Medical Science Journal
for Advance Research

Vol. 6, No. 1, March 2025
e-ISSN: 2774-4892

Epidemiology of Neural Tube Defects and Their Distributions within a Cohort Study in Al-Diwaniyah Governorate

Wissam Saleh Hakim
Department of Surgery, College of Medicine, University of Al-Qadisiyah, Iraq.
E-mail: wissam.hakim@qu.edu.iq

ABSTRACT

Background: *Neural tube defects (NTD) may result from incomplete or complete failure of a neural tube to close during embryonic development. In areas where folic acid is not supplemented into the diet, the incidence of NTDs remains between 0.5 to 2 in every 1000 births.* ***Objective*** *is to assess the incidence of NTDs and plan comprehensive care pathways for children with open NTDs in Al Diwaniyah, Iraq.* ***Method***: *This diagnostic study spans of 22 years, encompassing all deliveries recorded at the maternity and child teaching hospital at Al Diwaniyah region in Iraq.* ***Results***: *Of the 207 NTD patients evaluated, a birth prevalence rate of 9.4 per 1000 births was noted and a male to female ratio of approximately 3:1. The reports included spina bifida cases (66.6%), encephalocele cases (24.6%), and anencephalic cases (8.6%). 73.9 % or 153 of respondents did not take folic acid during the first trimester. 134 (64.7%) mothers were discovered to belong to low-income households, 20 (9.6%) very high-income, and 53 (25.6%) middle-class. Of the 49 mothers in this study, only 38% were from urban regions, while 62% were rural. 87% of the 163 cases had an antenatal diagnosis conducted.* ***Conclusion***: *Folic acid supplementation is suitable for preventing the recurrence of neural tube defects (NTDs) in infants of high-risk women.*

Keywords: Neural Tube Defects (NTDs); Spina bifida; Anencephaly.

Article Information
Received: January 30, 2025; Revised: February 28, 2025; Online: March 2025.

INTRODUCTION

Neural tube defects (NTDs) are a particular class of disfiguring congenital anomalies which arise due to the failure in closure of the neural tube within the embryonic period, usually during the first 28 days after conception [17]. These malformations include conditions such as spina bifida, anencephaly, and encephalocele, and are among the most common and devastating central nervous system birth defects worldwide [5,17]. The development of NTDs is caused by multiple factors, including a complex interplay of genetic factors, maternal nutritional deficits, environmental factors, and socioeconomic status [5,9,17]. The developing and developed nations set the average prevalence of NTDs between the rates of 0.5 to 10 births per 1,000. This rate drastically increases in developing countries where prenatal care and access to folic acid supplements are minimal [5,6,17].

These countries, such as the United States, are taking drastic measures in curbing NTD so have introduced folic acid fortification resulting in the prevalence instantly dropping to 1 out fo 10,000 births [17,18]. Yet low and middle income countries, especially iraq, face an instantaneous rise in numbers of NTD-owing babies making the burden immensely disproportionate [6,9,12]. Widespread use of depleted uranium in warfare coupled with

https://doi.org/10.46966/msjar.v6i1.258

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insufficient maternal health care services have been attributed to nutritional neglect during the pre conception phase deepens the problem in Iraq [9,12]. The clinical spectrum of NTDs include disabling conditions like meningocele and myelomeningocele to lethal outcomes like anencephaly where affected neonates typically die within hours or days of birth [17,19]. Spina bifida remains as one of the most physically disabling conditions for children and frequently accompanies other challenges like hydrocephalus and lifelong neurological deficits, andindeed, spina bifida is one of the most significant causes of disability in childhood [23].

The evidence around pre-conception supplementation of folic acid and reduction of NTDs risk remains consistent and strong, [2,3] as well as during early pregnancy. One of the studies performed in Malaysia was a randomized controlled trial that proved the effectiveness of even weekly supplementation in increasing maternal folate levels and accordingly lowering the chances of developing neural tube defects [2]. Nonetheless, adherence to recommendations of folic acid intake is still reported to be low in many countries including Iraq which suffers from low levels of awareness and access to the supplements [3,6]. In light of this context, the goal of this study is to assess the epidemiology and the trend of NTDs in Al-Diwaniyah Governorate over a period of 22 years. By pinpointing certain patterns associated with demographics, antenatal care, delivery method, type of defect, and geographic spread, this study aims to guide public health planning regarding NTDs and underscore the critical concern for proper maternal nutrition and prenatal care in the area.

METHODS

Study design

This descriptive study is derived from reporting all cases with a neural tube defects (NTD), whether or not it was associated with other anomalies in the Maternity and Children's Hospital at Al-Diwaniyah between 2003 and 2025. In this research, all women who had their baby or newborn exhibited an isolated or combined NTD were included, whether or not they were diagnosed during prebirth or postbirth. The results were regardless of the term of their pregnancy or the outcome of their child.

Data collection

Once a case is admitted, each couple is required to participate after receiving the necessary information. The information included is the demographic and reproductive characteristics of the mother (age, income, folic acid, delivery method and area of residence), as well as the infant's (sex, weight, gestational age, type of NTD and whether associated or isolated). Other than that, all births were evaluated for congenital disabilities. A doctor who oversaw the surveillance of the infants recognized the disabilities related to congenital issues. Additionally, informed consent was attained for the photographs.

RESULTS

A 207 neural tube defects victim were taken into account in this report. In 130 cases (62.8%), the average mother age was under 35 years, whereas in 77 cases (37.2 %), it was beyond 35 years. As a result, medical supervision was absent for one-third of the moms who gave birth. The opposite was true for 153 patients (73.9%) who failed to take folic acid during their first trimester of pregnancy. Additionally, 134 moms (64.7%) lived in low-income households, 20 of them (9.6%) had a very high-income level, and 53 (25.6%) were middle-class.

This study had 49 moms (23.6%) from urban regions and 158 mothers (76-3%) from rural regions. Antenatal diagnosis was conducted in 78.7% of 163 cases. Only seven cases included the medical termination of pregnancies. The majority of deliveries resulted in live births, with vaginal deliveries accounting for only 33 cases (15.9%), while Caesarean sections comprised the majority at 174 cases (84.1%) Figure (1).

Neural tube defects (NTDs) were linked to additional anomalies in 65 cases (31.4%) and occurred in isolation in 142 cases (68.5%), including three childrens with both spina bifida and encephalocele Figure (2). About 16.9% of newborns presented with low birth weight (2,500 g; n = 35), while 10.6% were born prematurely (37 weeks; n = 22). Spina bifida (n = 138;66.6%) represented the most common type of neural tube defect (NTD), with 82% of affected children being born alive. A significant proportion of the examined newborns displayed spine-related injuries, with 59.4% (n = 123) in the lumbosacral region and 31.4% (n = 65) in the lumbar region, as presented in figure (3). It is important to note that spina bifida occurred less frequently in females compared to males (n = 123 male: 59.4%; n = 84 female: 40.5%), whereas anencephaly was more common in females (Figure 4).

Encephalocele represented the second most common neural tube defect, with a prevalence of 24.6 % (n = 45) and Anencephaly was the third most common neural tube defect in this cohort (n = 18; 8.6%). While the majority of anencephaly cases are delivered alive, all patients ultimately perish within the first few hours after birth. The majority of newborns with encephalocele were born alive, with the condition primarily located in the occipital region (n = 5; 2.4%). The predominant type of NTD was meningocele, identified in 128 instances (61.8%), succeeded by myelomeningocele, observed in 51 cases (24.6%). In contrast, lipomeningocele was reported in merely 16 instances (7.7%), while lipomyelomeningocele and myelocystocele were observed in only 6 cases (2.8%) (Table 1).

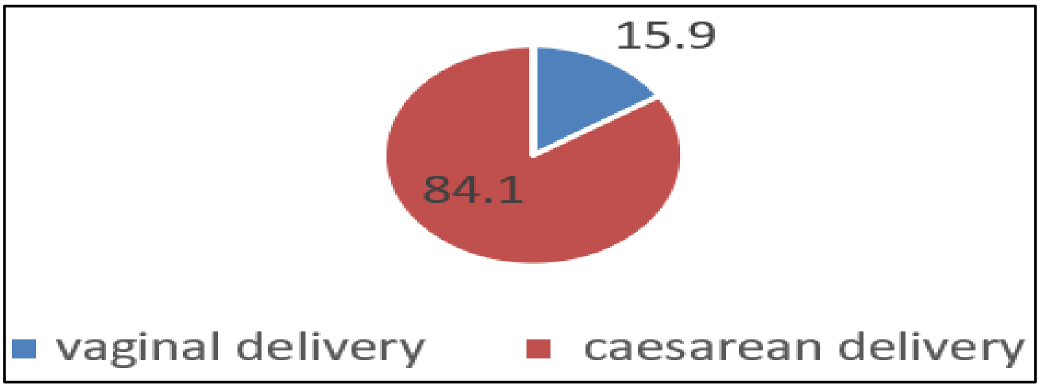


Figure (1): Vaginal and caesarean delivery distribution.

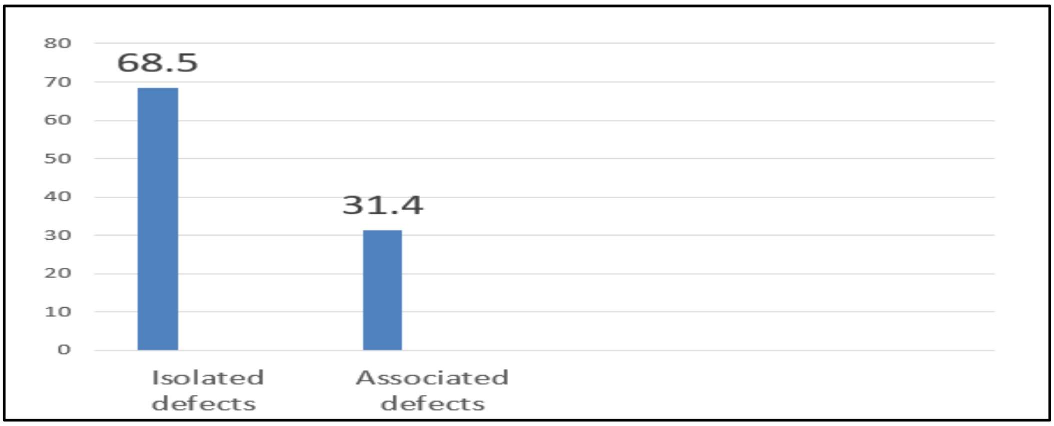


Figure (2): Isolated and associated defects distribution.

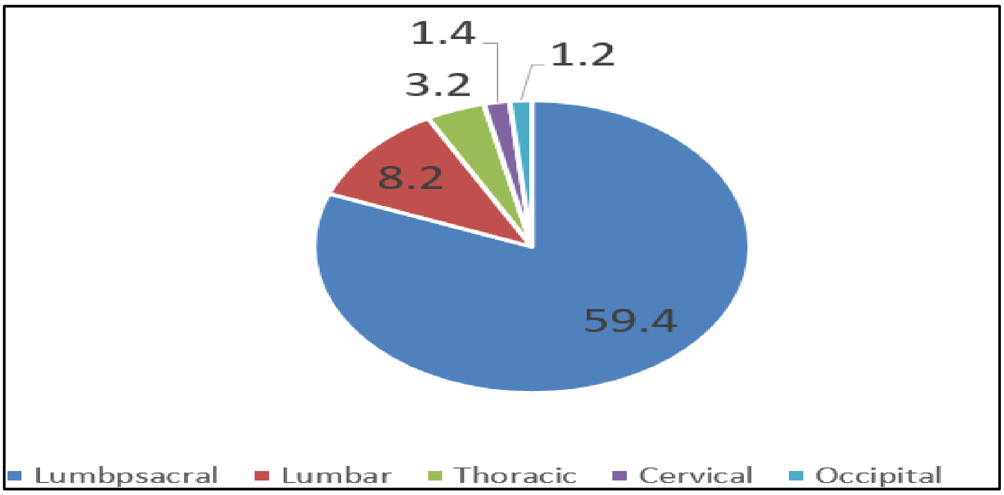


Figure (3): Locations of neural tube defects (NTDs).

Table (1): Categories of neural tube defects (NTDs).

Type	N	%
Meningocele	128	61.8
Meningomyelocele	51	24.6
LipoMeningocele	16	7.7
Lipomeningomyelocele	6	2.8
Myelocystocele	6	2.8

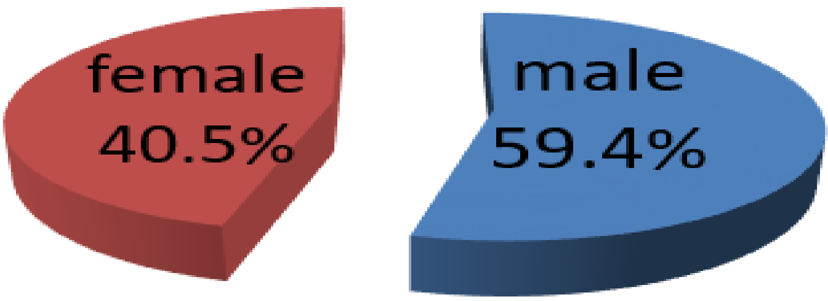
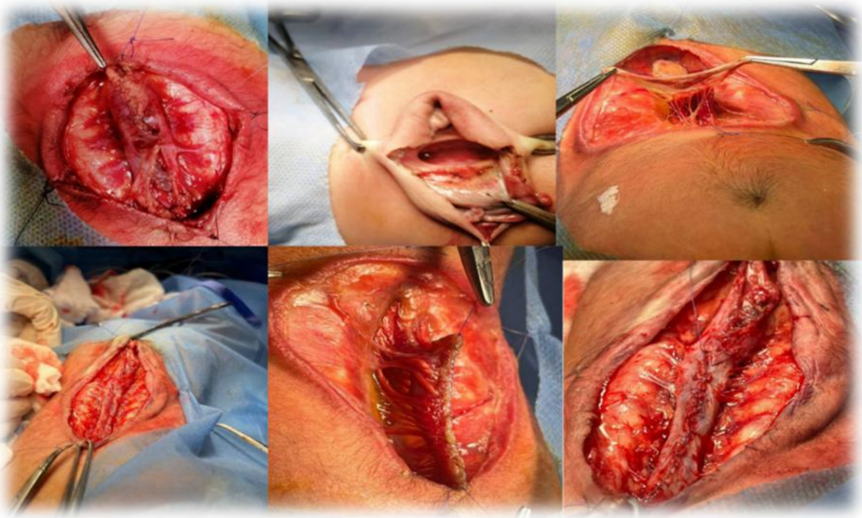


Figure (4): Sex distribution of Neglected Tropical Diseases (NTDs).

Picture (1): The results of double-flank incisions for a large defect.

Picture (2): Various types, sites, and forms of NTD.



Picture (3): Intraoperative findings and correction of NTD.

DISCUSSION

This study notes a strikingly high rate of neural tube defects (NTDs) in Al-Diwaniyah Governorate of Iraq—9.4 per 1,000 births—higher than previously local data (8.5/1,000) [6], as well as below Basrah (4.3/1,000) and Baghdad (4.4/1,000) [6]. However, it is still less than the astonishing figures recorded in Najaf (27/1,000) and Fallujah (95/1,000) [12]. These discrepancies are likely due to a mixture of environmental contaminants, such as depleted uranium [9], poor maternal diet, inadequate access to antenatal care, low folate levels, and socioeconomic conditions [6,9]. The predominance of spina bifida (66.6%) among NTD types observed in this study is consistent with other parts of Iraq, including Al-Ramadi [14], and internationally, India [17]. The following were encephalocele (24.6%) and anencephaly (8.6%), which are the next most frequent defects. This is consistent with previous literature where it is stated that spina bifida is generally the most prevalent NTD in developing countries [14,17]. Regarding sex distribution, our cohort was found to be predominantly male (59.4% male, and 40.5% female), particularly for spina bifida cases. This corresponds to findings from Uganda [13] and elsewhere [17]; however, some studies report female predominance for anencephaly cases [16].

This variation merits further research considering possible gender-based genetic or environmental susceptibility [17, 18]. One of the striking observations of this study is the very low rate of folic acid supplementation, with only 26.1% of mothers reporting to ingest folic acid in the first trimester. This is particularly alarming in light of strong evidence which claims the protective effect of folic acid against NTDs [2,3]. A Malaysian randomized controlled trial showed the significant increase in erythrocyte folate levels and reduction in the risk of NTDs with the addition of weekly folic acid supplementation [2]. Findings from Iraq add further evidence supporting this relationship and clearly point to the need for public health education and supplementation programs [3,6].

Antenatal diagnosis was accomplished in 78.7% of cases, but only seven pregnancies were actually terminated, which indicates sociocultural or legal limits on voluntary termination of pregnancy, even in the case of severe or lethal anomalies [24]. This is similar to the findings from Morocco where cultural factors restricted the rate of voluntary termination despite confirmed diagnoses [24]. The data highlights significant differences between urban and rural populations. A remarkable 76.3% of NTD cases came from rural areas, indicating that scarcity of health services, inadequate nutrition, and ignorance in these populations might explain the high prevalence. This is different from Uganda where most of the referrals were from urban or peri-urban populations which suggests better access to health care services and diagnostic facilities [13]. Caesarean sections are prevailing among cases of NTD (84.1%) and it is probable that trauma risk in neonates with complex congenital anomalies is the reason for this. Such practices are documented with other regions with the same concern on NTDs [4,19].

For other anatomical regions, the most affected areas: lumbosacral region (59.4%) and lumbar spine (31.4%), are in sync with the rest of the world epidemiologically [21]. Additionally, there is a 33.3% co-occurrence of hydrocephalus NTDs, most severely affected being thoracic and lumbosacral spina bifida, which is consistent with existing evidence that 80-85 % of the population suffering from spina bifida, excluding anencephaly and encephalocele, are believed to develop hydrocephalus [23]. Even with its merits, the study lacks the consideration of stillbirths and terminations which leads to an inflated estimate of NTDs. Not having an extensive follow up also means leaving out any outcomes regarding neurological damage or disabilities. Greater scope for longitudinal research is needed, particularly in relation to functional effects and in regard to patternal and wider environmental factors as suggested in studies from Algeria and Morocco [15,24]. Finally, despite the worldwide decline of NTD prevalence linked to routine folic acid fortification and prenatal screenings [1,2], the unyielding high rates in Iraq demonstrate that such public health strategies are inadequately employed or inaccessible to certain populations.

Limitations of the study

This is a descriptive study that included only live births, thus excluding the large number of stillbirths and abortions due to fatal syndromes associated with neural tube defects (NTDs), such as Meckel-Gruber syndrome and other diseases. Therefore, this study covered NTDs in medical centers. Extended follow-up is necessary to identify all anomalies, including functional impairment and disability; however, this was not addressed in this investigation. Consequently, we must contemplate more extensive investigations with prolonged follow-up.

CONCLUSION

This 22-year longitudinal study notes the persistent increase in the prevalence of Neural Tube Birth Defects (NTDs) spanning the Al-Diwaniyah Governorate of Iraq and registering a staggering 9.4/1000 births, which is even higher than comparable other regions of the country. Dominance of spina bifida, followed by encephalocele and aplasia of the scalp, epitomizes the tremendous burden these defects pose on the neonatal population and their life expectancy. The deficiency of folate, living in a rural area, limited prenatal care, and socioeconomically underprivileged status were some of the predisposing factors for the development of dichochisis according to the study. Although some progress has been noted with the management of NTDs using diagnostic techniques and surgery, the acceptance rate for periconceptional folic acid use remains low, thus making prevention efforts stagnated. Additionally, the high prevalence of cesarean deliveries among these patients, the majority of whom have coexisting hydrocephalus, illustrates the complexity of the condition along with the economic resources required for its treatment.

This sheds light particularly for rural areas with lower socioeconomic status and limited access to prenatal care, highlighting the dire need to implement policies regarding maternal education, folic acid allocation, and basic care opportunities at subsidized prenatal clinics. Detailed studies regarding the burden, outcomes and preventive strategies of NTDs in Iraq, as well as their specific types, require further population-based research with expanded time scope longitudinal studies at the national level. There is a need for comprehensive clinical, community, and policy action to multidisciplinary integrate to reduce the impact and prevalence of neural tube defects in the region.

ACKNOWLEDGEMENT

We want to thank all the people and participants who contributed to this study.

Informed consent: Patients provided informed consent.

Adversity of destination: The authors deny ha ving a conflict of interest.

REFERENCES

1. Vinodhini K, Singh S, Parthasarathy R, Priya N, Jamra K. Craniorachischisis totalis: A rare and severe neural tube defect. *J Clin Images Med Case Rep*. 2024; 5(8): 3211.

2. Samson KLI, Loh SP, Khor GL, et al. Effect of once weekly folic acid supplementation on erythrocyte folate concentrations in women to determine potential to prevent neural tube defects: a randomised controlled dose-finding *trial in Malaysia. BMJ Open.* 2020;10:e034598.

3. Wissam Saleh Hakim, Ali Saleh Aljanabi. The Aperta type of neural tube defect: The relevant experience in a local community with the diversity of the presentation. *Journal of Medicine and Life*. 2023; 16(10): 1499-1502.

4. Mailaram S, Nalini YL, Bai PV, Rani S, Lakshmi V. Neural tube defects: *A case series. MRIMS J Health Sci.* 2021;9:34-7.

5. K Varinder, S Jyoti. Neural Tube Defects: A Comprehensive Review. *Int J Sci Res (IJSR).* 2018;7(4):270-275.

6. Al-Shammosy MM. Neural tube defects in Diwaniah increasing incidence. Proceedings of the Conference on the Effects of the Use of DU Weaponry on Human and Environment in Iraq. Diwaniah (Iraq): *Ministry of Higher Education and Scientific Research;* 26-27 March 2002.

7. Oakeshott P, Hunt GM, Poulton A, Reid F. Expectation of life and unexpected death in open spina bifida: a 40-year complete, non-selective, longitudinal cohort study. *Dev Med Child Neurol*. 2010;52(8):749-753.

8. Copp AJ, Greene ND. Neural tube defects: disorders of neurulation and related embryonic processes. *Wiley Interdiscip Rev Dev Biol*. 2013;2(2):213-227.

9. Al-Sadoon I, Hassan GG, Yacoub AA-H. Depleted uranium and health of people in Basrah: Epidemiological evidence. *Proceedings of the Conference on the Effects of DU Weaponry*; 2002.

10. Murad AM, Murad MM, Jamil NF, et al. Incidence of neural tube defects in Al-Yarmouk Teaching Hospital over one year (2006–2007). *Iraqi J Comm Med.* 2008;21(4):331–334.

11. Mahmood AKA. Neural tube defects among infants delivered of mothers with tobacco smoke exposure. *Med J Basrah Univ.* 2007;25:25–28.

12. Simpson J. Falluja doctors report rise in birth defects. BBC News. March 4, 2010. Accessed April 20, 2010.

13. Barlow-Mosha L, et al. Prevalence of neural tube defects, maternal HIV status, and antiretroviral therapy from a hospital-based birth defect surveillance in Kampala, *Uganda. Birth Defects Res.* 2022;114(3-4):95–104.

14. Al-Ani ZR, Al-Hiali SJ, Al-Mehimdi SM. Neural tube defects among neonates delivered in Al-Ramadi Maternity and Children's Hospital, western Iraq. *Saudi Med J.* 2010;31(2):163–169.

15. Houcher B, Begag S, Egin Y, Akar N. Neural tube defects in Algeria. In: *INTECH;* 2012.

16. Sunil Kumar Rai, Royana Singh, et al. High incidence of neural tube defects in Northern part of India. *Asian J Neurosurg.* 2016;11(4): October–December.

17. Botto LD, Moore CA, Khoury MJ, Ericson JD. Neural tube defects. *N Engl J Med.* 1999;341:1509–1519.

18. Greene ND, Copp AJ. Neural Tube Defects: From Origin to Treatment. *Oxford University Press.* 2005. pp. 125–126. ISBN: 9780199775149.

19. Haslam RHA. Congenital anomalies of the central nervous system. In: Behrman RE, Kliegman RM, Jenson HB, editors. *Nelson Textbook of Pediatrics. 16th ed. Philadelphia: WB Saunders Co*; 2000. p. 1803–1810.

20. Rennie JM. Central nervous system malformation. In: Rennie JM, Roberton MRC, editors. *Textbook of Neonatology. 3rd ed. Edinburgh: Churchill Livingstone*; 1999. p. 1297–1311.

21. Wasant P, Sathienkijkanchai A. Neural tube defects at Siriraj Hospital, Bangkok, Thailand–10 years review (1990–1999). *J Med Assoc Thai.* 2005;88:S92–S98.

22. Al-Aziz Wannas Abd, et al. Study of Neural Tube Defects at Al-Diwaniyah Province / Iraq. *AL-Qadisiya Medical Journal.* 2018;14(26):83–93.

23. Rintoul NE, Sutton LN, Hubbard AM. A new look at Myelomeningoceles: functional level, vertebral level, shunting, and the implications for fetal intervention. Pediatrics. 2002;109:409–413.

24. Khenata Forci, et al. Incidence of neural tube defects and their risk factors within a cohort of Moroccan newborn infants. BMC Pediatrics. 2021;21:124.

25. Ahmad Behrooz, et al. Prevalence and Correlates of Neural Tube Defect in South West Iran. *Sultan Qaboos Univ Med J.* 2007;7(1).