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RESEARCH ARTICLE

AN OBSERVATIONAL STUDY TO ESTIMATE THE PREVALENCE OF CONGENITAL HYPOTHYROIDISM IN NEWBORNS AT A RURAL TERTIARY CARE HOSPITAL

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Abstract

Background: Congenital hypothyroidism (CH) is one of the most common preventable causes of intellectual disability and growth failure in children. Most affected newborns are asymptomatic at birth owing to transplacental transfer of maternal thyroxine, leading to delayed diagnosis in the absence of screening. Early detection through newborn thyroid-stimulating hormone (TSH) screening and prompt initiation of levothyroxine therapy can prevent irreversible neurodevelopmental impairment. Data from rural tertiary care settings in India remain limited.

Objectives: To estimate the prevalence of CH among newborns and to analyse the distribution of TSH levels in relation to selected demographic and perinatal factors.

Methods: This prospective observational cross-sectional study was conducted at a rural tertiary care hospital over 24 months. A total of 919 healthy newborns aged 72 hours to 7 days were enrolled after obtaining informed consent. Newborns with major congenital anomalies or born to mothers with overt hypothyroidism were excluded. Venous blood samples were collected, and serum TSH was estimated using a standardized immunoassay. Newborns with elevated TSH underwent repeat testing and confirmatory evaluation. Data were analysed using SPSS version 26.0, and statistical significance was set at $p < 0.05$.

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Results: Of the 919 newborns screened, one case of CH was confirmed, yielding a prevalence of 1.09 per 1000 live births (95% CI: 0.03–6.05). The majority of newborns had TSH levels within the normal range. No statistically

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significant association was found between elevated TSH levels and sex, birth weight, gestational age, mode of delivery, or other perinatal factors ($p > 0.05$).

Conclusion: The prevalence of CH in this rural tertiary care setting was comparable to that reported in other Indian studies. These findings support the need for routine newborn screening programmes in rural healthcare settings for early detection and prevention of long-term neurodevelopmental morbidity.

Introduction:-

Congenital hypothyroidism (CH) is a neonatal endocrine disorder characterized by inadequate availability of thyroid hormones at the tissue level from birth, owing to abnormalities in thyroid gland development, in thyroid hormone synthesis, secretion or transport, or in the hypothalamic–pituitary–thyroid (HPT) axis. It is one of the most common endocrine disorders of the newborn and remains one of the leading preventable causes of irreversible intellectual disability and impaired physical growth in children worldwide.¹ Thyroid hormones are indispensable for normal fetal and postnatal growth and development, particularly for maturation of the central nervous system. During fetal life and early infancy, thyroxine (T4) and triiodothyronine (T3) regulate neuronal proliferation, migration, differentiation, synaptogenesis, myelination, and cortical organization.²⁻⁴ Deficiency of thyroid hormones during these critical periods results in permanent neurodevelopmental impairment, manifesting as intellectual disability, delayed motor and language development, poor scholastic performance, and growth failure. Fortunately, these complications are largely preventable if congenital hypothyroidism is diagnosed early and levothyroxine therapy is initiated within the first two weeks of life.¹⁻⁴

Most newborns with congenital hypothyroidism appear clinically normal at birth because maternally derived thyroxine crosses the placenta and provides partial protection during fetal life.⁵⁻⁷ Consequently, reliance on clinical examination alone often delays diagnosis until irreversible neurological damage has already occurred. This limitation underscores the importance of universal newborn screening for early detection and timely treatment. The thyroid gland is the first endocrine organ to develop during embryogenesis. It originates from the floor of the primitive pharynx during the third to fourth week of gestation and migrates to its normal pretracheal position by the seventh to tenth week.⁸⁻¹⁰ Disruption of thyroid development results in thyroid dysgenesis, which accounts for the majority of cases of permanent congenital hypothyroidism. A smaller proportion of cases results from inherited defects in thyroid hormone synthesis (dyshormonogenesis). Moreover, the fetus remains dependent on maternal thyroxine during early gestation for normal brain development.⁵⁻¹⁰

Immediately after birth, exposure to the extrauterine environment induces a physiological surge in thyroid-stimulating hormone (TSH), followed by a rise in circulating T4 and T3 concentrations. This normal adaptation is essential for thermogenesis, metabolic homeostasis, and continued maturation of the neonatal brain.¹¹ Failure of this physiological response, owing to thyroidal or central defects, leads to congenital hypothyroidism, emphasizing the need for early diagnosis and treatment. Congenital hypothyroidism is broadly classified into primary, central, and transient forms.¹² Primary congenital hypothyroidism, resulting from thyroid dysgenesis or dyshormonogenesis, accounts for nearly 85–90% of permanent cases.¹²⁻¹⁴ Central congenital hypothyroidism results from hypothalamic or pituitary dysfunction causing inadequate TSH secretion, whereas transient congenital hypothyroidism may occur secondary to iodine deficiency or excess, maternal antithyroid medication, prematurity, or transplacental passage of TSH receptor-blocking antibodies.¹³⁻¹⁵

Newborn screening has revolutionized the management of congenital hypothyroidism and is regarded as one of the most successful public health interventions in neonatal medicine. Measurement of TSH in dried blood spot samples collected between 48 and 72 hours of life permits detection of affected infants before the onset of clinical manifestations.¹²⁻¹⁶ Early identification, followed by prompt initiation of levothyroxine therapy, results in normal physical growth, neurocognitive development, and quality of life, thereby transforming congenital hypothyroidism from a major cause of intellectual disability into a preventable disorder.¹²⁻¹⁷ Before the introduction of newborn screening, the diagnosis of congenital hypothyroidism was frequently delayed. In a population-based study from Denmark covering 436,959 live births between 1970 and 1975, only 10% of affected infants were diagnosed within the first month of life and 40% within the first three months, while in some children the diagnosis was delayed beyond five years of age.¹⁸ Because the neurocognitive deficit of untreated congenital hypothyroidism increases with every week of delay in initiating levothyroxine, biochemical screening of all newborns remains the only reliable strategy for ensuring timely diagnosis.^{19,20}

In India, newborn screening for congenital hypothyroidism was pioneered at the Bai Jerbai Wadia Hospital for Children, Mumbai, in the 1980s.²¹ Subsequently, the Indian Council of Medical Research (ICMR) Task Force on Inherited Metabolic Disorders conducted a multicentric screening study across different geo-ethnic regions of the country, covering 104,094 newborns,¹⁰ and in 2018 the Indian Society for Pediatric and Adolescent Endocrinology (ISPAE) published national guidelines for the screening, diagnosis, and management of congenital hypothyroidism.^{22,23} Nevertheless, newborn screening has not yet been implemented universally in India,²⁴ and worldwide nearly 70% of neonates still do not undergo newborn screening.²⁵ Despite the proven effectiveness of newborn screening, its implementation across India remains inconsistent, particularly in rural and resource-limited settings.²⁶ Most published Indian data are derived from urban tertiary care centres and may not accurately reflect the burden of congenital hypothyroidism in rural populations, where access to antenatal care, institutional deliveries, laboratory facilities, and follow-up services is often limited.²⁶⁻³⁰ The generation of region-specific prevalence data is therefore essential to strengthen newborn screening programmes, improve healthcare planning, optimize resource allocation, and facilitate early diagnosis and treatment. The present study was undertaken to estimate the prevalence of congenital hypothyroidism among newborns delivered at a rural tertiary care hospital, thereby contributing to the evidence base required for strengthening neonatal screening services and improving long-term neurodevelopmental outcomes in this population.

Aims and Objectives:-

Aim:-

To study the prevalence of congenital hypothyroidism among newborns attending a rural tertiary care hospital.

Objectives:-

Primary Objective:-

- To estimate the prevalence of congenital hypothyroidism among newborns at a rural tertiary care hospital, with a view to preventing neurodevelopmental morbidity through early detection.

Secondary Objectives:-

- To analyse the distribution of serum TSH levels among screened newborns.
- To assess the association between elevated TSH levels and selected demographic and perinatal factors.

Materials and Methods:-

Study Setting:-

This prospective observational cross-sectional study was conducted in the Department of Paediatrics and the Neonatal Unit of Akash Institute of Medical Sciences and Research Centre, Devanahalli, Bengaluru Rural, Karnataka. The institution functions as a rural tertiary care referral centre catering to the surrounding rural and semi-urban populations, with facilities for institutional deliveries, neonatal monitoring, neonatal intensive care unit (NICU) support, and laboratory services.

Study Design and Duration:-

The study was designed as a prospective observational cross-sectional study and was conducted over a period of 24 months, from March 2024 to February 2026.

Study Population:-

The study population comprised healthy live newborns delivered at the study hospital and those presenting to the neonatal outpatient services between 72 hours and 7 days of life. The screening window of 72 hours to 7 days was selected to avoid the immediate postnatal physiological surge in TSH, which typically occurs within the first 24–48 hours of life, thereby reducing false-positive results. Healthy newborns were defined as neonates with stable cardiorespiratory parameters, no major congenital anomalies, and a normal systemic examination at the time of screening.

Eligibility Criteria:-

Inclusion Criteria:-

- Live newborns delivered at the study hospital, or attending the neonatal outpatient services, between 72 hours and 7 days of life during the study period.

- Healthy newborns, defined as neonates with stable vital parameters and no evidence of major congenital malformations on clinical examination.
- Newborns whose parents or legal guardians provided written informed consent.

Exclusion Criteria:-

- Newborns of mothers with known overt hypothyroidism on treatment during pregnancy.
- Newborns with major congenital anomalies detected clinically at birth.
- Neonates with syndromic features suggestive of chromosomal or genetic disorders.
- Newborns whose parents or legal guardians did not provide written informed consent.

Study Procedure:-**Enrolment and Consent:-**

Approval of the Institutional Ethics Committee was obtained before initiation of the study. Written informed consent was obtained from parents in their preferred language after the purpose and procedure of the study had been explained. Eligibility was confirmed before enrolment.

Maternal Assessment:-

A detailed maternal history was obtained through a structured interview and review of antenatal records. Maternal age was recorded in completed years. Obstetric status was categorized as primigravida or multigravida. Any history of maternal hypothyroidism or hyperthyroidism was documented, and details of thyroid medication during pregnancy (levothyroxine, methimazole, or propylthiouracil) were recorded from antenatal records. History of gestational diabetes mellitus (GDM) and pregnancy-induced hypertension (PIH) was documented. Iodine exposure was assessed indirectly through a history of iodized salt consumption. History and degree of consanguinity were recorded. Antenatal screening, including nuchal translucency and anomaly scans, was documented when available.

Perinatal Assessment:-

Mode of delivery was recorded from delivery records as normal vaginal delivery (NVD), lower segment caesarean section (LSCS), or instrumental delivery. The presence of meconium-stained liquor was documented. Immediate cry at birth and the need for resuscitation were recorded from delivery room documentation. APGAR scores at 1 and 5 minutes were recorded as per the standard neonatal resuscitation protocol. Initiation of breastfeeding within the first hour of life and exclusive breastfeeding status were documented from nursing records. Passage of meconium within 24 hours was confirmed through nursing documentation and maternal history.

Anthropometric Measurements:-

Birth weight was measured using a calibrated digital neonatal weighing scale. Length was measured using a standard infantometer with the neonate positioned supine. Head circumference was measured using a non-stretchable measuring tape placed over the occiput and supraorbital ridges. Gestational age was determined from first-trimester ultrasound records wherever available.

Clinical Examination:-

A detailed systemic examination was performed for each neonate by the investigator.

Special emphasis was placed on identifying clinical features suggestive of congenital hypothyroidism, including:-

- Large anterior or posterior fontanelle
- Macroglossia
- Coarse facial features
- Umbilical hernia
- Dry or mottled skin
- Generalized hypotonia
- Hoarse cry

Primitive Reflex Assessment:-

Primitive reflexes were assessed as indicators of neurological maturity. The sucking reflex was evaluated during feeding. The rooting reflex was elicited by stroking the cheek. The Moro reflex was assessed using the standard

head-drop manoeuvre. Palmar and plantar grasp reflexes were elicited by tactile stimulation. All reflexes were documented as present or absent.

Blood Sample Collection and Laboratory Analysis:-

Venous blood sampling was performed between 72 hours and 7 days of life under strict aseptic precautions. Approximately 0.5 mL of venous blood was collected into a red-top (plain) Vacutainer tube. Serum TSH was estimated using a two-site immunoenzymometric assay (ST AIA-PACK TSH kit) on the TOSOH AIA automated analyser in accordance with the manufacturer's instructions. Internal quality control measures were maintained throughout the study period. Age at sampling (in hours) was recorded to account for variation related to the physiological neonatal TSH surge.

Interpretation of Thyroid Function:-

TSH values were interpreted according to neonatal reference standards:-

- TSH < 20 μ IU/mL was considered normal.
- TSH between 20 and 40 μ IU/mL was considered borderline, and repeat testing with free T4 estimation was advised.
- TSH > 40 μ IU/mL was considered strongly suggestive of congenital hypothyroidism, and confirmatory testing with repeat TSH and free T4 estimation was performed.
- Newborns with persistently elevated TSH and low free T4 on repeat testing were diagnosed as having confirmed congenital hypothyroidism and were referred for appropriate management.

Sample Size Calculation:-

The sample size was calculated for estimation of prevalence using the standard formula for a single population proportion:

$$n = (Z^2 \times p \times q) / d^2$$

Where:-

- n = required sample size
- Z = standard normal deviate at 95% confidence level (1.96)
- p = expected prevalence
- q = 1 – p
- d = absolute precision

The expected prevalence (p) was derived from a hospital-based newborn screening study conducted at a tertiary care centre in Kochi, South India, which reported a prevalence of congenital hypothyroidism of 2.1 per 1000 live births.³¹

$$p = 2.1/1000 = 0.0021$$

$$q = 1 - 0.0021 = 0.9979$$

Assuming a 95% confidence level (Z = 1.96) and an absolute precision of 0.296% (d = 0.00296), the sample size was calculated as follows:

$$n = ((1.96)^2 \times 0.0021 \times 0.9979) / (0.00296)^2$$

$$n = (3.8416 \times 0.002095) / 0.00000876$$

$$n = 918.8 \approx 919$$

Statistical Analysis:-

Data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

Descriptive Statistics:-

- Continuous variables such as birth weight, gestational age, and TSH levels were expressed as mean $\pm$ standard deviation (SD) when normally distributed and as median (interquartile range) when skewed.
- Categorical variables such as sex, mode of delivery, consanguinity, breastfeeding initiation, and elevated TSH status were expressed as frequency and percentage.

Estimation of Prevalence:-

The prevalence of congenital hypothyroidism was calculated as:-

Prevalence = (Number of confirmed CH cases / Total number of newborns screened) $\times$ 1000

Prevalence was expressed per 1000 live births, together with the 95% confidence interval (CI) calculated using the exact binomial (Clopper–Pearson) method.

Inferential Statistics:-

- The association between categorical variables and elevated TSH levels was analysed using the chi-square test.
- Fisher's exact test was applied when expected cell frequencies were less than 5.
- Continuous variables were compared between groups using the independent samples t-test or the Mann–Whitney U test, depending on data distribution.

A p-value < 0.05 was considered statistically significant. All tests were two-tailed.

Observations and Results:-

Table 1: Maternal Characteristics of the Study Population (n = 919)

Variable	Value
Maternal age (Mean $\pm$ SD)	27.08 $\pm$ 2.19 years
Median (Range)	27 (20–38)
GDM	53 (5.77%)
PIH	20 (2.18%)
Consanguinity	41 (4.46%)
Hypothyroidism	0
Hyperthyroidism	0
Thyroid medication	0
Radiation exposure	0
Iodized salt use	919 (100%)

GDM: gestational diabetes mellitus; PIH: pregnancy-induced hypertension; SD: standard deviation.

The mean maternal age was 27.08 $\pm$ 2.19 years, with a median of 27 years (range: 20–38 years), indicating that most mothers belonged to the optimal reproductive age group. Among maternal risk factors, gestational diabetes mellitus (5.77%), consanguinity (4.46%), and pregnancy-induced hypertension (2.18%) were the most frequently observed. None of the mothers had documented hypothyroidism, hyperthyroidism, thyroid medication use, or radiation exposure during pregnancy. Universal use of iodized salt (100%) was reported in the study population, reflecting adequate iodine intake in the maternal cohort

Table 2: Baseline Characteristics of the Neonates (n = 919)

Variable	Number (%)
Male	489 (53.21)
Female	430 (46.79)
Term	858 (93.36)
Preterm	61 (6.64)
$\geq$ 2.5 kg	822 (89.45)
<2.5 kg	97 (10.55)
LSCS	544 (59.19)
NVD	375 (40.81)
APGAR 7 at 1 min	67 (7.29)
APGAR 8 at 1 min	852 (92.71)
APGAR 9 at 5 min	919 (100)

APGAR scores are expressed at 1 and 5 minutes; LSCS: lower segment caesarean section; NVD: normal vaginal delivery. Among the 919 neonates included in the study, there was a slight male predominance (53.21%; male-to-female ratio 1.14:1). The majority were term neonates (93.36%) with a birth weight of ≥ 2.5 kg (89.45%). Delivery by lower segment caesarean section (59.19%) was more common than normal vaginal delivery. Most neonates showed satisfactory adaptation at birth, with 92.71% achieving an APGAR score of 8 at 1 minute and none scoring below 7, while all neonates (100%) had an APGAR score of 9 at 5 minutes, indicating good postnatal adaptation and an overall favourable neonatal status at birth.

Table 3: Clinical Examination and TSH Profile of the Study Population (n = 919)

Variable	Result
Clinical features suggestive of CH	None detected in any neonate (0%)
Primitive reflexes	Present in all neonates (100%)
Mean serum TSH ($\pm$ SD)	2.85 ± 4.44 μ IU/mL
Median serum TSH	1.56 μ IU/mL
Range	0.10–100 μ IU/mL
Normal TSH (<20 μ IU/mL)	917 (99.78%)
Repeat TSH required (20–40 μ IU/mL)	1 (0.11%)
Confirmed CH (>40 μ IU/mL)	1 (0.11%)
Prevalence of CH	0.1088% (1.09 per 1000 live births)
95% Confidence Interval	0.003–0.60%

CH: congenital hypothyroidism; CI: confidence interval; SD: standard deviation; TSH: thyroid-stimulating hormone.

None of the neonates had clinical features suggestive of congenital hypothyroidism, and all primitive neonatal reflexes were intact. The mean serum TSH concentration was 2.85 ± 4.44 μ IU/mL (median 1.56 μ IU/mL; range 0.10–100 μ IU/mL, the maximum value corresponding to the confirmed case, whose TSH exceeded 100 μ IU/mL). Of the 919 screened neonates, 917 (99.78%) had normal TSH values, one (0.11%) required repeat testing, and one (0.11%) was confirmed to have congenital hypothyroidism, yielding a prevalence of 0.1088% (1.09 per 1000 live births; 95% CI: 0.003–0.60%).

Table 4: TSH Category in Relation to Birth Weight, Gestational Age, and Sex (n = 919)

Variable	Category	Normal	Repeat	Confirmed	Total
Birth Weight	< 2.5 kg	97	0	0	97
	≥ 2.5 kg	820	1	1	822
Gestational Age	Preterm	61	0	0	61
	Term	856	1	1	858
Sex	Male	489	0	0	489
	Female	428	1	1	430
Total		917	1	1	919

Normal: TSH < 20 μ IU/mL; Repeat: TSH 20–40 μ IU/mL (repeat testing required); Confirmed: TSH > 40 μ IU/mL with congenital hypothyroidism confirmed on repeat TSH and free T4 testing.

Owing to the extremely small number of elevated TSH values, only a descriptive comparison was performed, and no statistically significant association could be demonstrated; the very low number of confirmed cases limited the power of association testing. The confirmed case of congenital hypothyroidism occurred in a female neonate born at term with a birth weight of ≥ 2.5 kg. No confirmed cases were observed among low birth weight or preterm neonates. The neonate requiring repeat testing was also a term female neonate of normal birth weight. Across all categories, the majority of neonates had normal TSH levels.

Discussion:-

Congenital hypothyroidism is one of the most important preventable causes of intellectual disability and growth failure in children. The introduction of newborn screening has transformed the prognosis of affected infants by enabling early diagnosis and prompt initiation of levothyroxine therapy, thereby preventing irreversible neurodevelopmental impairment.¹⁹ Consequently, neonatal screening for congenital hypothyroidism is now regarded as one of the most successful public health interventions in paediatric practice.

Prevalence of Congenital Hypothyroidism:-

The present prospective hospital-based study was undertaken to estimate the prevalence of congenital hypothyroidism among apparently healthy newborns delivered at a rural tertiary care hospital. A total of 919 neonates were screened between 72 hours and 7 days of life, and one neonate was confirmed to have congenital hypothyroidism on repeat thyroid function testing. The observed prevalence was 0.1088%, corresponding to 1.09 per 1000 live births (approximately 1 in 919 live births). Although only one confirmed case was detected, this estimate provides valuable epidemiological data for this rural population and adds to the limited literature from similar healthcare settings. The 95% confidence interval was wide, reflecting the rarity of the disease and the relatively small sample size, a finding expected in prevalence studies of uncommon disorders. Nevertheless, a single confirmed case within a clearly defined denominator still yields a valid point estimate, and reporting an exact binomial confidence interval conveys its precision transparently.³² A hospital-based prospective design was adopted because it permits standardized sample collection and laboratory analysis, complete ascertainment within a clearly defined denominator, and accurate estimation of prevalence. Such hospital-based programmes also serve as practical models for the stepwise implementation of universal screening in regions where community-based sampling infrastructure is still evolving.

The ICMR multicentric newborn screening study reported a prevalence of approximately 1 in 1130 live births after excluding transient hypothyroidism.¹⁰ A systematic review and meta-analysis of Indian studies reported a pooled prevalence of 0.97 per 1000 neonates (approximately 1 in 1031) in non-endemic regions, and a hospital-based study by Singh et al. reported a prevalence of 1 in 1470.^{24,33} The findings of the present study therefore fall within the reported national range, supporting the observation that congenital hypothyroidism is more common in Indian newborns than previously believed. Historically, Western countries reported a prevalence of approximately 1 in 3000–4000 live births.¹³ However, more recent reports from the United States and Europe indicate higher detection rates of approximately 1 in 2000–3000 live births, largely attributable to improved screening strategies, enhanced assay sensitivity, and lower TSH cut-off values.^{20,34} Despite these methodological advances, the prevalence reported from India continues to exceed that observed in many Western populations. This difference may reflect variations in genetic susceptibility, iodine nutrition, demographic characteristics, and screening methodology, as well as regional differences in neonatal healthcare practices.^{35,36}

A comparison of the present findings with selected Indian and international studies is presented in Table 5. The prevalence in the present study was closely comparable to that reported from Chennai (1.7 per 1000), where neonates of 34 weeks' gestation or more were similarly screened between 48 hours and 7 days of life,³⁷ and somewhat lower than the 2.1 per 1000 reported among inborn term neonates in Kochi.³¹ It was also comparable to the findings of a rural newborn screening programme in Uttar Pradesh, in which 11 cases were identified among 13,426 newborns,³⁸ a setting that closely resembles that of the present study. A recent mapping of Indian data showed that reported prevalence varies with sample size and methodology, with most larger studies (9500 neonates or more) reporting figures between 1 in 722 and 1 in 2835.³⁹ Internationally, reported prevalence ranges from 1 in 748 for permanent congenital hypothyroidism in Isfahan, Iran,⁷ and 1 in 1600 in a hospital-based programme in Karachi, Pakistan,⁸ to 1 in 2273 in the United States³⁴ and 1 in 6064 in Denmark in the pre-screening era;¹⁸ the last figure reflects the substantial under-ascertainment of cases when diagnosis depends on clinical recognition alone.

Table 5: Comparison of the Prevalence of Congenital Hypothyroidism in the Present Study with Other Studies

Study	Place and setting	Newborns screened	Prevalence of CH
Present study	Rural tertiary care hospital, Bengaluru Rural, Karnataka	919	1.09 per 1000 (1 in 919)
Sanghvi and Diwakar, 2008 ³¹	Tertiary care hospital, Kochi, Kerala	2,872	2.1 per 1000
Arasar Seeralar et al., 2016 ³⁷	Tertiary care hospital, Chennai, Tamil Nadu	1,695	1.7 per 1000
Gopalakrishnan et al., 2014 ³⁸	Rural population, Uttar Pradesh	13,426	0.82 per 1000 (1 in 1221)
ICMR Task Force, 2018 ¹⁰	Multicentric, India	104,094	1 in 722 overall; 1 in 1130 permanent*
Hashemipour et al., 2009 ⁷	Screening programme, Isfahan, Iran	—	1 in 748 (permanent CH)
Afroze et al., 2008 ⁸	Hospital-based programme, Karachi, Pakistan	—	1 in 1600
Harris and Pass, 2007 ³⁴	National screening data, United States	≈ 58 million	1 in 2273 (2002)
Jacobsen and Brandt, 1981 ¹⁸	Population-based, Denmark (pre-screening era)	436,959	1 in 6064

CH: congenital hypothyroidism; ICMR: Indian Council of Medical Research. *After exclusion of transient hypothyroidism. —, not reported as a single figure. Figures for other studies are as reported by their authors.

An important observation in the present study was that none of the screened neonates exhibited classical clinical features of congenital hypothyroidism at the time of examination, such as macroglossia, hypotonia, coarse facies, prolonged jaundice, or umbilical hernia. This finding is consistent with previous newborn screening studies demonstrating that the majority of affected infants are clinically asymptomatic during the neonatal period because maternally derived thyroxine provides partial protection before birth.^{19,40,41} Consequently, reliance on clinical examination alone would delay diagnosis until irreversible neurological injury has occurred. The present findings therefore reinforce the indispensable role of biochemical newborn screening in the early identification of affected infants. The present study employed a screening protocol in which blood samples were collected between 72 hours and 7 days of life, thereby avoiding the physiological neonatal TSH surge observed immediately after birth. This approach is consistent with international recommendations and improves screening specificity by reducing false-positive results while maintaining adequate sensitivity.^{42,43} Confirmation of abnormal screening results by repeat TSH and free T4 estimation further enhanced diagnostic accuracy and ensured appropriate identification of permanent congenital hypothyroidism.

Overall, the findings of the present study demonstrate that the prevalence of congenital hypothyroidism in this rural tertiary care population is comparable with contemporary Indian data and emphasize that congenital hypothyroidism remains an important neonatal health problem. Although the prevalence appears numerically low, the lifelong consequences of a missed diagnosis are profound. Identification and treatment of even a single affected infant prevent irreversible intellectual disability, improve long-term neurodevelopmental outcomes, and substantially reduce the future healthcare and societal burden. These findings support the continued expansion of universal newborn screening programmes, particularly in rural and resource-limited settings where epidemiological data remain limited.

Interpretation of Maternal and Neonatal Characteristics:-

The maternal and neonatal characteristics observed in the present study were broadly comparable with those reported in previous Indian newborn screening studies. The mean maternal age was 27.08 ± 2.19 years, with most mothers belonging to the optimal reproductive age group. Maternal age has not been established as an independent determinant of congenital hypothyroidism, and the age distribution in the present study was similar to that reported in other hospital-based Indian studies.^{10,33} Among the maternal risk factors evaluated, gestational diabetes mellitus (5.77%), pregnancy-induced hypertension (2.18%), and consanguinity (4.46%) were the most frequently observed. These frequencies are comparable with those reported in Indian obstetric populations.⁴⁴ Although maternal

metabolic and hypertensive disorders may influence fetal growth and transient neonatal endocrine adaptation, current evidence does not support a consistent association with permanent congenital hypothyroidism, which is predominantly caused by thyroid dysgenesis occurring during early embryogenesis.⁴⁵ Therefore, no meaningful relationship between these maternal factors and congenital hypothyroidism could be established in the present study. Consanguinity remains clinically relevant because inherited defects in thyroid hormone synthesis (dysthyronogenesis) follow an autosomal recessive pattern and are more frequently reported in populations with higher rates of consanguineous marriage.^{46,47} However, thyroid dysgenesis continues to account for the majority of cases of permanent congenital hypothyroidism worldwide.⁴⁵ In the present study, the relatively low prevalence of consanguinity and the identification of only one confirmed case precluded meaningful assessment of its association with congenital hypothyroidism. Nevertheless, documentation of consanguinity remains relevant for the genetic counselling of families of affected infants.

An important observation was the universal use of iodized salt (100%) among participating mothers. Universal salt iodization has substantially reduced iodine deficiency disorders in India and remains one of the most effective public health interventions for preventing thyroid dysfunction. Because the World Health Organization (WHO) recognizes the neonatal TSH distribution as a population-level indicator of iodine status, the low frequency of abnormal neonatal TSH values observed in the present study further supports adequate iodine nutrition in the study population.³⁵ The neonatal characteristics of the present cohort reflected a predominantly healthy newborn population. A slight male predominance (53.21%) was observed, comparable with the normal neonatal sex distribution reported in hospital-based studies. Although some international studies have described a female predominance among confirmed cases of congenital hypothyroidism, particularly those due to thyroid dysgenesis, no consistent association between neonatal sex and congenital hypothyroidism has been demonstrated in large newborn screening programmes.^{10,45} The present findings therefore support universal newborn screening irrespective of sex.

The majority of neonates were born at term (93.36%) and had a birth weight of ≥ 2.5 kg (89.45%). These findings are important because preterm and low birth weight infants are more likely to exhibit transient abnormalities of thyroid function owing to immaturity of the hypothalamic–pituitary–thyroid axis, often necessitating repeat screening.^{42,48,49} The predominance of term, normal birth weight neonates in the present study probably contributed to the low recall rate and reduced the likelihood of transient TSH elevation. More than half of the neonates (59.19%) were delivered by lower segment caesarean section, reflecting the obstetric profile of a tertiary care referral centre. Although operative delivery may produce transient alterations in neonatal endocrine responses because of perinatal stress, there is no convincing evidence of an association with permanent congenital hypothyroidism.⁵⁰ Accordingly, mode of delivery in the present study should be interpreted as a demographic characteristic rather than a causal factor. The neonatal condition at birth was satisfactory, as reflected by favourable APGAR scores. Most neonates (92.71%) achieved an APGAR score of 8 at 1 minute, and all achieved a score of 9 at 5 minutes, indicating a successful transition to extrauterine life. Severe perinatal stress or birth asphyxia has been reported to influence thyroid hormone concentrations transiently; however, the uniformly good APGAR scores in the present cohort minimized this potential source of confounding.⁵⁰

No statistically significant association was observed between congenital hypothyroidism and maternal or neonatal characteristics in the present study. However, this finding should be interpreted cautiously because only one confirmed case was detected. The primary objective of the study was to estimate prevalence rather than to identify risk factors, and the study was not adequately powered to detect associations between individual maternal or neonatal variables and congenital hypothyroidism; under such conditions, inferential testing carries a substantial risk of type II error. Larger multicentric studies with greater numbers of confirmed cases are required to evaluate these relationships more robustly. Overall, the maternal and neonatal characteristics of the present cohort are representative of a rural tertiary care hospital population. The findings indicate that congenital hypothyroidism can occur even in apparently healthy term neonates without identifiable maternal or neonatal risk factors, thereby emphasizing the importance of universal rather than selective, risk-based newborn screening.

TSH Findings and Screening Methodology:-

The principal objective of the present study was to determine the prevalence of congenital hypothyroidism through biochemical screening using serum TSH estimation. The mean serum TSH concentration among the screened neonates was 2.85 ± 4.44 μ IU/mL, with a median of 1.56 μ IU/mL and a range of 0.10–100 μ IU/mL. The TSH distribution was right-skewed, with most neonates having values within the normal range and a single markedly

elevated value corresponding to the confirmed case of congenital hypothyroidism. Such a distribution is characteristic of newborn screening populations and reflects the low prevalence of the disorder.^{36,45} Of the 919 neonates screened, 917 (99.78%) had normal TSH values, one (0.11%) required repeat testing because of a borderline elevation, and one (0.11%) was confirmed to have congenital hypothyroidism after repeat TSH and free T4 estimation. The markedly elevated TSH level ($> 100 \mu\text{IU/mL}$) together with a low free T4 strongly supported a diagnosis of permanent primary congenital hypothyroidism. These findings are consistent with international paediatric endocrine guidelines, which recommend confirmation of abnormal screening results by repeat thyroid function tests before the diagnosis is established.^{42,45}

The TSH cut-offs adopted in the present study are consistent with the ISPAE recommendations, which advise recall for confirmatory testing when the screening TSH exceeds $20 \mu\text{IU/mL}$ and immediate confirmatory estimation of venous TSH and T4 or free T4 when it exceeds $40 \mu\text{IU/mL}$.^{22,23} Markedly elevated values correlate strongly with permanent congenital hypothyroidism, particularly thyroid dysgenesis, whereas moderate elevations frequently represent transient hyperthyrotropinaemia related to prematurity, iodine exposure, maternal antibodies, or perinatal stress; confirmatory testing, rather than immediate commitment to lifelong therapy, is therefore recommended for such values.^{19,42} Appropriate timing of sample collection is a critical determinant of newborn screening accuracy. Neonatal thyroid physiology is characterized by a transient surge in TSH immediately after birth, which gradually declines over the first 48–72 hours of life. Screening during this physiological surge may produce false-positive results and unnecessary recalls.^{42,43} To minimize this effect, blood samples in the present study were collected between 72 hours and 7 days of life, in keeping with internationally accepted recommendations. This strategy reduced the influence of physiological TSH elevation while maintaining adequate sensitivity for detecting congenital hypothyroidism.

The eligibility criteria adopted in the present study further strengthened the validity of the prevalence estimate. Neonates born to mothers with overt thyroid disease or exposed to antithyroid drugs may show transient thyroid dysfunction because of transplacental passage of maternal hormones, antibodies, or medications; neonates with major congenital anomalies or syndromic features may have central or secondary hypothyroidism; and restriction of the study population to clinically stable neonates avoided the non-thyroidal alterations in thyroid function seen in critically ill infants. Exclusion of these groups minimized misclassification of transient or secondary thyroid dysfunction as permanent primary congenital hypothyroidism and prevented overestimation of prevalence.^{19,42} The low recall rate observed in the present study further supports the effectiveness of this screening protocol. Only one neonate required repeat testing, suggesting high specificity with minimal parental anxiety and reduced healthcare costs. Confirmation by repeat TSH and free T4 estimation ensured accurate differentiation between transient TSH elevation and permanent congenital hypothyroidism, thereby preventing both unnecessary treatment and missed diagnoses. The methodology adopted in the present study therefore represents a practical and reliable approach to newborn screening in routine clinical practice.

An important observation was that none of the neonates exhibited classical clinical features of congenital hypothyroidism at the time of screening, despite one neonate having severe biochemical hypothyroidism. Previous studies have consistently demonstrated that most affected newborns are clinically asymptomatic because maternally derived thyroxine provides temporary hormonal support during fetal life, delaying the appearance of characteristic clinical manifestations.^{19,40,41} The present findings reinforce the concept that congenital hypothyroidism is primarily a biochemical diagnosis in the neonatal period and that reliance on clinical examination alone would result in delayed diagnosis and irreversible neurodevelopmental impairment. The prevalence observed in the present study (1.09 per 1000 live births) is consistent with contemporary Indian literature and demonstrates that congenital hypothyroidism is not an uncommon disorder in the neonatal population. Although only one confirmed case was identified, its clinical significance is considerable. Early detection followed by prompt initiation of levothyroxine therapy can prevent irreversible intellectual disability, ensure normal growth and neurodevelopment, and substantially improve long-term quality of life.¹⁹ The diagnosis of even a single affected infant therefore represents an important clinical and public health achievement.

From a public health perspective, the findings of this study support the continued expansion of universal newborn screening programmes, particularly in rural and resource-limited settings where epidemiological data remain limited. The successful implementation of screening in a rural tertiary care hospital demonstrates that such programmes are feasible and can identify clinically silent cases before irreversible neurological damage occurs. Early diagnosis not only improves individual patient outcomes but also reduces the long-term economic and societal

burden associated with lifelong disability. Overall, the present study demonstrates that screening performed between 72 hours and 7 days of life, followed by confirmatory thyroid function testing, is an effective strategy for the early detection of congenital hypothyroidism. The findings emphasize that biochemical screening is indispensable because clinical examination alone is insufficient during the neonatal period. Expansion of universal newborn screening programmes across rural healthcare facilities has the potential to substantially reduce the burden of preventable intellectual disability and improve neonatal health outcomes in India.

Clinical Significance of the Confirmed Case:-

The present study identified one female neonate with confirmed congenital hypothyroidism among 919 screened newborns. The diagnosis was established following detection of a markedly elevated serum TSH level ($> 100 \mu\text{IU/mL}$), with persistently elevated TSH and low free T4 on repeat testing, fulfilling the biochemical criteria for primary congenital hypothyroidism. Ultrasonography of the neck demonstrated non-visualization of the thyroid gland, suggestive of thyroid agenesis, while radiographic evaluation showed delayed appearance of the distal femoral epiphyseal ossification centre, supporting antenatal onset of thyroid hormone deficiency. These findings are consistent with previous reports indicating that thyroid dysgenesis, particularly thyroid agenesis, is the commonest cause of permanent congenital hypothyroidism.¹³ Indian data suggest that the aetiological spectrum of permanent congenital hypothyroidism differs from that described in Western populations. In a recent Indian meta-analysis, thyroid dysgenesis accounted for 56.6% and dyshormonogenesis for 38.7% of permanent cases,²⁴ compared with approximately 85% due to dysgenesis in Western series.¹³ Among Indian children with thyroid dysgenesis, agenesis rather than ectopia has been reported to be the predominant form,⁵¹ which is in keeping with the finding of thyroid agenesis in the present case.

Despite severe biochemical hypothyroidism, the neonate had no classical clinical manifestations such as macroglossia, hypotonia, coarse facies, umbilical hernia, or prolonged feeding difficulty at the time of screening. The transient hyperbilirubinaemia that this neonate developed on day 4 of life resolved after 24 hours of phototherapy and therefore did not represent the prolonged jaundice characteristic of congenital hypothyroidism. This observation is in agreement with previous newborn screening studies demonstrating that maternally transferred thyroxine temporarily masks clinical manifestations during the neonatal period, making early diagnosis based solely on physical examination unreliable.^{19,40,41} The present case therefore highlights the indispensable role of biochemical newborn screening in identifying affected infants before irreversible neurological damage occurs. The confirmed case fulfilled all the inclusion criteria and none of the exclusion criteria adopted in the present study. There was no maternal history of thyroid disease, antithyroid drug exposure, gestational diabetes mellitus, pregnancy-induced hypertension, or consanguinity. The neonate was born at term with a normal birth weight and satisfactory APGAR scores, emphasizing that congenital hypothyroidism may occur in apparently healthy newborns without identifiable maternal or neonatal risk factors. This finding further supports the recommendation that newborn thyroid screening should be universal rather than risk-based, as selective screening would fail to identify many affected infants.

The identification of a single confirmed case also validates the screening protocol adopted in the present study. Collection of blood samples between 72 hours and 7 days of life, followed by confirmatory estimation of serum TSH and free T4, enabled accurate differentiation of permanent congenital hypothyroidism from transient neonatal thyroid dysfunction. The markedly elevated TSH level, together with low free T4 and imaging evidence of thyroid agenesis, confirmed permanent primary congenital hypothyroidism and justified immediate initiation of levothyroxine therapy. Early treatment in such infants has consistently been shown to normalize growth and neurodevelopment and to prevent irreversible intellectual disability.^{19,42,45}

Treatment and Follow-up:-

Current Indian, European, and American guidelines uniformly recommend that levothyroxine be commenced at a dose of 10–15 $\mu\text{g/kg/day}$ as soon as the diagnosis is biochemically confirmed, ideally within the first two weeks of life.^{23,25,52} Imaging by ultrasonography or radionuclide scintigraphy helps to establish the aetiology but should not delay the initiation of treatment.²³ The tablet is crushed and administered with a small volume of breast milk or water, and concomitant administration of soy formula, iron, or calcium should be avoided because these reduce its absorption.¹⁹ The ISPAE guidelines recommend estimation of serum T4 or free T4 at 2 weeks and of TSH with T4 or free T4 at 1 month after initiation of therapy, followed by monitoring every 2 months until 6 months of age, every 3 months from 6 months to 3 years, and every 3–6 months thereafter.²³ The aim of treatment is to maintain TSH within the age-specific reference range and free T4 in the upper half of the reference range during the first three years of life.²⁵ Infants in whom transient hypothyroidism is suspected should be re-evaluated at 3 years of age to

assess the need for lifelong therapy,²³ whereas infants with thyroid agenesis, such as the present case, require lifelong replacement.¹⁹ When treatment is initiated early and in adequate doses, affected children achieve essentially normal growth and neurocognitive outcomes in adulthood.^{16,25}

Implications for Screening Programmes:-

The findings of the present study have important public health implications. Although the prevalence of congenital hypothyroidism was low (1.09 per 1000 live births), the consequences of an undiagnosed case are lifelong and irreversible. Early identification through newborn screening provides an opportunity for timely intervention during the critical period of brain development, thereby preventing cognitive impairment and improving long-term quality of life. From a health systems perspective, newborn screening for congenital hypothyroidism is recognized as one of the most cost-effective preventive interventions in paediatric practice, because the cost of screening and treatment is substantially lower than the lifelong social and economic burden associated with untreated disease.²⁰ The present study also demonstrates the feasibility of implementing newborn screening in a rural tertiary care hospital. Most published Indian studies have originated from urban tertiary centres, whereas data from rural populations remain limited. The identification of a clinically asymptomatic but biochemically confirmed case in the present study highlights the need to strengthen newborn screening services in rural healthcare settings. Hospital-based screening of this kind can serve as a foundational model upon which district- and state-level programmes are built. Expansion of such programmes, coupled with timely confirmatory testing, treatment, and long-term follow-up, would contribute significantly to reducing preventable neurodevelopmental disability in India.

Taken together, the present study demonstrated a prevalence of 1.09 cases of congenital hypothyroidism per 1000 live births, comparable with contemporary Indian data. The confirmed case of thyroid agenesis emphasizes that congenital hypothyroidism is frequently clinically silent during the neonatal period and can be reliably detected only through biochemical screening. These findings strongly support the implementation of universal newborn screening programmes, particularly in rural and resource-limited settings, to ensure early diagnosis, prompt initiation of levothyroxine therapy, and prevention of irreversible neurodevelopmental impairment. The study adds valuable epidemiological data from a rural tertiary care hospital and reinforces the importance of integrating newborn screening into routine neonatal healthcare services.

Summary:-

Congenital hypothyroidism is a deficiency of thyroid hormone present at birth, most often caused by abnormal development of the thyroid gland. In the absence of early detection and treatment, affected infants develop irreversible neurodevelopmental impairment, growth failure, and long-term socioeconomic disability. The introduction of newborn screening programmes has dramatically transformed the prognosis of this disorder by enabling presymptomatic diagnosis and timely initiation of levothyroxine therapy. Given emerging evidence of relatively higher prevalence rates of congenital hypothyroidism in India compared with earlier Western reports, regional epidemiological data are essential to guide the implementation of universal newborn screening programmes. The present prospective observational study was conducted in a rural tertiary care hospital with the primary objective of estimating the prevalence of congenital hypothyroidism among apparently healthy neonates. The secondary objectives were to analyse the distribution of serum TSH levels among screened newborns and to assess the association between elevated TSH levels and selected demographic and perinatal factors.

A total of 919 neonates were enrolled consecutively over the study period. Only clinically stable neonates between 72 hours and 7 days of life were included, to avoid confounding by the physiological neonatal TSH surge and by non-thyroidal illness. Neonates born to mothers with overt thyroid disease or receiving antithyroid medication were excluded to prevent misclassification of transient or secondary thyroid dysfunction as primary congenital hypothyroidism. Serum TSH levels were measured using a standardized immunoassay. The screening algorithm categorized TSH values as follows: values below 20 μ IU/mL were considered normal; values between 20 and 40 μ IU/mL required repeat testing; and values exceeding 40 μ IU/mL were considered highly suggestive of congenital hypothyroidism and were confirmed by repeat TSH and free T4 estimation. Of the 919 neonates screened, 917 (99.78%) had TSH values within normal limits. One neonate (0.11%) had a borderline elevation requiring repeat testing, and one (0.11%) had a markedly elevated TSH ($> 100 \mu$ IU/mL) with low free T4 on confirmation and was diagnosed with congenital hypothyroidism. The calculated prevalence of congenital hypothyroidism in this cohort was 0.1088%, corresponding to 1.09 per 1000 live births, or approximately 1 in 919 live births. The exact (Clopper–Pearson) 95% confidence interval ranged from 0.003% to 0.60%. The demographic profile of the screened population showed a predominance of term neonates (93.36%) and normal birth weight infants ($89.45\% \geq 2.5$ kg).

The male-to-female distribution was comparable with expected neonatal ratios. Lower segment caesarean section accounted for 59.19% of deliveries, reflecting institutional referral patterns rather than any disease association. Among maternal variables, gestational diabetes mellitus was present in 5.77% of mothers, pregnancy-induced hypertension in 2.18%, and consanguinity in 4.46%. Universal use of iodized salt was reported, suggesting adequate iodine nutrition in the population.

The serum TSH distribution showed a mean of 2.85 $\mu\text{IU/mL}$, a median of 1.56 $\mu\text{IU/mL}$, a standard deviation of 4.44 $\mu\text{IU/mL}$, and a range of 0.10–100 $\mu\text{IU/mL}$. The distribution was right-skewed owing to a single markedly elevated outlier corresponding to the confirmed case. This pattern is characteristic of screening populations, in which the majority of neonates cluster within the normal range and rare high values represent clinically significant disease. The observed prevalence aligns closely with contemporary Indian studies, including the ICMR multicentric screening study, which documented a prevalence of approximately 1 in 1130 live births. International comparisons indicate a lower prevalence in many Western countries, often between 1 in 2000 and 1 in 3000 live births, although methodological differences influence such comparisons. The relatively higher prevalence observed in Indian cohorts may reflect genetic heterogeneity, evolving iodine nutrition patterns, and variations in screening thresholds.

Importantly, none of the neonates, including the confirmed case, exhibited classical clinical features of congenital hypothyroidism at the time of screening. This finding reinforces the well-established principle that congenital hypothyroidism is frequently clinically silent in the neonatal period because of transplacental transfer of maternal thyroxine. Biochemical screening is therefore essential for early detection. The study demonstrated a very low recall rate (0.11%), indicating high specificity of the screening protocol. Sampling after 72 hours probably minimized false-positive results related to the neonatal TSH surge. The number needed to screen to detect one confirmed case was 919, a figure that is acceptable given the severity and preventability of the condition. From a public health perspective, extrapolation of the observed prevalence suggests that approximately 10 to 11 of every 10,000 infants born in similar populations may be affected. Without systematic screening, these children would be at risk of delayed diagnosis and irreversible neurodevelopmental impairment. Early initiation of levothyroxine therapy within the first two weeks of life has been shown to normalize cognitive outcomes. In the present study, the confirmed case of congenital hypothyroidism was caused by thyroid dysgenesis (defective development of the thyroid gland), in the form of thyroid agenesis. In summary, this study confirms that congenital hypothyroidism in this rural tertiary care population occurs at a prevalence comparable to national Indian data. The findings demonstrate the feasibility of hospital-based newborn screening in rural settings, highlight the silent clinical presentation of affected neonates, and support the expansion of universal newborn screening programmes.

Conclusion:-

Congenital hypothyroidism, a deficiency of thyroid hormone present at birth, is a treatable condition and one of the most important preventable causes of intellectual disability. Early detection through newborn screening and prompt lifelong treatment are critical and allow most affected children to develop normally. The present prospective observational study, conducted in a rural tertiary care hospital, identified congenital hypothyroidism at a prevalence of 1.09 per 1000 live births (approximately 1 in 919 live births). This prevalence is consistent with contemporary Indian epidemiological data and underscores the public health relevance of the disorder in rural populations. The study demonstrated that congenital hypothyroidism is frequently clinically silent in the neonatal period, reinforcing the necessity of biochemical screening rather than reliance on clinical examination alone. The screening protocol adopted, including appropriate timing of sampling and evidence-based TSH cut-off values, resulted in high specificity and a minimal recall burden while successfully detecting a confirmed case.

These findings strongly support the implementation and strengthening of universal newborn screening programmes for congenital hypothyroidism in rural and semi-urban healthcare settings. Early identification and prompt initiation of levothyroxine therapy can prevent irreversible intellectual disability and significantly reduce the long-term societal burden. Although the number of confirmed cases was low and the confidence interval wide, the early detection of even a single case highlights the clinical and public health importance of neonatal thyroid screening. The findings support the feasibility of implementing routine newborn screening programmes in rural healthcare institutions. Larger multicentric studies are required for more precise prevalence estimates and for the evaluation of risk factors. Expansion of structured newborn screening services, establishment of reliable recall systems, and integration with existing maternal and child health programmes are recommended to ensure timely diagnosis and follow-up. Screening for congenital hypothyroidism should be regarded as an essential component of neonatal healthcare delivery.

The key conclusions of the present study regarding congenital hypothyroidism are as follows:-

- **Preventable disability:** congenital hypothyroidism is one of the most common preventable causes of intellectual disability.
- **Newborn screening is crucial:** most affected neonates are clinically silent, and biochemical screening is the only reliable means of early detection.
- **Effective treatment:** early and adequate levothyroxine therapy normalizes growth and neurodevelopment.
- **Outcome:** whereas untreated cases can lead to permanent severe intellectual disability and stunted growth, timely treatment provides an excellent prognosis.

Limitations of the Study:-

Single-centre study:-The study was conducted in a single rural tertiary care hospital; the results may therefore not be representative of the wider community.

Small number of confirmed cases:-Only one case of congenital hypothyroidism was identified; because of this small number, statistical comparison between groups was limited.

Not powered for association analysis:-The study was designed primarily to estimate prevalence rather than to identify risk factors. Therefore, the absence of statistical significance does not imply the absence of an association.

Wide confidence interval:-The confidence interval for the prevalence estimate was wide owing to the low event rate. Larger studies are needed for more precise estimates.

TSH-only screening:-Screening was performed using TSH alone; rare cases of central hypothyroidism may therefore have been missed.

Iodine status not assessed:-Maternal and neonatal iodine levels were not measured.

No long-term follow-up:-The study focused on early detection and did not assess long-term neurodevelopmental outcomes.

Declarations:-

Ethical approval: The study was approved by the Institutional Ethics Committee of Akash Institute of Medical Sciences and Research Centre, Devanahalli, Bengaluru Rural, Karnataka, before its initiation.

Informed consent: Written informed consent was obtained from the parents or legal guardians of all participating newborns.

Conflict of interest: The authors declare that they have no conflict of interest.

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