**Journal of Neonatal Surgery**
***ISSN(Online): 2226-0439***
***Vol. 14, Issue 18s (2025)***
*https://www.jneonatalsurg.com*

OPEN ACCESS

# Spectrum of Congenital Malformations - At A Tertiary Hospital

**Dr. Dinesh Kumar Murugesan**

[1]Assistant Professor, Department of Radiology, Sri Lalithambigai Medical College and Hospital, Maduravoyil, Chennai Tamilnadu.

**CORRESPONDING AUTHOR**

DR. Dinesh Kumar Murugesan

E.MAIL: docmdkumar@yahoo.co.in

Cite this paper as: Dr. Dinesh kumar Murugesan, (2025) Spectrum of Congenital Malformations - At A Tertiary Hospital. *Journal of Neonatal Surgery*, 14 (18s), 401-407.

**ABSTRACT**

Congenital anomalies have emerged as one of the leading cause of perinatal mortality and morbidity all over the world. Congenital malformations representsdysmorphogenesisoccuringin early fetal life. We are in need of systematic data on the magnitude of congenital anomalies, their prevalence, and their impact on neonatal health. The aim of this study was to determine the prevalence of lethal and non lethalcongenital anomalies observed during 2024-2025 . The study was conducted in the Department of Radiology, Sri Lalithambigai medical college and hospital,, a tertiary care hospital in Chennai, from March 2024 – February 2025 .

**Keywords:** Congenital anomalies, Malformations , Lethal and Non lethal anomalies

## 1. INTRODUCTION

According to WHO, Congenital anomalies are defined as structural or functional anomalies, including metabolic disorders which are present at the time of birth. [1,2] Birth defects, congenital malformations, congenital abnormalities and congenital anomalies (CAs) are interchangeable terms used to describe developmental defects that are present at birth.[3] Congenital malformation represents dysmorphogenesis occurring in early fetal life. Congenital anomalies are a spectrum of disorders with prenatal origin that can be caused by single gene defects, chromosomal disorders, multifactorial inheritance, environmental teratogens and or micronutrient deficiencies. Maternal infections such as rubella, CMV systemic illnesses like diabetes mellitus (DM), hypothyroidism and folic acid deficiency, exposure to medicinal and recreational drugs including alcohol and tobacco, certain environmental chemicals and doses of radiation are all other factors that cause birth defects.[4] The leading causes of infant morbidity and mortality in poorer countries are malnutrition and infections, whereas in developed countries they are cancer, accidents and congenital malformations. Congenital anomalies account for 8-15% of perinatal deaths and 13-16% of neonatal deaths in India.5,6 Congenital anomalies account for 11% of neonatal deaths globally and 9% in India. [3] The prevalence of birth anomalies in India is 6-7%. [3,4] Patients with multiple congenital anomalies present a relatively infrequent but tremendously difficult challenge to the physician. Thus, we are in need of systematic data on the magnitude of congenital anomalies, their prevalence, and their impact on neonatal health. Prevalence studies give an idea about the pattern of occurrence of anomalies in different places, changes over a period of time and also give some clues to identify the aetiology. The present study The aim of this study was to determine the prevalence of lethal and non lethal congenital anomalies observed during the period of march 2024- february 2025 .

## 2. MATERIALS AND METHODS

It is an observational cross sectional study carried out at our hospital , Sri Lalithambigai medical college and hospital from March 2024 to February 2025 .This study was done , wherein all the women attending for their first antenatal check up at our hospital Sri Lalithambigai Medical College and Hospital are enrolled and followed till outcome. All the live neonates from newborn to 30 days of age irrespective of their general condition with Congenital malformation alsocomprised the study population. All the relevantinformations regarding gender, weight, gestational age, mode of delivery, consanguinity, maternal age, antenatal visit record, and family history collected on a predesigned pro forma.

## 3. OBSERVATIONS AND RESULTS

During the study period the total number of pregnant patients whounderwent ultrasound was 1095 , of which the total number of congenital anomalies was 36. The prevalence rate is 3 %. The pattern of congenital malformations seen in neonates; most commonly affected musculoskeletal system 34 % followed by the central nervous system (32%), genitourinary system (30%), gastrointestinal system (8%), and syndromic (25%) [ Lethal anomalies ( 66 .6 % ) , Non lethal anomalies ( 33.3 % ) ]

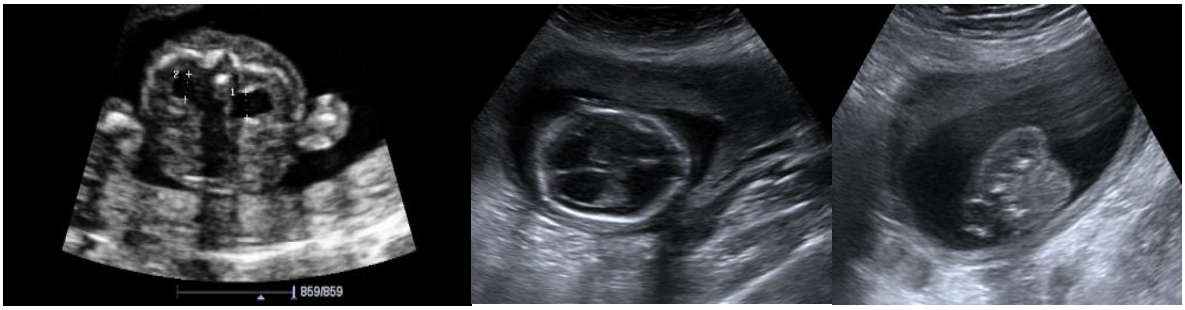
Multiparity was an important association among the risk factors studied. Among the maternal risk factors, gestational diabetes mellitus was found to be associated with birth of an anomalous baby, with nearly 24% of anomalous neonates being born to diabetic mothers . Regarding the maternal age, A higher proportion of anomalies were noted among teenage mothers and mothers less than 25 years with 5.5 % of anomalous babies being born to mothers less than 20 years and another54.4 % to mothers between 20 to 25 years. Mothers between 26-30 years had 10 anomalous babies (27.7%) and between 31-35 years had 4 (10.8 %) babies with anomalies ( Table 1 ) . Distribution and pattern of lethal and non lethal anomalies were tabulated ( Table1 )

**TABLE - 1**

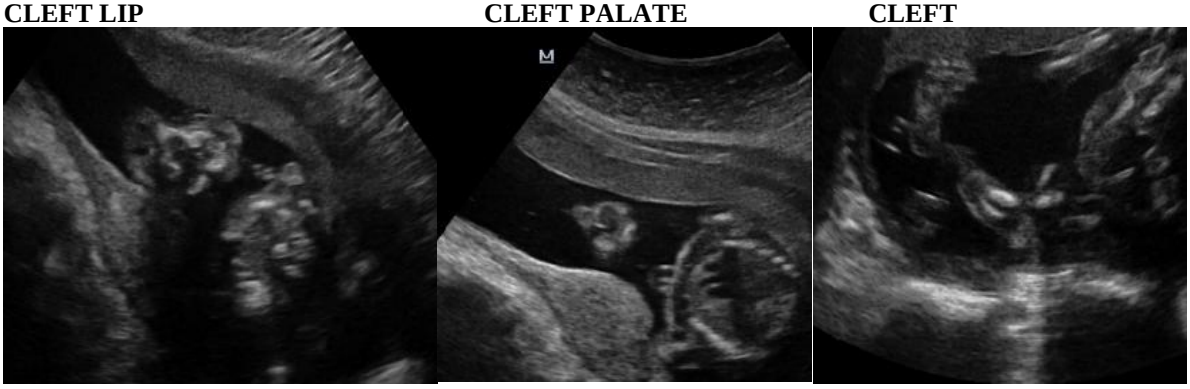
| S.NO | AGE (YRS) | GESTATIONAL AGE IN WEEKS | CONGENITAL ANOMALIES / SYSTEM INVOLVED | CONGENITAL ANOMALIES |
|---|---|---|---|---|
| 1 | 21 | 20 WEEKS | CNS<br>GUT | ANENCEPHALY<br>BILATERAL HYDRONEPHROSIS |
| 2 | 30 | 10-11 WEEKS | CNS<br>MSK | ANENCEPHALY<br>CYSTIC HYGROMA<br>CAUDAL REGRESSION SYNDROME |
| 3 | 32 | 21-22 WEEKS | CNS<br>SPINE | ARNOLD CHIARI MALFORMATION WITHMENINGOCELE |
| 4 | 24 | 22 WEEKS | CNS<br>SPINE<br>CVS | ARNOLD CHIARI MALFORMATION WITHMENINGOCELE<br>CARDIAC ECHOGENIC FOCUS |
| 5 | 22 | 23-24 WEEKS | CNS<br>SPINE | ARNOLD CHIARI MALFORMATION WITHMENINGOCELE |
| 6 | 24 | 18-19 WEEKS | GIT<br>RS<br>MSK | GASTROSCHISIS<br>NARROW THORAX<br>ABSENT RIGHT LOWER LIMB<br>PHOCOMELIA |
| 7 | 24 | 21-21 WEEKS | GUT<br>MSK | BILATERAL DILATED RENAL PELVIS<br>CLUB FOOT |
| 8 | 23 | 27-28 WEEKS | CNS | BILATERAL DILATED LATERAL VENTRICLES |
| 9 | 24 | 21 -22 WEEKS | MSK | TALIPES EQUINO VARUS |
| 10 | 26 | 21 WEEKS | CVS | EXOPHYTIC ECHOGENIC CARDIAC FOCUS |
| 11 | 30 | 20-21 WEEKS | GUT<br>FACE | MULTICYSTIC KIDNEY ,RIGHT<br>CLEFT PALATE AND CLEFT LIP |
| 12 | 23 | 35-36 WEEKS | FACE | RIGHT CLEFT PALATE AND CLEFT LIP ,SINGLE UMB ARTERY |
| 13 | 30 | 20-21 WEEKS | MSK | TALIPES EQUINO VARUS IN RIGHT SIDE |
| 14 | 32 | 35 WEEKS | MSK<br>CVS | BILATERAL TALIPES EQUINUS ,ECHOGENIC CARDIAC FOCUS |
| 15 | 25 | 19 WEEKS | RS<br>ABDOMEN | CHAOS<br>CPAM<br>ASCITES |
| 16 | 24 | 20 WEEKS | RS | CHAOS |

| | | | | |
|---|---|---|---|---|
| | | | ABDOMEN | CPAM<br>ASCITES |
| 17 | 20 | 19 WEEKS | RS<br>ABDOMEN | CPAM<br>CONG.LOBAR EMPHYSEMA<br>MESENTRIC CYST |
| 18 | 30 | 35 WEEKS | GUT | MULTICYSTIC KIDNEYS |
| 19 | 23 | 12 WEEKS | CNS | ACRANIA<br>EXCENCEPHALY |
| 20 | 24 | 18 WEEKS | GIT<br>RS | GASTROSCHISIS<br>NARROW THORAX |
| 21 | 23 | 19 WEEKS | GUT | PELVIC KIDNEY |
| 22 | 27 | 38 WEEKS | GUT | BILATERAL PUJ NARROWING |
| 23 | 23 | 18 -19 WEEKS | CNS<br>SPINE<br>CVS | ARNOLD CHIARI MALFORMATION WITH<br>MENINGOCELE<br>CARDIAC ECHOGENIC FOCUS |
| 24 | 22 | 13 -14 WEEKS | CNS<br>GUT<br>MSK | MECKEL GRUBER SYNDROME |
| 25 | 28 | 23 WEEKS | GUT | BILATERAL DILATED RENAL PELVES |
| 26 | 25 | 24 WEEKS | GUT | MULTICYSTIC DYSPLASTIC KIDNEYS |
| 27 | 22 | 20-21 WEEKS | CNS<br>SPINE<br>MSK | HOLOPROSENCEPHALY<br>ABSENT SACRUM<br>BILATERAL CLUB FOOT AND HAND |
| 28 | 28 | 20 WEEKS | CNS | VENTRICULOMEGALY |
| 29 | 20 | 31 WEEKS | CNS | SCHIZENCEPHALY |
| 30 | 25 | 21-22 WEEKS | GUT | POSTERIOR URETHRAL VALVE |
| 31 | 22 | 22 -23 WEEKS | MSK | SINGLE UMBILICAL ARTERY |
| 32 | 32 | 35 WEEKS | MSK<br>CVS | TALIPES EQUINUS IN RIGHT SIDE<br>TALIPES EQUINO VARUS IN LEFT SIDE<br>ECHOGENIC CARDIAC FOCUS |
| 33 | 27 | 15-16 WEEKS | MSK | ACHONDROGENESIS<br>ASPHYXIATING THORACIC DYSTROPHY |
| 34 | 21 | 21-22 WEEKS | CVS | SINGLE ARTERIAL TRUNK<br>TRUNCUS ARTERIOSUS |
| 35. | 26 | 21 WEEKS | MSK | CLUB FOOT<br>TALIPES EQUINO VARUS |
| 36 | 32 | 13 WEEKS | MSK | CYSTIC HYGROMA |

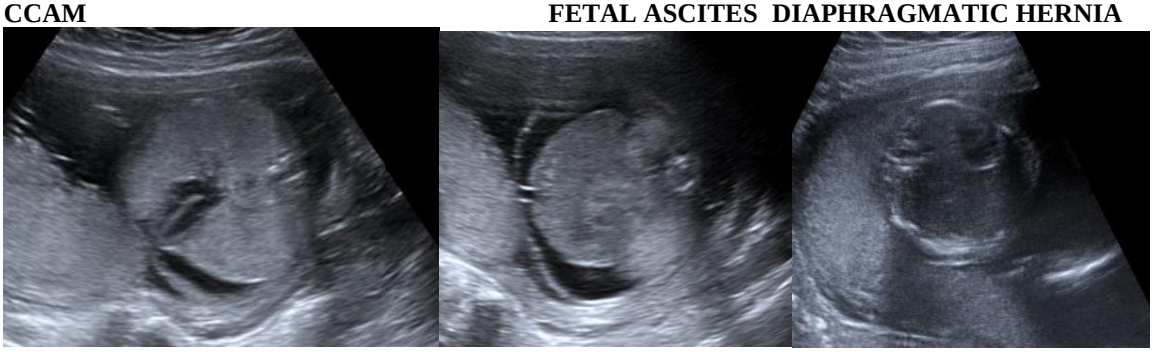
Dilated Renal Pelvis Dandy Walker Malformation Meningocele



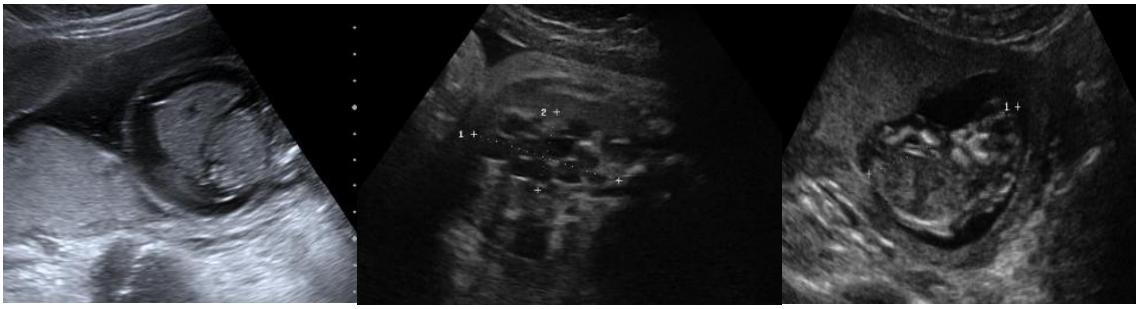
**CLEFT LIP** **CLEFT PALATE** **CLEFT** **FOOT**



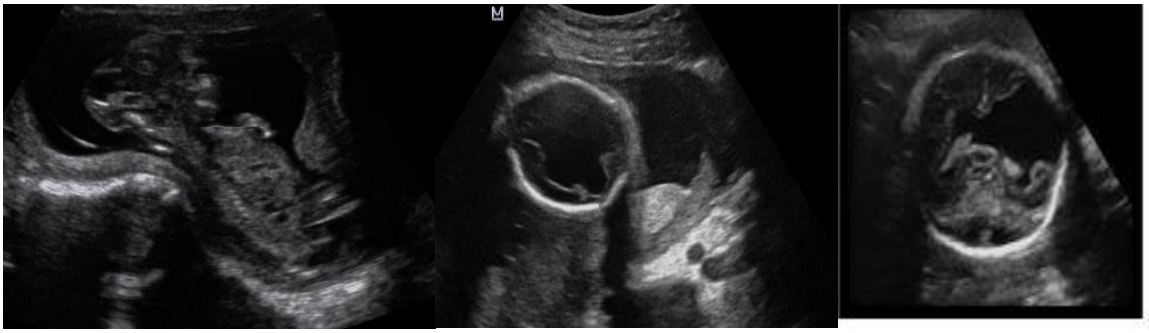
**CCAM** **FETAL ASCITES** **DIAPHRAGMATIC HERNIA**



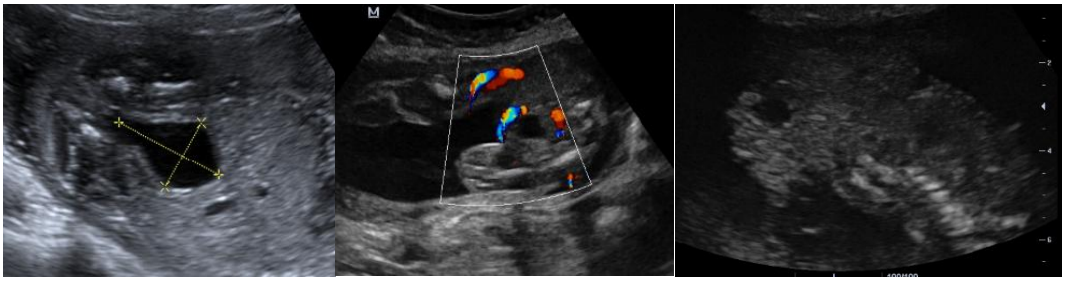
**HYDROTHORAX** **MULTICYSTIC KIDNEY** **ACRANIA**



**ENCEPHALOCELE** **HOLOPROSENCEPHALY** **SCHIZENCEPHALY**



**Posterior Urethral Valve** **Single Umbilical Artery** **Gastroschisis**



## 4. DISCUSSION

There are several factors that determine the incidence, pattern and prevalence of congenital malformations. Genetic, ethnic and racial background are the key factors and the other factors include socio economic, cultural and environmental factors and their interaction with the genetic component which determines the occurrence of an anomaly.

The incidence of anomalies detected in our study was 3% which is slightly comparable to studies done by Swain et al, Baht BV et al in South India (3.7%), Jehangir et al, Chathurvedi et al and Bhide et al. [6,7,8] The present study results are also compared to the study by Dolk H et al in Europe (2.39%) and also with the western data from the EUROCAT surveillance and found to be higher prevalence. [9, 10, 11]

Several factors like the study population, duration of the study, period and place where the study is conducted determines the incidence to a great extent . Thereforecomparison of incidence with the present study is relatively difficult. We had a slightly higher incidence compared to previous studies done in the Indian settings. This could be possibly explained by the fact that the study was conducted in a referral hospital which caters high risk pregnancies with higher percentage of consanguinity, low socioeconomic class, nutritional and maternal problems.

There are plenty of studies to support the increased incidence of congenital anomalies in advanced maternal age.[12, 13 , 14 , 15] But as the maximum number of deliveries occur in the age group 20-30 years, more anomalies were detected in babies born to mothers of this age group. In our study 76.8% of the anomalies were from this maternal age group.

Swain, Savaskar and Padma observed that congenital anomalies were more in multigravidae than in primigravidae. [16,17,18] It was significantly seen to be higher in mothers of gravidity 4 or more. [19,20] This study showed that 52.9% of the anomalies were in multigravidae. Congenital malformations are usually associated with low birth weight. Studies by Prajapati, Patel and Aman Taskade showed a significantly higher incidence of anomalies in preterm babies than term babies. [21,22,23] In present study 30.8% of the babies were born before 37 weeks of gestation. 47.9% of them were below 2.5kg.

The risk of congenital anomalies (excluding terminations) for gestational diabetes is 1.2 times higher than in the total population [24]

Statistically significant association was found between congenital malformation and consanguineous marriage. Agarwal SS and Desai N et al found highly significant correlation between congenital malformation and consanguinity.[25,27]. In our study statistically significant association was found between congenital malformation and previous child with malformation. Similar findings was also obtained in the study of Agrawal et al while Anand et al and Sagunabai et al did found such significant association between congenital malformation and previous child with malformation.[25,26,28]

In our study the pattern of congenital malformations seen in neonates are as follows; most commonly affected musculoskeletal system 34 % followed by the central nervous system (32%), genitourinary system (30%), gastrointestinal system (8%), and syndromic (25%).

Among the musculoskeletal anomalies, Congenital talipes equino varus was the commonest musculocutaneous abnormality observed in our study, followed by phocomelia, caudal regression, cleft lip, and cleft palate etc. (Table 1 )

With reference to the central nervous system anomalies, anencephaly ( most common ) followed by Arnold chiari malformations, ventriculomegaly, meningocele, holoprosencephaly, schizencephaly etc.

Regarding thegenito urinary anomalies, multicystic dysplastic kidneys, polycystic kidneys, pelvicalyceal system dilatations of all sorts like pelvi ureteric junction narrowing, low placed kidney, posterior urethral valve are seen.

In case of gastrointestinal system anomalies, two cases gastroschisis and mesenteric cyst are seen.

In cardiac anomalies, echogenic focus, cardiac myxoma and single arterial trunk -truncus arteriosus seen.

In respiratory system malformations we have detected congenital airway malformation (CPAM OR CCAM) and congenital lobar emphysema.

With reference to the syndromes that we encountered are the Arnold chiarimalformations, Dandy walker malformation , Meckel gruber syndrome, caudal regression syndrome, prune belly syndrome , posterior urethral valve , Greenberg syndrome, phocomelias etc.

## 5. CONCLUSIONS

In developing countries like India the important cause for the perinatal mortality and morbidity are the congenital malformations. Routine Antenatal surveillance and prenatal diagnosis are recommended to detect all the CNS, MSK,

GIT, AND GUT anomalies for effective prevention, early intervention and planned termination and appropriate treatment planning..

**REFERENCES**


[1] World Health Organization. Section on congenital anomalies. Available from: http://www.who.int/mediacentre/factsheets/fs370/en / Accessed October 2012.

[2] National health Portal of India. Section on congenital anomalies (birth defects). Available at https://www.nhp.gov.in/disease/gynaecology-andobstertrics/congenital-anomalies-birth-defects

[3] UNICEF. Neonatal Health. Available at Unicef.in/whatwedo/2/Neonatal-Health

[4] World Health Organization. Birth defects. Executive Board, 126th session, provisional agenda,December2009;EB126/10.http://apps.who.int/gb/ebwha/pdf_files/EB126/B126 _10-en.pdf

[5] Agarwal SS, Singh U, Singh PS, Singh SS, Das V, Sharma A, et al. Prevalence and spectrum of congenital malformations in a prospective study at a teaching hospital. Indian J Med Res. 1991;94:413-9.

[6] Chaturvedi P, Banerjee KS. Spectrum of congenital malformations in newborns from rural Maharashtra. Indian J Pediatr. 1989;56(4):501-7.

[7] Jehangir W, Ali F, Jahangir T, Masood MS. Prevalence of gross congenital malformations at birth in the neonates in a tertiary care hospital. In APMC. 2009;3(1):47-50.

[8] Bhide P, Gund P, Kar A. Prevalence of congenital anomalies in an Indian maternal cohort: healthcare.

[9] Swain S, Agarwal A, Bhatia BD. Congenital malformations at birth. Indian Paediatr. 1994;31:1187-91.

[10] Bhat BV, Babu L. Congenital malformations at birth: a prospective study from South India. Indian J Pediatr. 1998;65:873-81.

[11] Dolk H, Loane M, Garne E. The prevalence of congenital anomalies in Europe. Advances Exp Med Biol. 2010;686:349-64.

[12] Prajapati VJ, Kacha AR, Kakkad KM, Damor PB, Nandaniya AM. Study of congential malformations in neonates born at tertiary care hospital. Natl J Community Med. 2015;6(1):30-4.

[13] Swain S, Agarwal A, Bhatia BD. Congenital malformation at birth, Indian Pediatr. 1994;31:1187- 91.

[14] Savaskar SV, Mundada SK, Pathan AS, Gajbhiye SF. Study of various antenatal factors associated with congenital anomalies born at tertiary health centre. Int J Recent Trends Sci Technol. 2014;12(1):82-5.

[15] Parmar A, Rathod SP, Patel SV, Patel SM. Study of congenital anomalies in newborn. NJIRM. 2010;1(1):13-7

[16] Swain S, Agarwal A, Bhatia BD. Congenital malformation at birth, Indian Pediatr. 1994;31:1187- 91.

[17] Savaskar SV, Mundada SK, Pathan AS, Gajbhiye SF. Study of various antenatal factors associated with congenital anomalies born at tertiary health centre. Int J Recent Trends Sci Technol. 2014;12(1):82-5.

[18] Padma S, Ramakrishna D, Jijiya P, Ramana PV. Pattern of distribution of congenital anomalies in still born: a hospital based prospective study. Int J Pharma Bio Sci. 2011;2:604-10.

[19] Mohanty C, Mishra OP, Das BK, Bhatia BD, Singh G. Congenital malformation in newborn: A study of 10,874 consecutive births. J Anat Soc India. 1989;38:101-11.

[20] Kulshreshtha R, Nath LM, Upadhyaya P. Congenital Malformation in live born infants in a rural community. Indian Pediatr. 1982;19:1003-9.

[21] Patel ZM, Adhia RA. Birth defects surveillance study. Indian J Pediatr. 2005;72:489-91.

[22] Taksande A, Vilhekar K, Chaturvedi P, Jain M. Congenital malformations at birth in Central India: Arural medical college hospital based data. Indian J Hum Genet. 2010;16:159-63.

[23] Prajapati VJ, Kacha AR, Kakkad KM, Damor PB, Nandaniya AM. Study of congential malformations in neonates born at tertiary care hospital. Natl J Community Med. 2015;6(1):30-4.

[24] Sharpe PB, Chan A, Haan EA, Hiller JE. Maternal diabetes and congenital anomalies in South Australia 1986–2000: a population-based cohort study. Birth Defects Res. 2005;73:605-11

[25] Agarwal SS, Singh U, Singh PS. Prevalence and spectrum of congenital malformations in a prospective study at a teaching hospital, Indian journal of medical research. 1991;94:413-9.

[26] Anand JS, Javadekar BB, Belani M. Congenital malformations in 2000 consecutive births. Indian Pediatr. 1988;25:845-51.

[27] Desai N, Desai A. Congenital anomalies, a prospective study at Bombay hospital, Bombay hospital journal. 2006;48:442-5.

[28]Sagunabai NS, Mascarena M, Syamalan K. An etiological study of congenital malformation in the new born, Indian paediatrics. 1982;19:1003-7.

[29] Sobia Wassan, Chen Xi, Tian Shen, Kamal Gulati, Kinza Ibraheem, Rana M. Amir Latif Rajpoot, "The Impact of Online Learning System on Students Affected with Stroke Disease", Behavioural Neurology, vol. 2022, Article ID 4847066, 14 pages, 2022. https://doi.org/10.1155/2022/4847066

[30] Sobia Wassan, Tian Shen, Chen Xi, Kamal Gulati, Danish Vasan, Beenish Suhail, "Customer Experience towards the Product during a Coronavirus Outbreak", Behavioural Neurology, vol. 2022, Article ID 4279346, 18 pages, 2022. https://doi.org/10.1155/2022/4279346

[31] Dhiman, G.; Juneja, S.; Viriyasitavat, W.; Mohafez, H.; Hadizadeh, M.; Islam, M.A.; El Bayoumy, I.; Gulati, K. A Novel Machine-Learning-Based Hybrid CNN Model for Tumor Identification in Medical Image Processing. Sustainability 2022, 14, 1447. https://doi.org/10.3390/su14031447

[32] Akanksha, E., Sharma, N., & Gulati, K. (2021, January). OPNN: Optimized Probabilistic Neural Network based Automatic Detection of Maize Plant Disease Detection. In 2021 6th International Conference on Inventive Computation Technologies (ICICT) (pp. 1322-1328). IEEE.

[33] Gulati, K., Boddu, R. S. K., Kapila, D., Bangare, S. L., Chandnani, N., & Saravanan, G. (2021). A review paper on wireless sensor network techniques in Internet of Things (IoT). Materials Today: Proceedings.

[34] Gulati, K., Kumar, S. S., Boddu, R. S. K., Sarvakar, K., Sharma, D. K., & Nomani, M. Z. M. (2021). Comparative analysis of machine learning-based classification models using sentiment classification of tweets related to COVID-19 pandemic. Materials Today: Proceedings.

[35] Akanksha, E., Sharma, N., & Gulati, K. (2021, April). Review on Reinforcement Learning, Research Evolution and Scope of Application. In 2021 5th International Conference on Computing Methodologies and Communication (ICCMC) (pp. 1416-1423). IEEE.

[36] Singh, U. S., Singh, N., Gulati, K., Bhasin, N. K., & Sreejith, P. M. (2021). A study on the revolution of consumer relationships as a combination of human interactions and digital transformations. Materials Today: Proceedings.

[37] Gulati, K., Boddu, R. S. K., Kapila, D., Bangare, S. L., Chandnani, N., & Saravanan, G. (2021). A review paper on wireless sensor network techniques in Internet of Things (IoT). Materials Today: Proceedings.

[38] SANGEETHA, D. M., PRIYA, D. R., ELIAS, J., MAMGAIN, D. P., WASSAN, S., & GULATI, D. K. (2021). Techniques Using Artificial Intelligence to Solve Stock Market Forecast, Sales Estimating and Market Division Issues. Journal of Contemporary Issues in Business and Government, 27(3), 209-215.

[39] Dovhan, O.D., Yurchenko, O.M., Naidon, J.O., Peliukh, O.S., Tkachuk, N.I. and Gulati, K. (2021), "Formation of the counter intelligence strategy of Ukraine: national and legal dimension", World Journal of Engineering, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/WJE-06-2021-0358

[40] Billewar, S.R., Jadhav, K., Sriram, V.P., Arun, D.A., Mohd Abdul, S., Gulati, K. and Bhasin, D.N.K.K. (2021), "The rise of 3D E-Commerce: the online shopping gets real with virtual reality and augmented reality during COVID-19", World Journal of Engineering, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/WJE-06-2021-0338

[41] Sanil, H.S., Singh, D., Raj, K.B., Choubey, S., Bhasin, N.K.K., Yadav, R. and Gulati, K. (2021), "Role of machine learning in changing social and business eco-system – a qualitative study to explore the factors contributing to competitive advantage during COVID pandemic", World Journal of Engineering, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/WJE-06-2021-0357

[42] L. M. I. L. Joseph, P. Goel, A. Jain, K. Rajyalakshmi, K. Gulati and P. Singh, "A Novel Hybrid Deep Learning Algorithm for Smart City Traffic Congestion Predictions," 2021 6th International Conference on Signal Processing, Computing and Control (ISPCC), 2021, pp. 561-565, doi: 10.1109/ISPCC53510.2021.9609467.

[43] S. L. Bangare, S. Prakash, K. Gulati, B. Veeru, G. Dhiman and S. Jaiswal, "The Architecture, Classification, and Unsolved Research Issues of Big Data extraction as well as decomposing the Internet of Vehicles (IoV)," 2021 6th International Conference on Signal Processing, Computing and Control (ISPCC), 2021, pp. 566-571, doi: 10.1109/ISPCC53510.2021.9609451.

[44]V. P. Sriram, K. B. Raj, K. Srinivas, H. Pallathadka, G. S. Sajja and K. Gulati, "An Extensive Systematic Review of RFID Technology Role in Supply Chain Management (SCM)," 2021 6th International Conference on Signal Processing, Computing and Control (ISPCC), 2021, pp. 789-794, doi: 10.1109/ISPCC53510.2021.9609414.