

## Prevalence and Epidemiological Characteristics of Neonates with Neural Tube Defects at Bugando Medical Center: An 8- Year Hospital Based Survey

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### Abstract

**Introduction:** Neural tube defects (NTDs) are a common health burden in the countries of the sub-Saharan region (1) and the an important concern for the public health system (2). Prevalence in Africa has been reported at 11.7 per 10,000 (3) whereas the prevalence of NTDs in the lake zone region of Mwanza is yet to be known.

**Methods:** A cross-sectional hospital based retrospective descriptive study, involved all newborns with any type of neural tube defect admitted to the neonatal ward at Bugando Medical Center between 1st November 2013 to 28th February 2022.

**Results:** Out of the 17997 neonate admissions during the study period, the prevalence of NTDs was 44.6 :1000. Males were 438 (54.5%) more than females 366 (45.5%) with statistical significance of  $p=0.011$ . The mean age at admission 7.59 days ( $SD=7.12$ )  $CI$  0.49(7.10-8.10). Spina Bifida in particular Myelomeningocele was the most common among the neural tube defects was found in 673 (83.7%) of the admitted neonates whereas 82 (10.2%) presented with hydranencephaly and 49(6.1%) with encephalocele and with a prevalence ratio of 37.4 : 4.5 :2.7 per 1000 cases respectively.

**Conclusion:** The prevalence of neural tube defects in our study was 44.6:1000. Myelomeningocele is the commonest encountered NTD. The overall prevalence of neural tube defects from the lake zone region is very high compared to other regions of the world. Future work is needed to seek etiological explanations for the high regional prevalence differences and to develop improved methods for primary prevention of this public health burden.

**Key Words:** Neural Tube Defects, Myelomeningocele, Hydranencephaly, Encephalocele

### Introduction

Neural tube defects (NTDs) are a common health burden in the countries of the sub-Saharan region [1] and the an important concern for the public health system [2]. Prevalence in Africa has been reported at 11.7 per 10,000 [3] and the worldwide ranges from 0.17 to 6.39 per 1,000 live births [4].

Myelomeningocele (MMC) which is the most common form of NTDs, is characterized by an external immobilization of the neu-

ral placode through a posterior vertebral defect, surrounded by epithelial tissue [2]. The aetiology of NTDs has been widely linked to both environmental and genetic factors whereas the failure of closure of caudal neural pore and has been associated with poor intake of prenatal folic acid [5]. Other forms of NTDs include encephalocele and hydranencephaly. To date, NTDs can be detected both intrauterine using fetal ultrasound [6] during routine antenatal clinics (ANC) [7] or at birth on visual inspection as is the case in low middle income countries where poor ANC attendance has

been reported. NTDs have been reported to co-present with several systematic conditions such as hydrocephalus [1], lower limb deformities [8], urologic issues [9] and spine deformities [10] which may contribute to the long term burden of morbidity and mortality in patients with myelomeningocele.

Surgery after birth remains the mainstay of treatment for NTDs and involves both spina bifida closure and encephalocele repair with good outcomes [2, 11-13]. Intrauterine fetoscopic repair [14, 15] for MMCs has been mentioned in literature with mixed results although this procedure is not performed at our centre [16] with postnatal surgery being the mainstay our mainstay of treatment for NTDs.

At our institution, unpublished findings from hospital records show that NTDs are among the leading cause of admissions from local data however the local prevalence of NTDs has not been reported. Understanding the epidemiological profile of NTDs in the Lake-Zone region through analysing its prevalence and among socioeconomic regions is paramount in understanding the factors which may contribute to the aetiology, risk factors, morbidity and mortality of the disease. The main objective of this study is to report the prevalence and the geographical distribution of the relevant referral regions [2].

## Methods

### Study Design

A cross-sectional hospital based retrospective descriptive study, involved all newborns with any type of neural tube defect admitted to the neonatal ward at Bugando Medical Center between 1st November 2013 to 28th February 2022. Data was collected using admission medical records reviewing the age, sex, and region of referral to within the lake zone region.

**Table 1: Showing the Summary of Demographic Characteristics by Prevalence**

SEX	Count	Percentage	Prevalence by Sex
MALE	438	54.5%	24.3 PER 1000
FEMALE	366	45.5%	20.3 PER 1000
Total	804	100%	44.6 PER 1000
NTD SUBTYPE	Count	Percentage	Prevalence by NTD subtype
Spina Bifida	673	83.7%	37.4 PER 1000
Hydranencephaly	82	10.2%	4.5 PER 1000
Encephalocele	49	6.1%	2.7 PER 1000
TOTAL	804	100%	44.6 PER 1000

The mean number of admissions per year was 179.97 patients CI(171.9-188.03) with the January – December 2021 period posting the highest number of admissions at 2363 patients with subsequent highest prevalence at 71.1 per 1000. The prevalence was directly proportional to the total number of admissions per year although there were no statistically significant differences in NTDs prevalence by year within the 8-year period of study. (Figure 1)

## Study Area

The study was conducted at the Bugando Medical Centre (BMC). BMC is located along the shore of Lake Victoria has a 1000 bed capacity and serves as a tertiary consultant teaching hospital for the Catholic University of Health and Allied Sciences. BMC is the second largest referral hospital in the Tanzania and serves as a referral centre for tertiary referral centre with neurosurgery among the specialized services, for a catchment population of approximately 18 million people from the neighbouring regions within the Lake Zone region of Mwanza.

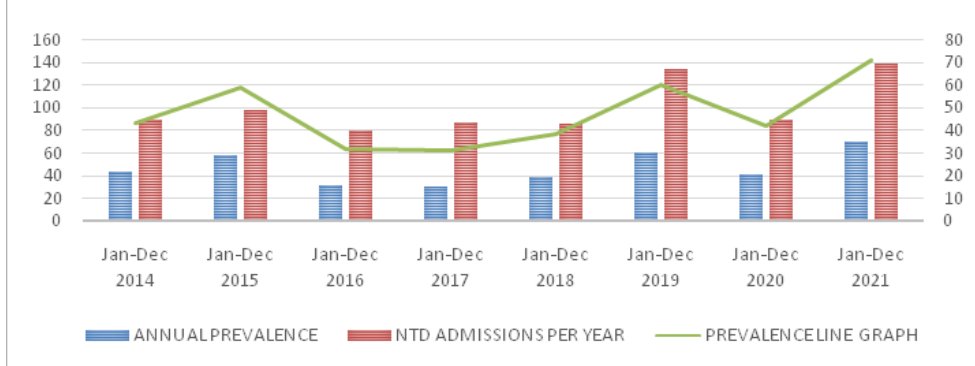
## Data Collection

The study data were collected and organized using Microsoft Excel sheet and was used to conduct the Chi-square, analysis of variance estimates. In all analyses, a p value of 0.05 or less was considered statistically significant, and 95% confidence intervals (CI) are reported, when appropriate. All prevalence estimates represent the number of cases per 1,000 admissions screened in the specified time period.

## Results

Out of the 17997 neonate admissions during the study period, the prevalence of NTDs was 44.6:1000. Males were 438 (54.5%) more than females 366 (45.5%) with statistical significance of  $p=0.011$ . The mean age at admission 7.59 days (SD=7.12) CI 0.49(7.10-8.10). Spina Bifida in particular Myelomeningocele was the most common among the neural tube defects was found in 673 (83.7%) of the admitted neonates whereas 82 (10.2%) presented with hydranencephaly and 49(6.1%) with encephalocele and with a prevalence ratio of 37.4 : 4.5 : 2.7 per 1000 cases respectively (Table 1)

## GRAPH SHOWING THE PREVALENCE OF NTDs AMONG NEONATES (PER 1000 ADMISSIONS) FOR THE 8-YEAR PERIOD



On geographical distribution within the lake zone region (figure 3) Mwanza had the highest number of referrals with 234(29.1%) and least Rukwa region with 2 patients(0.25%) (Table 2)

REGION	Number of Referrals	PERCENTAGE
MWANZA	234	29.1
SIMIYU	113	14.1
GEITA	101	12.6
TABORA	90	11.2
SHINYANGA	88	10.9
MARA	71	8.8
KIGOMA	41	5.1
KAGERA	38	4.7
SINGIDA	15	1.9
KATAVI	10	1.2
MBEYA	3	0.37
RUKWA	2	0.25
Total	804	100%

### Discussion

This study presents estimates of NTDs prevalence for neonates admitted at BMC representing the epidemiological prevalence of the Lake zone region of Mwanza, Tanzania. The overall prevalence of neural tube defects from in the Lake zone region is high compared to other regions of the world. Table 3 summarises the notable prevalence of NTDs reported in different regions around the globe and our findings rank way higher than other prevalence figures in the other countries of the sub-Saharan region and the world at large.

In line with our findings, Myelomeningocele, identified in 83.7% (673/804), was the commonest NTD encountered in our cohort. In contrast, some studies have reported a higher prevalence of anencephaly than spina bifida at 65.9 and 58.1, 14.7 per 10,000 respectively by Zhi et al [17] whereas Lisa et al [18] reporting at 0.49 (95% CI 0.46–0.53), 0.42 (95% CI 0.38–0.45) for anencephaly, spina bifida and encephalocele respectively.

**Table 3: Showing Global Summary of Prevalence of Ntds Worldwide In Comparison With Our Study**

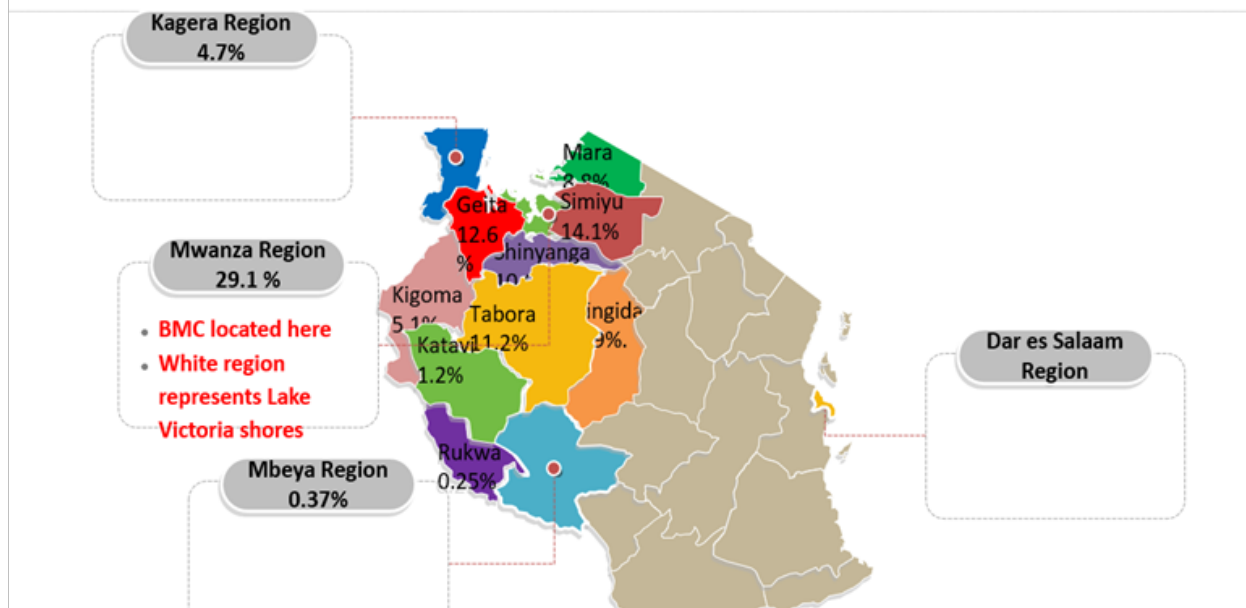
Author, Year of publication	Study Type	Place of study	Prevalence	Study duration
Feuchtbaum et al(18)1999	California NTD Registry	California, USA	0.96 (95% CI 0.91–1.00) NTDs cases per 1,000	1990-1994
Li et al(17)2006	Review of data from population-based birth defects surveillance system in 4 counties	Shaanxi Province, China	138.7/10,000 births	2003
Sorri et al(19)2015	Cross-sectional survey	Addis Ababa, Ethiopia	6.1/1000	2009-2012
Allagh et al(20)2015	Systematic review	India	4.5 per 1000 total births	1990- 2013
Atta et al(21)2016	Systematic review and meta-analysis	Worldwide	mandatory (33.86 per 100,000 LBs) versus voluntary (48.35 per 100,000 LBs)	January 1985 and December 2010
Omer et al(22)2016	Review of hospital records	Khartoum, Sudan	2.8:1000.	August 2014-July 2015
North et al(23)2018	Review of hospital records	British Columbia	2.5/10,000	1971 and 1981
			1.1/10,000	1996 and 2006
Lowry et al(24)2019	Review of hospital records	Alberta, Canada	0.37/1,000 births	2001 and 2015
Krzesinski et al (25)2019	Review of hospital records	Western Cape, South Africa	0.76 - 0.80 per 1000 live births	6-year period :post-fortification era (2003, 2004, 2007, 2009, 2011 and 2012
Ibrahim et al(26) 2019	Kingdom of Saudi Arabia National Registry Registry	Saudi Arabia	0.8-1.46/1000 births.	1979-2005
			0.44-1.46/1000 births.	Post fortification policy era
Spazzapan et al (27)2021	Cross-sectional survey	Slovenia	1/10000 births.	2007 and 2017
Peake et al (28)2021	Cross-sectional survey	United Kingdom	12.14 per 10,000 births	2006 and 2011
Linda et al(3)	Review of hospital records	Uganda	9.8 per 10000 births	August 2015 and December 2018
Our study 2022	Review of hospital records	Lake zone region of Mwanza, -Tanzania	44.6per 1000 admissions(live births)	November 2013 – February 2022

Although there was a gradual increase in annual increase of prevalence (no statistical significance) in subsequent years within our study, on contrary, the global trend observed a declining prevalence in several regions with time [21, 29] and this can be attributed to measures such as folic acid fortification [30] and measures to improve levels of reproductive health sex education [31]. Bowman et al [4] attributed the declining prevalence of myelomeningocele to folic acid fortification, prenatal diagnosis with termination of affected fetuses, and other unknown factors. Zhi et al [17] further mentioned an increase in pregnancy termination following prenatal diagnosis of anencephaly, spina bifida, and encephalocele. Such measures are not routinely undertaken in our institution hence may explain the high prevalence as compared to several regions on the world. In a local study by Mashuda et al [32], lack of peri-conceptual use of folic acid (OR=3.1; 95% CI=1.4-6.7; p=0.005), a maternal age of above 35 years (OR=2.2; 95% CI=1.1-4.3; p=0.024) and inadequate attendance to antenatal clinics were

found to be significantly associated with congenital anomalies among which Central Nervous System anomalies were reported to be the commonest in a study of 445 infants where the prevalence of congenital anomalies was reported at 29% in a period between October 2012 and January 2013.

On geographical distribution, most of the referrals were from within Mwanza region 29.1%, however, this figure could be obscured by the fact that most patients who come to Mwanza have relatives within the region hence adopt their hospital registration of the relatives' or guardian yet in actual sense they are referred from other surrounding regions for neurosurgical management which is only accessible at our institution within the vastness of the lake-zone region. The overall burden of NTDs is notably significant given the distance of these regions from BMC, Mwanza as summarized in Figure 2 below.

## Map showing the geographical distribution(percentage ) of NTDs Referrals from different regions around the Lake zone region



Economically, the regions around the lake zone region are known for mining and fishing activities as among the major source of job creation. Whereas our study did not focus on studying the risk factors for NTDs, Elias et al in his study in Northern Tanzania found reported that infants born to women in areas with artisanal and small-scale gold mining activities had a higher significant risk for neurodevelopmental impairment and which was associated with prenatal exposure to higher concentrations of mercury [33, 34]. Future studies are necessary to further understand the risk factors of NTDs.

In our setting, practice of our antenatal care package includes provision of folic acid to pregnant mothers [32], however, follow up on mothers who had given birth to babies with NTDs are not followed up for preconception folate before next pregnancy and this follow up component and counselling is lacking in most of our clinics since pregnant mothers are not binded and have the liberty to attend follow up clinics at any nearby health centre. In other regions, several measures have been taken by health officials through prenatal clinics and sex education to emphasize sensitization about use of folic acid [31].

### Limitations

Our study was not without limitations. We did not interview the patients' mothers for prenatal folic acid intake therefore, we could not establish the role of poor folic acid intake as a risk factor for NTDs. Our study did not discuss the surgical outcomes in respect to mortality and morbidity as this was not scope of our study but we aim to present this chapter in our upcoming studies. NTDs are known to be associated with other systemic anomalies, however,

given the retrospective nature of the study we did not fully capture the associated systemic anomalies due to challenge in record keeping. Additionally, in comparison to other studies, we did not study the prevalence of NTDs in pregnant mothers [28], stillbirths, and terminated pregnancies. Furthermore, future funding will enable study the genetics and molecular characteristics of the NTD genes. Finally we did not study the role of mothers' age and level of education [17] as possible factor associated with high prevalence.

### Conclusion

The prevalence of neural tube defects in our study was 44.6:1000. Myelomeningocele is the commonest encountered NTD. The overall prevalence of neural tube defects from the lake zone region is very high compared to other regions of the world. Future work is needed to seek etiological explanations for the high regional prevalence differences and to develop improved methods for primary prevention of this public health burden.

### Authors' contributions

MM, HK, AM, KL, OL, NC diagnosed, managed, selected the patients and supervised the work. DS, AM collected the clinical data and performed the statistical analysis. MR, FC, NC, GM and JL participated in the design and helped in the supervision of the research. All authors approved the final manuscript.

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### Competing interests

The authors declare that they have no competing interests.

### Availability of data and materials

The study protocol, documentation, data and all other information generated were held in strict confidence.

### Ethics and consent to participate

Ethical approval was obtained from the Joint CUHAS and BMC Ethical Review Board.

### Funding

The authors declare that we have not received funds from any organization. No financial competing interests.

### Abbreviations

BMC – Bugando Medical Center

CUHAS – Catholic University of Health and Allied Sciences

MMC - Myelomeningocele

SB – Spina Bifida

NTDs – Neural Tube Defects

HANC- hydranencephaly

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