

A Silent Epidemic of Gross Congenital malformations in Tigray, Northern Ethiopia: Hospital-Based Study

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Abstract

Background

Congenital malformations are defects of the morphogenesis of organs or body during the pregnancy period and are identifiable at pre- or postnatal. It is identified as the major cause of child mortality worldwide. There is a need to understand the prevalence of congenital malformations in Tigray in particular and Ethiopia in general as surveillance data are lacking. Hence, this study was designed to investigate the burden of gross congenital malformations in the Tigray Region, Northern Ethiopia.

Methods

This cross-sectional study was conducted of birth outcomes diagnosed with structural malformations in the labor ward admitted to Ayder comprehensive specialized university hospital and five general hospitals namely Alamata, Lemlem Karl, Adwa, St Mary and Shul Hospitals from Tigray region between January 2018 and January 2019. Data on demographic and clinical findings of the mothers and their pregnancy outcomes were collected using a standard data collection tool. Simple descriptive statistics were used to characterize the study subjects. Statistical analysis was done using chi-square analysis and P value < 0.05 was considered significant.

Results

A total of 12225 births were recorded in the six hospitals during the study period. Of these, 383 births had gross congenital malformations of different degrees of severity and 12 of them were stillbirths. The overall occurrence of congenital malformations was 3.1 % of the total births (live births and stillbirths) examined. Central nervous system anomaly mainly Neural tube defect were found the commonest anomalies observed in this study. The maternal factors (maternal age, gravidity, abortion history, parity) and fetal factors (birth weight and gestational ages were significantly associated with the occurrence of the gross congenital malformations ($p < 0.05$).

Conclusion

This study has shown a high prevalence of gross congenital anomalies exists in the study communities. High prevalence of central nervous system-related malformations was observed in the Tigray region, given the high prevalence of nutritional deficiency and lack of periconceptional care that can impact the formation of the nervous system in the current study population. Hence, there should be an immediate food fortification with folic acid and periconceptional folic acid supplementation for all reproductive-age women in the region and the country at large.

Plain Of English Summary

Congenital malformations are defects of the morphogenesis of organs or body during the pregnancy period and are identifiable at pre- or postnatal. The causes of the congenital anomalies could be genetic, environmental or a combination of both. In Ethiopia, particularly in the Tigray regional state, there is currently a scarcity of birth defect data necessary to develop evidence-based prevention strategies. Therefore, this study was aimed to investigate the prevalence of congenital malformations in the Tigray region, Northern Ethiopia. This study will help to complement the ongoing scientific and policy dialogues for the intervention of the anomalies/NTDs in the region and the country at large.

The study was collected using a standard data extraction format developed based on labor ward records and pretested in hospitals of a similar setting. The format was used to collect the data from labor ward records in each hospital. All relevant information (any type of gross congenital malformations, demographic and obstetric factors) about neonates, mothers and the presence of gross congenital defects detected within 24 hours after delivery were collected. All malformations were classified as per the International Classification of Diseases (ICD) 10 classification. The assessment of gestational age was determined from the last menstrual period (LMP) to the date of birth. This was best estimated using combinations of the last menstrual period (LMP), early clinical examination and early ultrasound scans.

Of the total gross congenital malformations observed, the central nervous system anomalies specifically central nervous system defects were found the commonest anomaly accounted for 263 (68.7%). Of these CNS defects 262 (68.4 %) were neural tube defect (NTDs) cases. The overall prevalence of NTDs was 2.1% of the total births examined. Moreover, this study has shown that some of the maternal factors and fetal factors were found to be significantly associated with occurrence of structural birth defects.

In conclusion, this study has shown a high prevalence of gross congenital anomalies in the study communities, given the high prevalence of nutritional deficiency and lack of periconceptional care that can impact on births of neonates in study population. Hence, there should be an immediate food fortification with folic acid and periconceptional folic acid supplementation for all reproductive-age women in the region and the country at large.

Background

Congenital malformations are single or multiple defects of the morphogenesis of organs or bodies identified at birth or during the intrauterine life [1]. Congenital anomalies could be minor or major malformation. Major structural malformations include anomalies in central nervous system anomalies (neural tube defects), the musculoskeletal system (orofacial clefts, and limb reduction defects), gastrointestinal tract, genitourinary system, and congenital heart disease (CHD). These malformations are life-threatening, having grievous effects on the well-being and survival of children born affected by these defects [1, 2]. The majority of congenital malformations and almost all (95%) mortality due to the congenital anomalies among children occur in resource-poor settings [2]. March of Dimes global report on

congenital anomalies has shown that the hidden toll of mortality associated with congenital malformations is estimated at 3.3 million children under age five years [2].

The causes of the congenital anomalies could be genetic, environmental or a combination of both [3, 4]. In general, birth defects are responsible for ~ 7% of all under-five deaths [5]. The global prevalence of all congenital malformations is 2–3% [1, 6], while the reported incidence of malformations of the various systems of the body ranges from 1 to 5% [7]. This considerable variation has been reported in different populations, from as low as 1.07% in Japan to as high as 3% in Taiwan [8]. Birth prevalence of selected major structural birth defects in Tanzania has shown to be 0.283 % of the total births [10]. Nowadays, this problem is getting attention for research study because of the high frequency of occurrence and its devastating effect that may have on the individual and his or her family.

Recently, a hospital-based study on the incidence of neural tube defects (NTDs), have been done in the Tigray region, Northern Ethiopia [9] and this study was limited both in scope and type of anomalies studied. Apart from this, in Ethiopia, particularly in the Tigray regional state, there is currently a scarcity of birth defect data necessary to develop evidence-based prevention strategies. Therefore, this study was aimed to investigate the prevalence of congenital malformations in the Tigray region, Northern Ethiopia. This study will help to complement the ongoing scientific and policy dialogues for the intervention of the anomalies/NTDs in the region and the country at large.

Methods

Study design and period:

A prospective hospital-based cross-sectional study was conducted over period between January 2018 and January 2019.

Study Setting and population

Tigray Region is one of the nine regional state of Ethiopia, which has a total population of 4,316,988, of whom 2,126,465 are men and 2,190,523 women; urban residency for 19.55% of the total population. In the region, there are 992, 635 households, which accounts for an average for the region of 4.4 persons to in a household, with urban households having on average 3.4 and rural households 4.6 people [37]. The standard of living in Tigray region is distributed as 31.6% of the inhabitants fall into the lowest wealth quintile; adult literacy for men is 67.5% and for women 33.7%; and the regional infant mortality rate is 67 infant deaths per 1000 live births, which less than the nationwide average of 77; at least half of these deaths occurred in the infants' first month of life [38].

Tigray has fourteen Hospitals, 170 Health Centers and 552 Health Posts (providers of basic health care and family planning in the rural areas). Of these fourteen Hospitals, six hospitals including Ayder Comprehensive Specialized Hospital, Lemelem Karl Hospital, St. Mary Hospital, Sihul Hospital, Adigrat hospital, Alamata Hospital Hospital were selected randomly. These hospitals are the major public

hospitals found in six administrative zones (Mekelle zone, Eastern zone, Central zone, North West zone, Southern zone, of the Tigray region, serving populations with diverse demographic characteristics as well as health-related behaviors.

According to The Ethiopian Demographic and Health Survey (EDHS) 2016, showed that Tigray region of Ethiopia has the recent 5 years coverage of ANC1 (antenatal care at least one visit) accounts 90%, ANC 4+ (at least four visits) in 57%, 5 years coverage of deliveries attended by skilled provider in 59%, and recent 2 years coverage of deliveries attended by skilled provider in 69%, and postnatal care in was 47.7%, respectively. 57% of Tigray residents deliver at health facility or at one of the eight general hospitals (11). While there is no clear data about where or how much other deliveries occur (private hospitals, home births, etc.).

A pregnancy outcome affected with anomaly was defined as any live birth or stillbirth observed in the event of giving birth with a selected gross congenital malformation in any of the six hospitals during the study period. Stillbirth is defined as the birth of an infant that has died in the womb (strictly, after having survived through at least the first 28 weeks of pregnancy. The required data were derived from the abstraction of the gynecology and obstetrics (GYOB) ward in each hospital admission. Data were retrieved and recorded by trained midwives, midlevel obstetric professionals (trained in emergency surgery and obstetrics) resident physicians and sometimes by senior obstetricians. Every pregnant mother who delivered at gynecology and obstetrics (GYOB) ward were recorded. Maternal demographic characteristics like gravidity, parity, antenatal care, previous abortions, maternal illness, age, medication and malformation history were documented. After delivery, all relevant information about neonates (gestational age, birth weight, sex, and presence congenital malformations) were collected.

Data collection

The study was collected using a standard data extraction format developed based on labor ward records and pretested in hospitals of a similar setting. The format was used to collect the data from labor ward records in each hospital. All relevant information (any type of gross congenital malformations, demographic and obstetric factors) about neonates, mothers and the presence of gross congenital defects detected within 24 hours after delivery were collected. All malformations were classified as per the International Classification of Diseases (ICD) 10 classification. The assessment of gestational age was determined from the last menstrual period (LMP) to the date of birth. This was best estimated using combinations of the last menstrual period (LMP), early clinical examination and early ultrasound scans. Ultrasound examinations were not carried out routinely, because the equipment was not available/working at some of the hospitals at all times.

Statistical analysis

Data on demographic and clinical findings of the mothers and their pregnancy outcomes were collected using a standard data collection tool. The data collected was coded; cleaned and analysed using Statistical Packages for Social Sciences (SPSS version 20). Simple descriptive statistics were used to

characterize the study subjects. Statistical analysis was done using chi-square analysis and P value < 0.05 was considered significant.

Results

A total of 12225 births were observed in the six public hospitals over one year of the study period. Three hundred eighty-three cases of gross congenital malformation were observed during the study period. Overall prevalence of gross congenital malformations was 3.13 % of total births (live and still births). Table 1 summarizes the prevalence of gross congenital malformations in public hospitals of the Tigray regional state, Northern Ethiopia.

Table 1
Hospital based prevalence of gross congenital malformations in Tigray, Northern Ethiopia, 2019 (n = 12225).

Hospital	Total Births		Gross congenital malformation			
	N	%	No	%	Yes	%
Ayder	4366	35.7	4200	34	166	1.4
Lemlem Karl	1371	11	1318	10.8	53	0.4
Alamata	2308	18.9	2273	18.6	35	0.28
Adwa	2297	18.8	2259	18.5	38	0.3
St Marry	2707	22	2648	21.7	59	0.48
Sihul	1832	15	1800	14.7	32	0.26
Total deliveries	12225	100	11842	96.7	383	3.13
Percentages were calculated by taking the corresponding "total number" as denominator.						

Typology of congenital anomalies

Of the total gross congenital malformations observed, the central nervous system anomalies specifically central nervous system defects were found the commonest anomaly accounted for 263 (68.7%). Of these CNS defects 262 (68.4 %) were neural tube defect (NTDs) cases. The overall prevalence of NTDs was 2.1% of the total births examined. The types of central nervous system malformation identified were mainly spinal bifida, encephalocele, anencephaly, and hydrocephalus respectively. Among the 263 newborns with CNS defects there were 25 with additional malformations (twenty cases of the NTDs with gastrointestinal tract defects and five cases of the NTDs with Musculoskeletal defects). The congenitally malformed neonates (n = 383) identified in this study were classified into 10 categories according to the international classification of diseases version 10, ICD10 (Table 2).

Table 2
Type and prevalence of the gross congenital anomalies in Tigray, Northern Ethiopia, 2019.

Type of gross congenital anomalies	Frequency	Percent of the total births assessed	Percent of the observed gross congenital malformations
Central nervous system anomalies	263	2.1	68.7
Musculoskeletal system anomalies	1	0.0	.3
Gastrointestinal tract anomalies	11	0.1	2.9
Genitourinary system	12	0.1	3.1
Musculoskeletal and genitourinary defects	29	0.2	7.6
Genitourinary and gastrointestinal defects	29	0.2	7.6
Musculoskeletal and gastrointestinal defects	36	0.3	9.4
Conjoined twins	2	0.0	.5
Total	383	3.1	100.0
No congenital malformation	11842	96.9	
Total	12225	100.0	

Association of gross congenital malformation in relation to maternal and fetal characteristics

This study has shown that the maternal factors (maternal age, gravidity, abortion history, and parity) and fetal factors such as birth weight and gestational ages were found to be significantly associated with occurrence of structural birth defects. The maternal and fetal factors associated with gross congenital anomalies at birth are as depicted at Table 3.

Table 3

Association of gross congenital malformation in relation to maternal and fetal characteristics, Tigray, Ethiopia, 2019 (n = 12225).

Risk factor		Total births = n	Babies born with congenital malformations = n (%)	P-value
Maternal factor				
Maternal age	<=20	1052	53 (0.43)	0.001
	21–25	3285	122 (1)	
	26–30	4357	120 (.98)	
	31–35	2991	45 (0.37)	
	>35	540	43 (0.35)	
Abortion history	Yes	1475	77 (0.63)	0.001
	No	10750	306 (2.5)	
Gravidity	<=2	7592	195 (1.6)	0.001
	3–4	2761	116 (0.94)	
	>4	1872	72 (0.59)	
Parity	0–2	8701	280 (2.3)	0.001
	3–4	2673	60(0.5)	
	>4	851	43 (0.35)	
Antenatal care (ANC)	Yes	8653	262 (2.14)	0.304
	No	3572	121 (0.99)	
Previous congenital malformations	Yes	295	7 (0.05)	0.61
	No	11930	376 (3.09)	
Maternal illness	Yes	1047	35 (0.28)	0.65
	No	11178	348 (2.85)	
Medication	Yes	5556	170 (1.39)	0.67
	No	6669	213 (1.74)	
Fetal factors				
Gestational age	< 28	696	41 (0.33)	0.001

A cross-tabulation with the Chi-square test was done, and the resulting *P-value* < 0.05 was considered as significant.

Risk factor		Total births = n	Babies born with congenital malformations = n (%)	P-value
	28–31	1378	37 (0.3)	
	32–36	1895	52 (0.42)	
	37–38	3370	72 (0.6)	
	39–40	4596	136 (1.12)	
	> 40	290	45 (0.36)	
Sex	Male	5835	188 (1.53)	0.985
	Female	6378	194 (1.59)	
	Missing	12	1	
Birth weight	< 2.5	3579	136(1.11)	0.006
	>=2.5	8166	232(2.02)	
	Missing	480		

A cross-tabulation with the Chi-square test was done, and the resulting *P-value* < 0.05 was considered as significant.

Discussion

This study has shown a high prevalence of gross congenital malformations was observed in the study community. The overall magnitude of malformations in live births and stillbirths was 3.1%. This is higher than hospital-based studies from Egypt [11], Kolkata (India) [12], Odisha (India) [13]. Central nervous system defect specifically neural tube defects were the common malformation identified in our study. This finding is in agreement with the finding from China [14], Iran [15] and Tanzania [16] who reported CNS was the most common malformation observed in their study setting. On the contrary, birth defects of the musculoskeletal system were identified to be the commonest in Egypt [11], Kolkata (India) [12], Odisha (India) [13].

In the present study, a high number of NTDs malformations were observed which is higher than the prevalence rate (1.31%) recently reported from the similar study setting (Tigray regional state of Ethiopian) [9]. Other studies also reported different prevalence rate of NTDs: in Spain 0.2% [17], in Libya (0.24%) [18], in India (0.272%) [19]. The prevalence of NTDs observed in the present study is high which calls for immediate action by the health sectors, both at the Federal and Regional levels. Variations in prevalence might be explained by environmental and social differences which are evident in genetic disorder (i.e. consanguinity) [20]. Various clinical and experimental studies have been reported that mandatory folic acid fortification and periconceptional supplementation can prevent the occurrence and recurrence of NTDs [21, 22]. Comparably, studies showed that the risk of NTDs among all US women

dropped considerably from a pre-fortification (1988-94) estimated 35.9 (95% uncertainty interval 28.1 to 46.2) NTDs per 10 000 births to a post-fortification (2005-10) 14.6 (12.4 to 17) NTDs per 10 000 births [22].

Furthermore, this high burden of malformations, particularly NTDs, may be related to the problem of maternal nutritional deficiency, i.e., folate supplementation around the time of conception or before pregnancy during the first years of their reproductive age [23]. Several studies have shown that periconceptional folic acid supplementation reduces the risk of having an NTDs by 72% [24, 25].

The effect of nutritional deficiency is transgenerational and hence could pass to the subsequent generations of the offspring [26]. Thus, the present high burden of congenital anomalies may be linked with widespread chronic malnourishment in the region [27, 28].

In this study, more male neonates were affected with NTDs, in agreement with the previous study of the same study area [9]. A similar finding was reported from North African and Sub-Saharan countries as well [29, 30]. However, the burden of NTDs was higher in female neonates in European reports [31, 32]. The relation of the observed sex difference with the genesis of NTDs is not yet confirmed. This could indicate that different mechanisms are contributing to the genesis of NTDs and this requires further investigation.

This study has shown that the maternal factors such as maternal age, gravidity, abortion history and parity were significantly associated with the occurrence of the gross congenital malformations. This finding is in line with findings reported from various countries, which showed maternal age, gravidity, abortion history and parity were significantly associated with incidence of gross congenital malformations [12, 33].

Moreover, our study has shown fetal factors such as birth weight and gestational ages were found to be significantly associated with occurrence of structural birth defects. Comparable findings have been reported from hospital-based studies conducted from different part of India [34, 35], and population-based study from China [15]

As the study was not a community-based study, the prevalence could be artificially low when only using data from a limited number of hospitals (not including other delivery locations) and not capturing prevalence after birth (i.e., many heart defects). Moreover, fail to include congenital anomalies during miscarriages, medically terminated pregnancies, abortions and hence it can lead to potential misclassification and generalizability.

Conclusion

This study has shown a high prevalence of gross congenital anomalies in the study communities. Central nervous system (CNS) anomalies, specifically neural tube defects were the commonest anomaly observed in this study, given the high prevalence of nutritional deficiency and lack of periconceptional care that can impact the formation of the nervous system in the current study population. Hence, there

should be an immediate food fortification with folic acid and periconceptional folic acid supplementation for all reproductive-age women in the region and the country at large.

Abbreviations

CHD

congenital heart disease; NTDs:neural tube defects; CNS:Central nervous system; ICD10:international classification of diseases version 10; MSS:Musculoskeletal system; LMP:last menstrual period; HIV:human immunodeficiency virus; GUS:genitourinary system; TCG:thoracopagus; GIT:gastrointestinal tract; GYOB:Gynecology and Obstetrics

Declarations

Ethics approval and consent to participate

The study was ethically approved by the Institutional Review Board of the College of Health Sciences, Mekelle University before the starting of the actual data collection. The possibility of maltreatment or discomfort expected in this study were none existent. Well trained data collectors were used and strictly followed ethical principles. Verbal consent (as most of them were not able to read and write) was obtained from study participants before the beginning of the interviews and this was approved by the Health Research Ethics Review Committee (reference number: ERC 1279/2018). All study participants were assured that their participation was voluntary and if any discomfort, they could withdraw from the study without any problem at any stage of the data collection. Moreover, all data obtained from the respondent remained confidential and the dissemination of the study findings will be unspecified but the general source population.

Consent for publication

Not Applicable.

Availability of data and materials

All relevant data are within the paper.

Competing interests

None

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Authors' contributions

HKM has designed the study, managed data, analyzed data, and drafted the manuscript. YB, BAB, HT, AH, LG, EH, TM, and AM contribute to writing the manuscript, carry out the collection of data, and the statistical analysis. All authors read and approved the final manuscript.

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