, Bernane M. Congenital anomalies in neonates admitted to a	a tertiary
hospital in Southwest Ethiopia: a cross sectional study. <i>Ethiopian journal of health</i>	i sciences.
$_{38}411$ 2021;31(6).	
39 412 22. UNICEF. Levels & Trends in Child Mortality Estimation Child Mortality. Un Igma	<i>e</i> .
40 413 https://www.unicef. org/media//93/1/file/UN-IGME-child-mortality-report-2020.	pdf. pdf.
41 414 2020.	
$\frac{42}{43}$ 415 23. Penchaszadeh VB. Preventing congenital anomalies in developing countries. <i>Publi</i>	ic Health
$\frac{16}{44}$ 416 Genomics. 2002;5(1):61-69.	
45 417 24. World Health Organization. <i>Prevention and control of birth defects in South-East</i>	Asia
46 418 <i>Region: strategic framework (2013-2017).</i> WHO Regional Office for South-East A	Asia;2013.
47 419 25. Vandenbroucke JP, Elm Ev, Altman DG, et al. Strengthening the Reporting of	
48 420 Observational Studies in Epidemiology (STROBE): explanation and elaboration. A	Innals of
⁴⁹ 421 <i>internal medicine</i> . 2007;147(8):W-163-W-194.	
⁵⁰ 422 26. Assefa N, Oljira L, Baraki N, et al. HDSS profile: the Kersa health and demograph	lic
surveillance system. <i>International Journal of Epidemiology</i> . 2016;45(1):94-101.	
⁵³ 424 27. Zhang X, Chen L, Wang X, et al. Changes in maternal age and prevalence of conge	enital
anomalies during the enactment of China's universal two-child policy (2013–2017)) in
55 426 Zhejiang Province, China: an observational study. <i>PLoS medicine</i> . 2020;17(2):e100	03047.
56 427 28 Moorthie S Blencowe H Darlison MW at al Estimating the hirth prevalance and	
τ_{21} τ_{20} τ_{21} τ_{20} τ	<i>t</i> 1,
⁵⁷ 428 pregnancy outcomes of congenital malformations worldwide. <i>Journal of communit</i>	ıy
⁵⁷ 428 pregnancy outcomes of congenital malformations worldwide. <i>Journal of communit</i> ⁵⁸ 429 <i>genetics</i> . 2018;9:387-396.	ı y
 ⁵⁷ 428 ⁵⁸ 429 ⁵⁹ 429 ⁶⁰ 430 ⁵⁰ 29. ⁵⁰ Hoortine S, Diencowe H, Darnson WW, et al. Estimating the ortal prevalence and pregnancy outcomes of congenital malformations worldwide. <i>Journal of communit genetics</i>. 2018;9:387-396. ⁵⁰ Neel JV. A study of major congenital defects in Japanese infants. <i>American journal journal of communit genetics</i>. 	iy il of

1		
² 432	30.	Todros T, Capuzzo E, Gaglioti P. Prenatal diagnosis of congenital anomalies. <i>Images in</i>
4 4 3 3	2.1	paediatric cardiology. 2001;3(2):3.
5 434	31.	Elkarnat Z, Kindil Z, Zarouf L, et al. Chromosomal abnormalities in couples with recurrent
6 435		spontaneous miscarriage: a 21-year retrospective study, a report of a novel insertion, and a
7 436		literature review. Journal of assisted reproduction and genetics. 2019;36:499-507.
8 437	32.	Toufaily MH, Westgate MN, Lin AE, Holmes LB. Causes of congenital malformations.
9 438		<i>Birth defects research</i> . 2018;110(2):87-91.
10 439	33.	Xia S, Meng C, Cheng X, et al. Trends in the prevalence of births with chromosomal
¹¹ 440		abnormalities—Haidian District, Beijing Municipality, China, 2013–2022. China CDC
12 441		Weekly. 2023;5(36):791.
13 14 442	34.	Lassi ZS, Imam AM, Dean SV, Bhutta ZA. Preconception care: screening and management
15 443		of chronic disease and promoting psychological health. <i>Reproductive Health.</i> 2014;11:1-20.
16 444	35.	Geltore TE, Anore DL. The impact of antenatal care in maternal and perinatal health.
17 445		Empowering midwives and obstetric nurses. 2021;107.
¹⁸ 446	36.	Mebratie AD, Nega A, Gage A, Mariam DH, Eshetu MK, Arsenault C. Effect of the
¹⁹ 447		COVID-19 pandemic on health service utilization across regions of Ethiopia: an interrupted
²⁰ 448		time series analysis of health information system data from 2019–2020 PLOS global public
21 449		health 2022.2(9):e0000843
$\frac{22}{22}$ 450	37	Tilahun B Nigusie A Zelalem M Mekonnen ZA Effect of COVID-19 pandemic on
23 150	57.	maternal and child health services and strategies for effective service implementation in
25 / 52		Ethionia Journal of Multidisciplinary Healthcare 2022:2781-2795
26 153	38	Kibret GD Demant D Haven A The effect of distance to health facility on neonatal
27 455	58.	mortality in Ethionia, BMC Health Services Persearch, 2022;22(1):114
28 454	20	Tayobi N. Vazdani K. Naghshin N. The providence of congonital malformations and its
29 455	39.	rayedi N, Yazuani K, Nagishini N. The prevalence of congenital manormations and its
30 430	40	Correlation with consanguineous marriages. <i>Oman medical journal</i> . 2010;25(1):57.
31 45 /	40.	Petno B, Matral A, Agocs G, et al. Maternal age is nightly associated with non-chromosomal
32 458		congenital anomalies: Analysis of a population-based case-control database. BJOG: An
34 459		International Journal of Obstetrics & Gynaecology. 2023;130(10):1217-1225.
35 460	41.	Bhalerao A, Garg R. Pattern of congenital anomalies at birth. Int J Obstet Gynaecol Res.
36 461		2016;3(7):420-426.
37 462	42.	Thornton J. Perinatal mortality rises both with prematurity and with the degree to which the
38 463		baby's birthweight is below that expected for gestational age. European Journal of
39 464		<i>Obstetrics, Gynecology, and Reproductive Biology.</i> 2001;95(1):5-5.
40 465	43.	Roberfroid D, Huybregts L, Lanou H, et al. Effects of maternal multiple micronutrient
⁴¹ 466		supplementation on fetal growth: a double-blind randomized controlled trial in rural
⁴² 467		Burkina Faso. The American journal of clinical nutrition. 2008;88(5):1330-1340.
44 468	44.	Prada J, Tsang R. Biological mechanisms of environmentally induced causes of IUGR.
45 469		European Journal of Clinical Nutrition. 1998;52:S21-27; discussion S27.
46 470	45.	Shawky RM, Sadik DI. Congenital malformations prevalent among Egyptian children and
47 471		associated risk factors. Egyptian Journal of Medical Human Genetics. 2011;12(1).
48 472	46.	Kebede A, Kebede A, Belina S, Biratu Y. Trends and determinants of small birth weight in
⁴⁹ 473		Ethiopia: further analysis of Ethiopian Demographic and Health Surveys. Ethiopian Journal
⁵⁰ 474		of Health Sciences. 2021;31(2).
51 52 475	47.	Endalamaw A, Engeda EH, Ekubagewargies DT, Belay GM, Tefera MA. Low birth weight
53 476		and its associated factors in Ethiopia: a systematic review and meta-analysis. Italian journal
54 477		of pediatrics. 2018;44:1-12.
55 478	48.	Kyung-Shin L. Yoon-Jung C. Jinwoo C. et al. Environmental and Genetic Risk Factors of
56 479	-	Congenital Anomalies: an Umbrella Review of Systematic Reviews and Meta-Analyses.
⁵⁷ 480		Journal of Korean Medical Science. 2021:36(28):1-24.
⁵⁸ 481	49.	Ameen SK, Alalaf SK, Shabila NP. Pattern of congenital anomalies at birth and their
59 60 482	• • •	correlations with maternal characteristics in the maternity teaching hospital Erbil city Iraq
483		BMC pregnancy and childbirth. 2018:18:1-8
		- r - O

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2 519	Figure 1. Trend of congenital anomalies in newborns at Kersal Health and Demographic
4 520	Surveillance System in Eastern Ethiopia: an eight-year open cohort analysis from January 2015 to
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- Figure 2. Prevalence of congenital anomalies in newborns in Kebeles found at Kersal Health and
- Demographic Surveillance System in Eastern Ethiopia: an eight-year open cohort analysis from
 - January 2015 to December 2022.

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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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7 8	4	Muluken Kumera Didisa ¹ , Yohannes Baye ² , Eyerusalem Tamiru ² , Gezaheng Mengesha ³ , Lencho
9	5	Kajela Solbana ⁴ , Tesfaye Assebe Yadeta ^{*2}
10 11	6	
12		
13 14	7	Author affiliations:
15	8	¹ Hiwot Fana Specialized Hospital, Haramaya University, Harar, Ethiopia
10	9	² School of Nursing and Midwifery, Haramaya University, Harar, Ethiopia
18 19	10	³ Hararghe Health and Demographic Surveillance Systems, Harar, Ethiopia
20	11	⁴ Department of Nursing, College of Health Sciences, Assosa University, Assosa, Ethiopia
21 22	12	
23		
24 25	13	Author emails:
26 27	14	MkD: <u>didissamuluken@gmail.com</u>
28	15	YB: <u>yohannesbaye21@gmail.com</u>
29 30	16	ET: eyerusalemtamiru9@gmail.com
31 32	17	GM: gmange2004@gmail.com
33	18	LKS: lejch7@gmail.com
34 35	19	TAY: <u>tesfaye.assb@gmail.com</u>
36 37	20	
38	0.1	
39 40	21	Correspondence to:
41 42	22	Testaye Assebe Yadeta, School of Nursing and Midwifery, College of Health and Medical Sciences,
43	23	Haramaya University, P.O. Box. 235, Harar, Ethiopia
44 45	24	E-mail: <u>tesfaye.assb@gmail.com</u>
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1 2 3	31	Abstract
4	32	Objectives: This study aimed to investigate the trends and factors associated with congenital
6	33	anomalies (CAs) among newborns in Eastern Ethiopia, from 2015 to 2022.
8	34	Design: Open cohort study
9 10	35	Setting: The Kersa Health and Demographic Surveillance System (KHDSS), which is located in the
11 12	36	Kersa district of the Oromia region in Eastern Ethiopia, covering 24 kebeles.
13	37	Population: Newborns registered at birth in the database of the KHDSS site in Eastern Ethiopia.
14	38	Methods: The KHDSS tracks demographic and health changes in the community. Newborn data at
16 17	39	birth was extracted using a checklist. Trends in CAs over time (in years) were analyzed, and
18 19	40	associated factors were identified through logistic regression analysis.
20	41	Outcome measure: Newborn CAs, which are structural or functional abnormalities present at birth,
22	42	were assessed through thorough physical examinations and detailed interviews conducted by trained
23 24	43	data collectors using a standardized questionnaire.
25 26	44	Results: Between 2015 and 2022, a total of 27,350 newborns were recorded in the KHDSS, 104 with
27	45	CAs. The overall rate of CAs was 3.83 per 1000 live births (95% CI: 3.19-4.61). There was a
20 29	46	significant increase in the trends of CA over the study period, with a Mantel-Haenszel $\chi 2$ of 82.76 (p
30 31	47	= 0.001). Factors associated with CA included maternal age over 35 years (adjusted odds ratio
32 33	48	[AOR]: 1.68, 95% CI: 1.07, 2.62), place of birth (AOR: 2.04, 95% CI: 1.04, 4.02), and normal birth
34	49	weight (AOR=0.14, 95% CI: 0.04, 0.47).
36	50	Conclusion: The data from the KHDSS revealed a rising trend in CAs. CA was associated with
37 38	51	factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for healthcare
39 40	52	providers and stakeholders to consider these factors in efforts to reduce the prevalence of CAs.
41 42	53	
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44 45	54	Keywords: Congenital anomalies, associated factors, prevalence, new-borns
46 47	55	
48 49	56	Strengths and limitations of this study
50 51	57	• This community-based study with a large sample size provides valuable insights into
52	58	congenital anomalies in newborns.
53 54	59	• The study provides evidence covering a substantial time period.
55 56	60	• Unaccounted and residual confounding factors may have influenced the associations found.
57 58	61	• The study did not specify the specific types of congenital anomalies that were observed.
59	62	• The true prevalence may have been underestimated by relying only on physical examinations
00	63	and maternal interviews for diagnosis.
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65 INTRODUCTION

66 Congenital anomalies (CAs) are structural or functional abnormalities that occur during fetal 67 development.^{1,2} They can vary in severity, with major CAs being a leading cause of death in children 68 under 5.³ Common types of CAs include neural tube defects, congenital heart disease, cleft lip/palate, 69 and limb defects.^{4,5} Causes of CAs include genetic factors, chromosomal disorders, environmental 70 teratogens, and nutrient deficiencies. Early detection and intervention are crucial in managing these 71 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

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97 Health and demographic surveillance systems (HDSS) have become a crucial source of representative 98 data for evidence generation, particularly in rural areas and countries with weak vital registration 99 systems. Unlike facility-based studies or Demographic and Health Surveys, HDSS offers longitudinal 10 11 100 data on a known and stable target population, allowing for the analysis of trends and changes in 12 13 101 mortality determinants for tailored interventions. Unfortunately, research on CA in Ethiopia are often 14 15 102 limited to health facilities and lack appropriate denominators, reducing their applicability.^{4,17-20} 16 103 Therefore, there is a pressing need for more comprehensive evidence that can illustrate the evolution 17 18 104 of CA and identify the related factors. This study aims to analyze trends and factors associated with 19 20 105 CA in the Kersa HDSS from 2015 to 2022. 21

METHODS 25 107

108 This paper is follows the guidelines of the Strengthening the Reporting of Observational Studies in 29 109 Epidemiology (STROBE; online supplemental appendix A)²⁵

31 Study design and setting 110 32

33 An open cohort study design was conducted using data from the Kersa Health and Demographic 111 34 35 112 Surveillance System (KHDSS) in eastern Ethiopia, which is affiliated with the College of Health and 36 Medical Sciences at Haramaya University. The KHDSS is located in the Kersa district of the Oromia 37 113 38 114 region in Eastern Ethiopia. The district consists of 38 Kebeles, with 36 being rural and two small 39 ⁴⁰ 115 towns. The KHDSS was established in 12 Kebeles in 2007 and later expanded to include an additional 41 12 Kebeles in 2015. A Kebele is the smallest administrative unit in Ethiopia, typically consisting of 42 116 43 44 117 around 1500 households, and is responsible for providing basic services such as education, 45 118 healthcare, agriculture, water, and rural infrastructure. Currently, the KHDSS covers 24 Kebeles and 46 47 119 collects updated data every 6 months on demographic and health events. The majority of the 48 49 120 population in the area are farmers, with some engaged in small trade, government roles, or casual 50 50 51 121 labor. Khat is a prominent cash crop in the region, with wheat, barley, and vegetables being common 52 122 crops in the highland areas, and sorghum, maize, and potatoes in the lowland areas.²⁶ This study 53 54 123 analyzed trends and associated factors of CA in KHDSS from 2015 to 2022. 55

57 124 56 Study population and eligibility ciritera

58 125 The KHDSS is a cohort study that collects health and demographic data to monitor changes in a 59 60 1 2 6 stable population. It tracks demographic and health events at regular intervals and updates

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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.

8 130 Study variables

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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).

¹⁷ ₁₈ 135 Measurements and data collection

19 The KHDSS questionnaire covers a wide range of information, including morbidity surveillance, 136 20 21 1 37 mortality registration, child immunization records, economic details, housing conditions, migration 22 23 138 history, pregnancy monitoring, and pregnancy outcomes. The variables for this study were selected 24 139 based on a literature review. Data is collected twice a year using Omicron Delta Kappa (ODK) by 25 26 140 trained staff through face-to-face interviews, physical examinations, and electronic birth weight 27 28 141 measurements.²⁶ Field supervisors ensure data quality by checking GPS coordinates, response 29 consistency, and validity before transferring it to the Open HDSS database. Any errors are corrected 142 30 31 143 by supervised data collectors. The collected data is initially stored on ODK aggregate, reviewed by 32 33 144 the data manager, and then migrated to the final Open HDSS database. The study focused on 34 35 145 congenital anomalies (CAs) as the outcome variable. Congenital anomalies are structural or 36 146 functional defects present at birth that originate during prenatal development. In this study, the 37 38 147 diagnosis of congenital anomalies was based on physical examination and interviews with the mother 39 40 148 or caregiver. If a congenital anomaly was reported, detailed information on functional and structural 41 42 149 abnormalities was collected through physical examinations and interviews conducted by trained data 43 150 collectors using a standard questionnaire within four weeks of delivery. The CAs variable was 44 45 151 categorized as 'congenital anomaly' or 'no congenital anomalies', with 'congenital anomaly' assigned 46 a value of "1" and 'no congenital anomalies' a value of "0". We measured the newborn's birth weight 47 152 48 153 using a WHO-recommended calibrated digital scale with a precision of 10g within the first hour of 49 50 154 life. The newborn was placed on the scale on a stable surface, covered with a cleaned cloth, and 51 52 155 zeroed before placing the undressed baby on it. The weight was recorded in grams once it stabilized. 53 For analysis, birth weight was categorized according to the WHO classification into four groups: 54 156 55 56 157 normal birth weight (≥2500 g to <4000 g), low birth weight (1500 g to <2500 g), very low birth 57 158 weight (<1500 g), and big birth weight (\geq 4.0 kg). 58

⁵⁹₆₀ 159 **Data processing and analysis**

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2 160 The data from the HDSS database was exported to SPSS version 26 for analysis. The study aimed to 3 track changes in congenital anomalies over time (measured in years) by analyzing data from January 161 4 162 1, 2015, to December 31, 2022. Descriptive statistics and a chi-square test were used to compare 163 observed and expected trends in congenital anomalies each year. The Mantel-Haenszel chi-square 8 9 164 test was used to assess linear trends in the proportion of newborns with congenital anomalies. 10 Participant characteristics such as the mother's age, place of delivery, father's educational and 11 165 12 166 occupational status, antenatal care, birth weight, and mother's educational status were considered in 13 14 167 the analysis. Binary logistic regression analysis was conducted to select explanatory variables for the 15 16 168 final model with a p-value of 0.25 and a 95% confidence interval. In the multivariate analysis, only 17 variables or categories with a p-value less than 0.25, as identified in the bivariate analysis, were 169 18 19 170 included to control for confounders. Factors associated with congenital anomalies were identified 20 21 171 using multivariable logistic regression analysis, and adjusted odds ratios (AOR) with a 95% 22 23 172 confidence interval were calculated. A p-value of <0.05 was considered statistically significant. 24 173 Multi-collinearity was assessed using the variance inflation factor (VIF) for all independent variables. 25 ²⁶ 174 The model's goodness of fit was evaluated using the Hosmer and Lemeshow test, with a p-value 27 28 175 >0.05 indicating a good fit. 29

176 Patient and public involvement

177 None.

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RESULTS 36 179

180 Sociodemographic, maternal, and neonatal characteristics

40 181 In this study, a total of 27,350 newborns from the KHDSS dataset were analyzed. Among the 42 182 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, 183 ⁴⁵ 184 24,351 (89.03%) of the community members in the study area had a family size of six or more. In 47 185 this study, 12,630 (46.34%) mothers were multipara at the time of giving birth, 17,534 (64.33%) did 186 not receive antenatal care, and 20,010 (73.44%) gave birth at home. Among the newborns studied, 187 23,996 (87.73%) had a normal birth weight (Table 1).

evie

52 188 Table 1. Sociodemographic, maternal, and newborn characteristics of study participants with and 53 54 189 without congenital anomalies at the KHDSS in Eastern Ethiopia from January 2015, to December 55 190 2022 (n=27,350) 56

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

Age of the mother in	20-34	58 (0.34)	17,128 (99.66)
years	≥35	36 (0.52)	6, 910(99.48)
Maternal educational	No formal education	73 (0.40)	18,894 (99.6)
status	Elementary	30(0.4)	7263 (99.6)
	Secondary and above	1(0.1)	1089 (99.9)
Maternal marital	Married	86 (0.4)	22,993 (99.6)
status	Divorced	2 (0.8)	247 (99.2)
	Single	16 (0.4)	3869 (99.6)
	Widowed	0 (0)	137(100)
Maternal	Farmer	3 (0.4)	834 (99.6)
occupational status	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	No formal education	70 (0.4)	18, 522(99.6)
the father	Elementary (1-8)	33 (0.4)	7595 (99.6)
	Secondary and above	1 (0.1)	1, 129(99.9)
Occupational status	Farmer	80 (0.4)	20, 519 (99.6)
of the father	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(03)	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 low	3(2.1)	142 (97.9)
Birth weight	Very low Low	3(2.1) 16 (1)	142 (97.9) 1621 (99)
Birth weight	Very low Low Normal	3(2.1) 16 (1) 72 (0.3)	142 (97.9) 1621 (99) 23, 924 (99.7)
Birth weight	Very low Low Normal Big	3(2.1) 16 (1) 72 (0.3) 13(0.8)	142 (97.9) 1621 (99) 23, 924 (99.7) 1559 (99.2)
Birth weight Gestational age	Very low Low Normal Big <37 weeks	$\begin{array}{c} 3(2.1) \\ \hline 3(2.1) \\ \hline 16(1) \\ \hline 72(0.3) \\ \hline 13(0.8) \\ \hline 2(0.8) \end{array}$	142 (97.9) 1621 (99) 23, 924 (99.7) 1559 (99.2) 258 (99.2)
Birth weight Gestational age	Very low Low Normal Big <37 weeks 37-42 weeks	3(2.1) $16 (1)$ $72 (0.3)$ $13(0.8)$ $2(0.8)$ $94 (4)$	142 (97.9) 1621 (99) 23, 924 (99.7) 1559 (99.2) 258 (99.2) 25, 140 (99.6)

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

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2 197 0.0025 (95% CI: 0.001–0.004) in 2022. The trend of congenital anomalies was statistically significant 3 with a Mantel-Haenszel $\chi 2 = 82.76$ (p = 0.001), and the number of congenital anomalies varied over 198 4 5 199 the 8-year period (Table 2). 6

8 Table 2. Trends in congenital anomalies adjusted for birth year at the KHDSS in Eastern Ethiopia 200 9 10 201 from January 2015 to December 2022

Birth Yea	r 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	$\chi 2=82.76$ (p=0.0001)

202 χ^2 : Chi-square; OR: Odds Ratio; p: p-value; CI: Confidence interval

203 Trend analysis of congenital anomalies

³⁵ 204 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). 37 205

39 206 Prevalence of congenital anomalies in each kebele 40

41 207 The prevalence of CAs was found to be highest in two kebeles (Yabeta Lencha (1.80%) and Rameta 42 43 208 (1.70%)). Whereas, zero prevalence was observed in Burka water, Gola Belina, and Metakoma 44 45⁴⁵209 kebeles (Figure 2). Whereas, the number of deliveries was relatively higher in Sodu (2, 439), Bala 210 langey (1,860), and Handura Kosum (1,623) kebeles (Figure 2).

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49 211 **Factors associated with congenital anomalies** 50

51 212 In bivariable binary logistic regression, seven variables had a p-value less than 0.25 in the bivariate ⁵² 213 52 analysis and were identified as potential factors for multivariable binary logistic regression. These ⁵⁴ 214 variables include antenatal care follow-up status, educational status of the father and mother, place 55 56 215 of birth, age of the mother, occupational status of the mother, and birth weight. The Adjusted Odds 57 ₅₈ 216 Ratios (AOR) were calculated to determine the relative contribution of each factor to congenital 59 217 anomalies. The analysis revealed that newborns with normal birth weight had a 86% lower risk of 60

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

Variables	Characteristics	Congenital anomalies		COR (95% CI)	p-value	AOR (95% CI)	р-
		Yes (%)	No (%)	-			value
Age of the	<20	10(0.31)	3,208 (99.59)	1.61 (0.95,2.73)	0.076	0.79 (0.39, 1.58)	0.510
mother	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	Home	77 (0.4)	20010(99.6)	1		1	
delivery	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	No formal education	70 (0.4)	18, 522(99.6)	1		1	
father	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	Farmer	80 (0.4)	20, 519 (99.6)	1		1	
status of the	Merchant	1 (0.2)	406 (99.8)	0.63 (0.09,4.55)	0.648	0.49 (0.66, 3.64)	0.485
father	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	Yes	44 (0.5)	9712 (99.5)			1	
care	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	No formal education	73 (0.40)	18,894 (99.6)	1			
mother	Elementary	30(0.4)	7263 (99.6)	1 07 (0 70 1 64)	0 759	0.52 (0.16.1.71)	0 284

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		Secondary and	1(0.1)	1089 (99.9)	0.24 (0.03,1.71)	0.154	0.93 (0.01, 4.15)	0.986
		above						
	*AOR significa	ant at p<0.05.				L		
AOR, adjusted OR; COR, crude OR; CI: Confidence interval.								

DISCUSSION 228

14 229 This study analyzed data from 27,350 newborns from the KHDSS in Eastern Ethiopia revealed a 230 prevalence of congenital anomalies at 0.38%. The study also observed a significant increasing trend 17 231 in congenital anomalies from 2015 to 2022 (Mantel-Haenszel $\chi 2 = 82.76$, p = 0.001). Factors such as 19 232 maternal age over 35 years, place of birth, and birth weight showed statistically significant 233 associations with congenital anomalies.

23 234 The prevalence of congenital anomalies in newborns was 3.83 per 1000 live births, which is lower 24 than rates reported in studies from China,²⁷ and worldwide.²⁸ This difference may be due to variations 25 235 26 ²⁰₂₇ 236 in inclusion criteria. In China, all births, including live births, early fetal losses, stillbirths, and early ²⁸ 237 neonatal deaths, are recorded. Additionally, differences in screening criteria may also contribute to 29 the discrepancy. Physical examination and interviews are used for diagnosis, but only around 30% 30 238 32 239 of congenital malformations can be reliably diagnosed this way.^{29,30} This study did not include 33 240 stillbirths and terminated pregnancies, the assessment only covers the first few weeks of life, and 34 ³⁵ 241 physical examination and interviews were used for diagnosis limiting the prevalence rate estimates. 36

38 242 The study found a rise in the prevalence of congenital anomalies (CAs) from 2015 to 2022, peaking 39 40 243 39 at 1.4% in 2020. This increase aligns with a study in China showing a significant increase in the live ⁴¹ 244 birth rate of infants with CAs born before 28 gestational weeks.²⁷ The study also indicated that the 42 43 245 prevalence of chromosomal abnormalities, which can cause congenital anomalies in newborns, has 44 45 246 been increasing in recent years.³¹ Factors such as increasing in maternal age,^{32,33} and increased 46 247 exposure to environmental factors are believed to contribute to this upward trend in CA prevalence. 47 48 248 The critical role of folic acid supplementation in preventing neural tube defects is well-established 49 50 249 ³⁴. However, low coverage of folic acid supplementation³⁵ and contraceptive utilization, along with 51 51 250 high fertility rates³⁶, may also contribute to an increase in CAs. Improving the accessibility of ⁵³ 251 54 maternity care mainly preconception,³⁷ and antenatal care,³⁸ could reduce the rates of CAs.

55 56 252 The increased prevalence of CAs in 2020 may be attributed to the impact of the Covid-19 pandemic 57 57 58 253 on healthcare services, particularly maternal healthcare.³⁹ Strengthening maternal health services 59 60 during epidemics can help reduce neonatal morbidity.⁴⁰ One possible contributing factor could be the 254

255 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 256 257 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 258 259 of CAs, highlighting the need for further research to investigate the underlying causes of this 10 11 260 disparity.

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¹³ 261 In this study, neonates born to mothers over 35 years old were 1.68 times more likely to have 14 15 262 congenital anomalies compared to those born to mothers aged 20-34 years. Similar findings have 16 17 263 been reported in studies from different countries, indicating a higher risk of congenital anomalies 18 264 with increased maternal age.^{17,18,43} The increased risk of congenital anomalies after 35 years of age 19 20 265 may be attributed to the higher likelihood of chromosomal anomalies and accumulated environmental 21 exposures over time.⁴³ Therefore, it is crucial to improve screening services for pregnant women over 22 266 23 24 267 35 years old to mitigate the risk of congenital anomalies and associated complications.

26 268 This study also found a correlation between birth weight and newborn congenital anomalies. The 27 findings of this study are consistent with research conducted in different parts of the world.⁴⁴ 28 269 29 ²₃₀ 270 Monitoring birth weight is a simple way to assess prenatal health in a population.⁴⁵ Women born with 31 271 low birth weight are more likely to give birth to low birth weight infants, perpetuating a cycle of 32 malnutrition and poverty across generations.⁴⁶ Maternal malnutrition, particularly micronutrient 33 272 34 deficiencies, is believed to be a significant factor in intrauterine growth restriction (IUGR).⁴⁷ Another 35 273 ³⁶ 37 274 study reported that 71.04% of patients with congenital anomalies had a birth weight less than 2.5 ³⁸ 275 kg.⁴⁸ The relationship between birth weight and congenital malformations is complex and influenced 39 40 276 by factors such as maternal medical conditions like hypertension, diabetes, and infections. Previous 41 42 277 studies in Ethiopia have identified factors such as maternal age under 20 years, inter-pregnancy 43 44 278 interval under 24 months, low body mass index, gestational age under 37 weeks, maternal educational 45 279 status, parity as associated with low birth weight, and lack of antenatal care follow-up.7,49,50 46 47 280 Enhancing women's empowerment through education and socioeconomic status, and quality 48 49 281 maternal care can help decrease the likelihood of low birth weight and congenital anomalies.⁴⁹

51 282 This study found that hospital deliveries are linked to congenital anomalies, but this association may 52 53 283 not be directly related to the risk of hospitals causing congenital anomalies. Women with complicated 54 55 284 pregnancies are more likely to give birth in a hospital due to the presence of specialists and equipment ⁵⁶ 285 57 to monitor and treat complications.⁵¹ Factors such as maternal history of previous congenital 58 286 anomalies, parental consanguinity, and history of medical disorders were important factors associated 59 with congenital anomalies, ⁵² which may also influence the decision to opt for hospital deliveries. 60 287

Page 13 of 19

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288 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 289 290 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 291 292 supplementation, and adequate prenatal care. Preconception and peri-conception healthcare, ₁₁ 293 including genetic screening and counseling, are crucial for identifying and managing congenital 12 294 anomalies. Screening during the neonatal period is also essential for early detection and treatment.

15 295 It is crucial to improve the quality of antenatal care to reduce the incidence of congenital anomalies. 16 17 296 By providing high-quality antenatal care, healthcare professionals and stakeholders can advise 18 297 pregnant women on maintaining proper nutrition, following recommended supplementation, 19 20 298 monitoring maternal weight regularly, and taking necessary actions for high-risk individuals ⁵⁵. 21 22 299 Prenatal screening using ultrasound can help diagnose congenital anomalies before birth. This 23 24 300 screening is a common practice in routine prenatal care and has been used for many years. Detecting ²⁵ 301 these anomalies early on can lead to better management of the pregnancy and the baby's health.^{56,57} 26 27 302 In Ethiopia, widespread ultrasound-based screening for congenital anomalies is not currently in place, 28 29 303 but implementing such screening could significantly enhance the management of these conditions. 30

31 304 Community-based HDSS provide valuable longitudinal data on a stable population, improving 32 33 305 representativeness. Research on congenital anomalies in Ethiopia is often limited to health facilities, 34 35 306 lacking representative samples. This study examined congenital anomalies in newborns within the 30 37 307 community with a large sample size, aligning with world health organization (WHO) ³⁸ 308 recommendations to strengthen surveillance systems. However, the study is observational and cannot 39 40 309 establish causality. There may be unaccounted confounding factors contributing to congenital 41 42 310 anomalies, and the types of anomalies observed were not specified. Relying solely on physical 43 44 311 examinations and maternal interviews for diagnosis may have underestimated the true prevalence of 45 312 congenital anomalies. Incorporating genetic tests and ultrasound alongside physical examinations 46 and interviews could enhance the assessment of congenital anomalies for more effective intervention 47 313 48 49 314 strategies.

⁵¹ 315 CONCLUSION 52

⁵³ 316 The data from the KHDSS revealed a rising trend in congenital anomalies. This trend was associated 54 55 317 with factors such as the mother's age, place of birth, and the baby's birth weight. It is crucial for 56 50 57 318 healthcare providers and stakholders to focus on developing strategies that consider these factors to ⁵⁸ 319 reduce the prevalence of congenital anomalies effectively. 59

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35 ₃₆ 340 37 341 38 39 342 40 41 343 42 ^{¬∠} 344 44 345 45 46 3 4 6 47 48 347 49 50 348 51 349 data request and sharing policy. 52 53 350 54 55 351 **ORCID** iDs ⁵⁶ 352 Muluken Kumera Didisa 58 353 Yohannes Baye 59 60 354 Eyerusalem Tamiru

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25 334 Patient consent for publication: Not applicable. 26

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27 335 Ethical approval: The Kersa HDSS has recieved ethical clearance from the national ethical review 28 29 336 committees of the Science and Technology Minister of the Federal Democratic Republic of Ethiopia 30 337 (Ref No. EPHA/OG/1861/15) and the Institutional Health Research Ethical Review Committee 31 ³² 338 (IHRERC) of the College of Health and Medical Sciences, Haramaya University (Ref No. 33 34 3 39 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

1		
2 355		Gezaheng Mengesha https://orcid.org/0000-0001-6450-1806
3 4 356		Lencho Kajela Solbana https://orcid.org/0000-0002-3155-9363
${}^{5}_{6}$ 357		Tesfaye Assebe Yadeta http://orcid.org/0000-0003-3015-8979
⁷ 358		
9		
10 359 11 12	REFE	CRENCES
$\frac{13}{360}$	1	World Health Organization, Congenital disorders: key fact: accesses on 27 February 2023
14 ³⁶⁰	1.	https://www.who.int/news-room/fact-sheets/detail/hirth-defects_20023
16 362	2	Reece EA Friksson II Congenital malformations: enidemiology nathogenesis and
17 363	2.	experimental methods of induction and prevention. <i>Diabetes in Women: Adolescence</i>
18 364		Programmy and Manonauso 3rd ad Philadalphia: Lippincott Williams & Wilkins
19 265		Philadolphia 2004:160-204
20^{303}_{266}	2	Fniludelphild. 2004.109-204.
$21\frac{300}{207}$	3.	Kang L, Cao G, Jing W, Liu J, Liu M. Global, regional, and national incidence and
22 36/		mortality of congenital birth defects from 1990 to 2019. European Journal of Pediatrics.
23 368		2023;182(4):1781-1792.
24 369	4.	Mekonnen AG, Hordofa AG, Kitila TT, Sav A. Modifiable risk factors of congenital
25 370		malformations in bale zone hospitals, Southeast Ethiopia: an unmatched case-control study.
26 371		BMC pregnancy and childbirth. 2020;20:1-9.
²⁷ 372	5.	Seyoum G, Adane F. Prevalence and associated factors of birth defects among newborns at
$\frac{20}{29}373$		referral hospitals in Northwest Ethiopia. Ethiopian Journal of Health Development.
₃₀ 374		2018;32(3).
31 375	6.	World Health Organization. Congenital disorders. Retrieved December 19, 2023, from
32 376		https://www.who.int/news-room/fact-sheets/detail/birth-defects. 2023.
33 377	7.	Katiso NA, Kassa GM, Fekadu GA, Kidanemariam Berhe A, Muche AA. Prevalence and
³⁴ 378		determinants of low birth weight in Ethiopia: a systematic review and meta-analysis.
³⁵ 379		Advances in Public Health. 2020;2020:1-13.
36_{37} 380	8.	Liu L, Oza S, Hogan D. Global, regional, and national causes of under-5 mortality in 2000–
38 381		15. an updated systematic analysis with implications for the Sustainable Development
39 382		<i>Goals</i> .388:30273035.
40 383	9	Sitkin NA Ozgediz D Donkor P Farmer DL Congenital anomalies in low-and middle-
41 384		income countries: the unborn child of global surgery <i>World journal of surgery</i> 2015:39:36-
⁴² 385		40
43 386	10	Kassaw MW Abebe AM Abate BB Kassie A Zemariam AB Proportion of structural
44 387	10.	congenital anomaly in eastern A frica. A systematic review and meta-analysis <i>I Pediatr</i>
45 388		Neonatal Care [Internet] 2020:10(2):43-50
46 300	11	Mayer MMM Velanhi S. Incidence, types and outcomes of congenital anomalies in babies
47 307	11.	horn at a public tertiory bospital in South African South African Journal of Child Health
49 201		2021.15(1).102 107
50 202	12	2021, 15(4). 195-197. Abmed AM El Veder S El Hemid A Geofer HM Assessment of risk fectors for fetal
51 202	12.	Annieu Alvi, El-Kauer S, El-Hanniu A, Gaarar Hivi. Assessment of fisk factors for fetal
52 393	10	congenital anomalies among pregnant women at Calro University Hospitals. 2011.
53 394	13.	Serra-June C, Rodriguez-Santiago B, Cusco I, et al. Contribution of rare copy number
54 395		variants to isolated human malformations. 2012.
55 396	14.	Organization WH. World health statistics 2010. World Health Organization; 2010.
50 397	15.	Christianson A, Howson CP, Modell B. March of Dimes: global report on birth defects, the
58 - 53		hidden toll of dying and disabled children. 2005.
59 399	16.	Dua'a F, Kawatha MM, Abdullah KL, Shawish NS, Kamel AMA, Basyouni NR.
60 400		Psychological problems among parents of children with congenital anomalies. <i>Journal of</i>
401		<i>Neonatal Nursing.</i> 2023;29(6):846-850.

Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

1		
2 402	17.	Mekonen HK, Berhe Y, Berihu BA, et al. A silent epidemic of major congenital
³ 403		malformations in Tigray, northern Ethiopia: hospital-based study. Scientific Reports.
⁴ 404		2021;11(1):21035.
⁵ 405	18.	Gedamu S, Sendo EG, Daba W. Congenital anomalies and associated factors among
7 406		newborns in Bishoftu General Hospital, Oromia, Ethiopia: a retrospective study. Journal of
8 407		Environmental and Public Health. 2021;2021.
9 408	19.	Taye M, Afework M, Fantaye W, Diro E, Worku A. Factors associated with congenital
10 409		anomalies in Addis Ababa and the Amhara Region, Ethiopia: a case-control study. BMC
¹¹ 410		pediatrics. 2018:18:1-11.
¹² 411	20.	Getachew B. Alemavehu T. Abebe S. et al. Prevalence of overt congenital anomalies and
13 412		associated factors among newborns delivered at Jimma University medical center.
15 413		Southwest Ethiopia, 2018: a cross-sectional study. International Journal of Africa Nursing
16 414		<i>Sciences</i> , 2023:18:100513.
17 415	21	Birhanu K Tesfaye W Berhane M Congenital anomalies in neonates admitted to a tertiary
18 416	21.	hospital in Southwest Ethionia: a cross sectional study <i>Ethionian journal of health sciences</i>
¹⁹ 417		2021·31(6)
²⁰ 418	2.2	UNICEF Levels & Trends in Child Mortality Estimation Child Mortality Un Igme
21 419	22.	https://www.unicef.org/media/79371/file/UN-IGME-child-mortality-report-2020.pdf.pdf
$\frac{22}{23}$ 420		2020
23 120	23	Penchaszadeh VB Preventing congenital anomalies in developing countries <i>Public Health</i>
25 422	23.	Genomics 2002:5(1):61-69
26 423	24	World Health Organization Prevention and control of hirth defects in South-Fast Asia
$27 \frac{423}{424}$	27.	Region: strategic framework (2013-2017) WHO Regional Office for South-East Asia: 2013
$28 \frac{424}{425}$	25	Vandenbroucke IP Elm Ev. Altman DG et al. Strengthening the Reporting of
$29^{+2.5}$	23.	Observational Studies in Epidemiology (STROBE): explanation and elaboration Annals of
30 420		internal medicine 2007:147(8):W 163 W 104
31421	26	A scofe N. Oliira I. Baraki N. at al. HDSS profile: the Karsa health and domographic
33 420	20.	Asserta N, Oljila L, Dalaki N, et al. HDSS pione. the Kersa health and demographic
34 429	27	Theng V. Chan L. Wang V. et al. Changes in maternal age and provalence of congenital
35_{421}	27.	Zhang A, Chen L, wang A, et al. Changes in maternal age and prevalence of congenitar anomalies during the anastment of Ching's universal two shild policy (2012, 2017) in
$36 \frac{451}{422}$		The province Chines on characterianal study <i>DL</i> of modicine 2020:17(2):e1002047
37 432	20	Zhejiang Province, China. an observational study. <i>PLos medicine</i> . 2020,17(2).e1005047.
38 433	20.	programaty system as of congenital malformations worldwide. <i>Journal of community</i>
39 4 34		pregnancy outcomes of congenital mattermations worldwide. <i>Journal of community</i>
40 435	20	genetics. 2018;9:387-396.
42 427	29.	Neel JV. A study of major congenital defects in Japanese infants. American journal of
43_{420}	20	numan genetics. 1958;10(4):398.
44 438	30.	Todros T, Capuzzo E, Gaglioti P. Prenatal diagnosis of congenital anomalies. <i>Images in</i>
45 439	21	paeatatric caratology. 2001;3(2):3.
46 440	31.	Elkarnat Z, Kindil Z, Zarouf L, et al. Chromosomal abnormalities in couples with recurrent
4/441		spontaneous miscarriage: a 21-year retrospective study, a report of a novel insertion, and a
48 442	22	literature review. Journal of assisted reproduction and genetics. 2019;36:499-507.
⁴⁹ 443	32.	Toutaily MH, Westgate MN, Lin AE, Holmes LB. Causes of congenital malformations.
51 444		Birth defects research. 2018;110(2):87-91.
52 ⁴⁴⁵	33.	Xia S, Meng C, Cheng X, et al. Trends in the prevalence of births with chromosomal
53 446		abnormalities—Haidian District, Beijing Municipality, China, 2013–2022. China CDC
54 447		Weekly. 2023;5(36):791.
55 448	34.	McDonald SD, Ferguson S, Tam L, Lougheed J, Walker MC. The prevention of congenital
57 449		anomalies with periconceptional folic acid supplementation. Journal of Obstetrics and
57 450	a -	<i>Gynaecology Canada</i> . 2003;25(2):115-121.
59 451	35.	Tamırat KS, Kebede FB, Gonete TZ, Tessema GA, Tessema ZT. Geographical variations
₆₀ 452		and determinants of iron and folic acid supplementation during pregnancy in Ethiopia:

1		
2 453		analysis of 2019 mini demographic and health survey. BMC pregnancy and childbirth.
³ 454		2022;22(1):127.
⁴ ₅ 455	36.	Central Statistical Agency (CSA) [Ethiopia] and ICF. 2016 Ethiopia Demographic and
⁵ 456		Health Survey Key Findings. Addis Ababa, Ethiopia, and Rockville, Maryland, USA. CSA
7 457		and ICF. 2017.
8 458	37.	Lassi ZS, Imam AM, Dean SV, Bhutta ZA. Preconception care: screening and management
9 459		of chronic disease and promoting psychological health. <i>Reproductive Health</i> . 2014;11:1-20.
10 460	38.	Geltore TE, Anore DL. The impact of antenatal care in maternal and perinatal health.
¹¹ 461		Empowering midwives and obstetric nurses. 2021;107.
$^{12}_{12}462$	39.	Mebratie AD, Nega A, Gage A, Mariam DH, Eshetu MK, Arsenault C, Effect of the
13 463		COVID-19 pandemic on health service utilization across regions of Ethiopia: an interrupted
15 464		time series analysis of health information system data from 2019–2020 PLOS global public
16 465		health 2022.2(9):e0000843
17 466	40	Tilahun B Nigusie A Zelalem M Mekonnen ZA Effect of COVID-19 pandemic on
18 467	10.	maternal and child health services and strategies for effective service implementation in
19 168		Ethionia Journal of Multidisciplinary Healthcare 2022:2781-2705
$20\frac{400}{469}$	<i>4</i> 1	Kibret GD Demant D Haven A The effect of distance to health facility on neonatal
$21 \frac{40}{170}$	71.	mortality in Ethionia <i>BMC Health Services Research</i> 2023:23(1):114
22 + 70	12	Tavahi N. Vazdani K. Naghshin N. The provalence of congenital malformations and its
23 + 1	42.	approlation with consensuince we marriages. Organ medical journal, 2010;25(1):27
24 4/2	12	Dethő D. Métroi Á. A géog C. et al. Meternel ago is highly aggesisted with non-abromosomel
25 4/5	43.	Petito B, Matiai A, Agoes O, et al. Maternal age is highly associated with hon-chromosomal
$\frac{-6}{4}$ $\frac{4}{4}$ $\frac{27}{475}$		congenital anomalies: Analysis of a population-based case-control database. BJOG: An
$28 \frac{4}{37}$	4.4	International Journal of Obstetrics & Gynaecology. 2023;130(10):1217-1225.
29 4 / 6	44.	Bhalerao A, Garg K. Pattern of congenital anomalies at birth. Int J Obstet Gynaecol Res.
30 4 / /	4.5	2016;3(7):420-426.
31 478	45.	I hornton J. Perinatal mortality rises both with prematurity and with the degree to which the
32 47/9		baby's birthweight is below that expected for gestational age. European Journal of
34 480		Obstetrics, Gynecology, and Reproductive Biology. 2001;95(1):5-5.
35 481	46.	Roberfroid D, Huybregts L, Lanou H, et al. Effects of maternal multiple micronutrient
36 482		supplementation on fetal growth: a double-blind randomized controlled trial in rural
37 483		Burkina Faso. <i>The American journal of clinical nutrition</i> . 2008;88(5):1330-1340.
38 484	47.	Prada J, Tsang R. Biological mechanisms of environmentally induced causes of IUGR.
39 485		<i>European Journal of Clinical Nutrition</i> . 1998;52:S21-27; discussion S27.
40 486	48.	Shawky RM, Sadik DI. Congenital malformations prevalent among Egyptian children and
41 487		associated risk factors. Egyptian Journal of Medical Human Genetics. 2011;12(1).
42 488	49.	Kebede A, Kebede A, Belina S, Biratu Y. Trends and determinants of small birth weight in
44 489		Ethiopia: further analysis of Ethiopian Demographic and Health Surveys. Ethiopian Journal
45 490		of Health Sciences. 2021;31(2).
46 491	50.	Endalamaw A, Engeda EH, Ekubagewargies DT, Belay GM, Tefera MA. Low birth weight
47 492		and its associated factors in Ethiopia: a systematic review and meta-analysis. Italian journal
48 493		of pediatrics. 2018;44:1-12.
⁴⁹ 494	51.	Kyung-Shin L, Yoon-Jung C, Jinwoo C, et al. Environmental and Genetic Risk Factors of
⁵⁰ 495		Congenital Anomalies: an Umbrella Review of Systematic Reviews and Meta-Analyses.
57 496		Journal of Korean Medical Science. 2021;36(28):1-24.
₅₃ 497	52.	Ameen SK, Alalaf SK, Shabila NP. Pattern of congenital anomalies at birth and their
54 498		correlations with maternal characteristics in the maternity teaching hospital, Erbil city, Iraq.
55 499		BMC pregnancy and childbirth. 2018;18:1-8.
56 500	53.	Organization WH. Community control of genetic and congenital disorders. 1997.
⁵⁷ 501	54.	Modell B, Darlison MW, Malherbe H, et al. Congenital disorders: enidemiological methods
⁵⁸ 502	-	for answering calls for action. Vol 9: Springer: 2018:335-340.
59 60 503	55.	Organization WH. WHO recommendations on antenatal care for positive pregnancy
504		exprience 2016:12.
		1

Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

$ \begin{array}{r} 2 505 \\ 3 506 \\ 4 507 \\ 5 507 \end{array} $	56.	Boyle B, Addor M-C, Arriola L, et al. Estimating global burden of disease due to congenital anomaly: an analysis of European data. <i>Archives of Disease in Childhood-Fetal and Neonatal Edition</i> . 2018;103(1):F22-F28.
5 508 7 509 8 510	57.	Bidondo MP, Groisman B, Duarte S, Tardivo A, Liascovich R, Barbero P. Prenatal detection of congenital anomalies and related factors in Argentina. <i>Journal of Community Genetics</i> . 2020;11(3):313-320.
9 10 511 11		
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¹³ 14 512 15	FIG	URE TITLES
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17 31 <i>3</i>		
$\frac{10}{19}514$	Figur	re 1. Trends of congenital anomalies in newborns at Kersal Health and Demographic
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