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Original Article

# Prevalence of Congenital Hypothyroidism and Related Factors in Gorgan: A Cross-Sectional Study

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**Abstract**

**Background and aims:** Congenital hypothyroidism (CH) is an important preventable cause of mental disability in infants. Early diagnosis through timely screening can prevent its adverse outcomes. This study aimed to investigate the prevalence of CH and associated factors in Gorgan.

**Methods:** This cross-sectional study included 292 hypothyroid newborns born in Gorgan in 2021, based on a 5-year census. Data on first-screening and second-screening results, venous samples, and demographic characteristics were extracted from health records. Then, statistical analyses were performed by SPSS 16 using descriptive statistics, chi-square tests, and independent t-tests.

**Results:** The prevalence of CH was 1:589 live births (1:558 in females and 1:621 in males). Girls accounted for 51.4% of cases, and 15% of newborns had a family history of hypothyroidism in first-degree relatives. Moreover, normal thyroid-stimulating hormone (TSH) levels were observed in 15.8% and 18.3% at the first and second screenings, respectively, and 4.2% of venous samples. Consistency between screening and venous sample results was 44% and 53% for the first and second screenings, respectively. Ultimately, infant TSH levels were influenced by birth weight and statistically correlated with thyroxine levels.

**Conclusion:** Overall, the prevalence of CH in Gorgan was lower than in other provinces but higher than global averages. These findings highlight the importance of ongoing screening programs, and further research is required to identify the causes and preventive factors.

**Keywords:** Congenital hypothyroidism, Neonatal screening, Thyroid-stimulating hormone

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## Introduction

Congenital hypothyroidism (CH) is a deficiency of thyroid hormone present at birth, which can be classified into permanent and transient types.[1] It is one of the most common endocrine disorders and a crucial, preventable cause of mental disability.[2] Genetic, environmental, and geographical factors all contribute to the occurrence of this disease.[3-5] Moreover, CH can lead to cardiomyopathy, retinopathy, premature neonatal death, low birth weight in term infants, and an increased risk of congenital anomalies.[6-9] Most hypothyroid newborns appear normal at birth and do not present with specific clinical symptoms. Therefore, if diagnosis is based solely on clinical manifestations, infants may suffer from irreversible complications, such as deafness and intellectual disability.[10] Conversely, IQ impairments caused by CH can be prevented if the disease is diagnosed during infancy; thus, early and timely screening is essential.[11]

Today, routine screening in many developed countries is performed by measuring thyroid-stimulating hormone (TSH) and thyroxine (T4) in cord blood or heel-prick samples. However, this practice is not fully implemented in a variety of developing countries. Consequently, various infants with hypothyroidism remain undiagnosed and untreated.[11-13] CH screening programs were first initiated in North America in 1972.[14] In Iran, the first screening program for CH was implemented in 1987.[15] The prevalence of CH widely varies across Iranian provinces, ranging from 1:313 in Fars[16], 1:446 in Southwest of Iran[17], 1:453 in northern Iran[18], to 1:1250 in Hamadan.[19] Overall, the prevalence of CH in Iran is higher than that reported in other countries, such as Egypt (1:16,667)[20], Saudi Arabia (1:834)[21], and the United States (1:1,684)[22], with 1:2,115 reported in Alabama.[23] Several factors influence the occurrence of CH, including maternal age, birth weight, gender of the infant, mode of delivery,[11] environmental and genetic factors,[12] maternal intake of anti-thyroid drugs, iodine intake through diet, exposure to radiation, congenital anomalies, and either iodine deficiency or excess.[5, 9, 13]

Given the clinical significance of CH, it is essential to determine its prevalence, particularly in the Gorgan region, in order to prevent its complications on child growth through effective planning and preventive

measures. It should be noted that the etiology of CH remains incompletely understood. Considering that affected infants often lack specific clinical symptoms, this study has been designed as a descriptive-analytical cross-sectional investigation to examine the epidemiology of CH in Gorgan, thereby enabling long-term planning and comparison with data from other provinces and nationally.

## Materials and Methods

### *I. Selection and Description of Participants*

This cross-sectional study investigated all infants born in Gorgan from April 2015 to March 2019 who were included in the hypothyroidism screening plan. Infants' information was extracted from the Software Information System (NAB) through an Excel file. Finally, 292 patients were included in the study. Complete information registration in the patient file in the lean system of Gorgan was the criterion for entering the study. On the other hand, the criterion for exclusion from the study was the incomplete registration of information in the newborn's file. The first round of screening was conducted on days 3–5 of birth, and the second, if indicated, on days 8–14 at accredited laboratory centers established by Gorgan University of Medical Sciences.

### *Sampling*

After warming the baby's foot and cleaning the heel area with alcohol, a few drops of blood (4 drops) were collected on filter paper (903 S&S) using a lancet needle applied to the outer surface of the baby's heel. After 3–4 hours, the samples were dried at room temperature and then sent to the city's central central laboratory as soon as possible, according to the country's instructions. The TSH concentration was checked, and the results were reported accordingly.[24]

### *II. Technical Information*

In this study, infants were divided into three groups based on the TSH value obtained from the first screening. In this way, babies with TSH < 5 were considered normal on screening, and babies with TSH between 9.9 and 5 were referred for a second screening. In addition, T4 samples and venous TSH were checked in babies whose TSH was more than 10 in the first screening.

The results of newborn screening were divided into the following four categories: **(a)** TSH < 5, **(b)** 5 < TSH < 9.9, **(c)** 10 < TSH < 19.9, and **(d)** TSH > 20. Statistical analysis was performed on B, C, and D categories. According to the national protocol for infants (1–4 weeks), serum T4 < 5.6 μg/dL and TSH > 10 μU/mL indicate hypothyroidism.[25] In addition, in this study, the newborns were examined in terms of birth weight in the form of weight less than 2500 g and more than 2500 g. A blood sample was prepared using a simple standard blood collection technique, and 2 cc of blood was taken.

Furthermore, serum tests were conducted by the enzyme-linked immunosorbent assay method. A checklist was designed to collect demographic information and newborn characteristics at birth, and it was completed using information recorded in the Ministry of Health's newborn information registration system. The checklist included questions about the child's gender, birth weight, gestational age, TSH level at birth, and type of delivery.

This study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Golestan University of Medical Sciences under the number (date: 03.07.2022, No.: 2021-125). All participants and their parents were informed that participation was voluntary and assured that responses would remain confidential. Additionally, informed written consent was obtained from all participants' parents who completed the questionnaires. Participants could withdraw from the study at any point without penalty and would receive no compensation for participation. In this study, participants' personal information collected during the consent/data collection processes was stored securely.

### *III. Statistical Analysis*

The obtained data were entered into SPSS software, version 16. Quantitative data were described using descriptive statistics (means and standard deviations), and qualitative data were described using a frequency distribution table (frequencies and percentages). In addition, the correlation between qualitative variables was assessed using the chi-square and Fisher's exact tests. Moreover, the normality of quantitative data was measured by the Shapiro-Wilk test. Further, an independent t-test and analysis of variance were used to compare means of standard variables. Furthermore, Whitney and Kruskal-Wallis tests were utilized for non-normal variables. A *P*-value of 0.05 was considered statistically significant.

## Results

This study was conducted on male and female infants over the 5 years from 2015 to 2019. The prevalence of CH was 1:589 per live birth and 1:558 and 1:621 in females and males, representing approximately equal incidence between the two gender groups and slightly higher in girls (female: male ratio 1.06:1). The number of live births during this period was 172,059, of which 83,824 were girls (48%). Additionally, the number of diagnosed cases of CH in these 5 years was equal to 292 cases, of which 150 cases (51.3%) were in female babies. The number of cases of CH by gender and year is presented in Table 1.

Demographic characteristics of infants with CH revealed that the mean weight of infants was 3037 ± 1645 g, and their average height was 48.6 ± 3.4 cm. Nearly 50.7% of babies were born through cesarean section, and parents of 26.4% of babies had a family relationship. About 15.1% of infants had a family history of hypothyroidism in the first-degree family, and 1.5% of newborns had associated anomalies (Table 2).

Among 292 patients, 272 had undergone the first screening test, and 43 had normal results. These 43 babies

**Table 1.** Frequency Distribution of Congenital Hypothyroid Cases by Gender and Year

| Year | Total Number of Births | Total Number of Hypothyroid (%) | Girls (%) | Boys (%) |
|---|---|---|---|---|
| 2017 | 39,216 | 82 (0.2) | 39 (47.6) | 43 (52.4) |
| 2018 | 38,353 | 85 (0.21) | 46 (54.1) | 39 (45.9) |
| 2019 | 34,995 | 40 (0.11) | 22 (55.0) | 18 (45.0) |
| 2020 | 30,597 | 42 (0.13) | 20 (47.6) | 22 (52.4) |
| 2021 | 28,898 | 43 (0.14) | 23 (53/5) | 20 (46.5) |
| | 172,059 | 292 (0.16) | 150 (51.4) | 142 (48.6) |

**Table 2.** Demographic Characteristics of Infants With Congenital Hypothyroidism

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Mode of delivery | Normal vaginal delivery | 148 | 50.7 |
| | Cesarean section | 144 | 49.3 |
| Parental consanguinity | Yes | 77 | 26.4 |
| Family history of hypothyroidism (first-degree relatives) | Yes | 44 | 15.1 |
| Associated anomalies | Present | 4 | 1.5 |

with TSH below 5 were subject to repeat screening for the second or even the third time due to risk factors, such as being underweight or having twins. Of 292 patients, 131 have undergone the second screening test, which combines rows 1 and 2 of the first screening, both of which indicate repeating the screening. Among the patients who performed the second screening test, 24 had normal results. In addition, 12 out of 24 cases with expected results weighed less than 1500 g and were subjected to the third screening. Among the 292 patients, 259 patients were examined with venous samples. In the venous sample, TSH was normal in 4.2% of cases, and TSH was > 20 in 52.5% of cases (Table 3).

The compatibility of the first-screening and second-screening results with the venous sample was also examined in this study. The results demonstrated that of the 43 people with a TSH below 5 in the first round of screening, 37 had a recorded venous sample, and 35 had a TSH above 5 in the venous sample. Out of 206 people for whom screening TSH was reported above 5, 200 people (97.1%) also had TSH above this value in the venous sample. The agreement between these two variables was 44%. Moreover, 21 out of 22 people with TSH below 5 μIU/mL in the second screening had a venous sample above 5. Of the 99 people whose TSH on the second screening was above 5 uIU/mL, the venous sample also showed TSH above 5. Additionally, the TSH agreement rate of the second screening and the venous sample was 53% (Table 4).

Mean TSH levels significantly declined from the first to the second screening in both weight categories ( < 2500 g and ≥ 2500 g, $P = 0.001$), reflecting the physiological postnatal decrease in TSH during the first week of life. In addition, infants with a birth weight ≥ 2500 g exhibited higher TSH levels compared to those weighing < 2500 g. Conversely, the timing of screening (3–5 days versus ≥ 6 days) did not significantly influence TSH concentrations ($P = 0.661$), indicating the relative stability of TSH levels within this screening window (Table 5).

**Table 3.** Frequency Distribution of Screening Results and Venous Samples in Patients With Hypothyroidism

| Level TSH* (uIU/mL) | First Screening | Second Screening | Venous Sample |
|---|---|---|---|
| < 5 | 43 (15.8) | 24 (18.3) | 11 (4.2) |
| 5-9.9 | 92 (33.8) | 61 (46.6) | 42 (16.2) |
| 10-19.9 | 58 (21.3) | 25 (19.1) | 70 (27) |
| ≤ 20 | 79 (29) | 21 (16) | 136 (52.5) |
| Total | 272 (93.15) | 131 (44.9) | 259 (88.7) |

*Note*. * TSH: Thyroid-stimulating hormone.

The level of venous T4 was checked for 229 people. Of these, 39.7% had T4 levels less than 6.5 (which suggests hypothyroidism). Nearly 43.2% of males had a T4 level below 6.5 compared with 36.4% of females. Furthermore, the frequency of T4 levels among male and female babies, as well as the average height and weight of babies in different T4 levels, did not show statistically significant differences. Examining the behavior of serum TSH and T4 in relation to each other revealed that the TSH of the venous sample increases significantly when the T4 of the venous sample is less than 6.5. Their agreement rate was also 33% (Table 6).

## Discussion

In the present study, the prevalence of CH was 1:589 per live birth, with a prevalence of 1:558 and 1:621 in females and males, respectively. Overall, CH prevalence was approximately equal across genders, with a slightly higher rate observed in girls (female-to-male ratio: 1.06:1).

Nonetheless, the incidence rate of CH varied across Iranian provinces. In Kohkiluyeh and Boyer Ahmad, the incidence was 5.79 per 1000 live births,[26] whereas in Fars province, it was 1:3 316. Amiri et al[27] reported an incidence of 1:135 in southern Kerman, with male infants exhibiting a 1.17-fold higher incidence than female infants. In Markazi province, Dorreh et al[28] found a prevalence of

**Table 4.** Comparison of the Results of TSH* Values in Screening Times With Venous Samples

| Screening | Level TSH (uIU/mL) | Venous Sample >5 | Venous Sample <5 | Total | *P*-Value |
|---|---|---|---|---|---|
| First screening | >5 | 2 (5.4) | 35 (94.6) | 37 | 0.001** |
| | <5 | 6 (2.9) | 200 (97.1) | 206 | |
| Second screening | >5 | 1 (4.5) | 21 (95.5) | 22 | 0.001** |
| | <5 | 2 (2) | 97 (98) | 99 | |

*Note*. *TSH: Thyroid-stimulating hormone, ** Fishers' exact test.

**Table 5.** Comparison of the TSH of the First and Second Screening According to the Infant's Weight and Screening Time

| Variable | Screening Time | First Screening (Mean ± SD) | Second Screening (Mean ± SD) | *P*-Value |
|---|---|---|---|---|
| Weight (g) | ≤2500 | 8.16 ± 7.14 | 7.67 ± 7.16 | 0.001** |
| | ≥2500 | 12.23 ± 6.72 | 10.96 ± 8.2 | 0.001** |
| Screening time | TSH levels | 3–5-day N (%) | ≥6-day N (%) | |
| | >5 | 35 (15.0) | 7 (18.4) | |
| | 9.95 | 74 (33.5) | 14 (36.8) | 0.661*** |
| | 10-19.9 | 48 (21.7) | 7 (18.4) | |
| | >20 | 64 (29.0) | 10 (26.3) | |

*Note*. *TSH: Thyroid-stimulating hormone, **Mann-Whitney U test, *** Kruskal-Walli's test. TSH: Thyroid-stimulating hormone; SD: Standard deviation.

**Table 6.** Correlation of T4 Level of Venous Sample With Demographic Characteristics and Screening of Hypothyroid Infants

| Variable | *TSH Levels | >6.5 | 6.5-9.9 | 10< | *P*-Value |
|---|---|---|---|---|---|
| Gender | Girl | 43 (36.4) | 41 (34.7) | 34 (28.8) | 0.264** |
| | Boy | 48 (43.2) | 41 (36.9) | 22 (19.8) | |
| | Total | 91 (39.7) | 82 (35.8) | 56 (24.5) | - |
| Type of delivery | Normal vaginal delivery | 55 (44) | 43 (34.7) | 26 (21) | 0.260** |
| | Cesarean section | 36 (34.3) | 39 (37.1) | 30 (28.6) | |
| TSH levels | >5 | 1 (11.1) | 3 (33.3) | 5 (55.6) | 0.001*** |
| | 5-9.9 | 7 (20) | 15 (42.9) | 13 (37.1) | |
| | 10-19.9 | 15 (26.8) | 24 (42.9) | 17 (30.4) | |
| | 20< | 65 (52.8) | 40 (32.5) | 18 (14.6) | |
| Height (cm) | | 48.72 ± 3.6 | 48.76 ± 2.99 | 48.36 ± 4 | 0.76**** |
| Weight (k/g) | | 3069 ± 683 | 3070 ± 562 | 3024 ± 729 | 0.74*** |

*Note*. *TSH: Thyroid-stimulating hormone, **Chi-square test, ***Fisher's exact test, ****Kruskal-Wallis test.

1:307, slightly higher in boys (boy-to-girl ratio 1.05:1). Likewise, Beheshti et al[18] observed an incidence of 1:491 for male hypothyroidism in Mazandaran province, with the disease being more common in boys. Compared with these regions, the occurrence of CH in the present study was 0.22 times that in southern Kerman, 0.5 times that in Markazi, and 0.8 times that in Mazandaran. Globally, CH prevalence varies by region, ranging from 1:3000 to 1:4000 live births, with higher prevalence observed in girls.[29] Compared with neighboring countries, Iran demonstrates a higher incidence; neonatal hypothyroidism has been reported as 1:650, 1:2259, and 1:2470 in Turkey,[30] Syria, [31]and Saudi Arabia,[32] respectively.

Although the CH incidence in Golestan province is lower than in other Iranian provinces, it remains higher than global estimates and rates reported in different countries. Differences in neonatal screening cutoff values may partly explain this discrepancy; in Iran, a TSH level > 5 μIU/mL has been considered positive since the screening program began.[24] These findings underscore the need for comprehensive studies to elucidate factors contributing to the higher occurrence in this region. In the present study, a notable proportion of affected infants had normal TSH levels (< 5 μIU/mL) during initial screening (15.8% in the first round and 18.3% in the second round), which decreased to 4.2% following venous sampling. This indicates that TSH screening alone is insufficient for definitive diagnosis and should be complemented with the assessment of risk factors and venous TSH and T4 measurements in suspected cases.

Of 37 infants initially identified as negative for CH, 35 (94.6%) were later confirmed positive via venous testing, whereas among 206 infants initially identified as positive, 200 (97.1%) were confirmed via venous testing. These results confirm the high sensitivity of first-round screening. Notably, false-negative cases included infants with risk factors undetected during initial screening, such as prematurity, very low (< 1500 g) or low (< 2500 g) or high (> 4000 g) birth weight, multiple births, hospitalization, blood transfusions, or exposure to

medications like dopamine, highlighting the necessity for risk-based second-round screening.[24] Second-round screening demonstrated a sensitivity of 82.2%, confirming that targeted repeat screening effectively identifies cases missed in the first round, minimizing undiagnosed patients.[24] Applying a correction factor of 1.5 to initial TSH results revealed considerable discrepancies at TSH levels > 20 μIU/mL and 5–9.9 μIU/mL, indicating that first-round screening alone may not reliably detect all cases. Other factors, such as sampling technique, assay methodology, kit variability, and personnel expertise, may influence reported results. To the best of our knowledge, no previous studies have systematically compared first-round and second-round screening with venous TSH measurements; thus, these findings are presented for the first time. Only Ayyad et al[33] in Isfahan reported that a TSH cutoff of 7.5 μIU/mL yielded the highest sensitivity (74.8%) and specificity (71.3%), emphasizing the need for nationwide studies to determine the most cost-effective and accurate neonatal TSH cutoff.[33]

In a study by Yarahmadi et al[34], a TSH cutoff of 5 μIU/mL improved sensitivity while reducing false negatives; however, the exact number of false negatives remained unclear, necessitating further research.[34] Gender comparisons of infants with low T4 levels (< 6.5 μg/mL) revealed no significant differences, suggesting that gender does not influence low T4. Moreover, timing of the first TSH screening (days 3–5 vs. ≥ 6) did not significantly affect TSH levels, indicating that early screening is as effective as later testing for timely diagnosis and prevention of CH complications.[34] TSH levels were higher in infants with birth weight ≥ 2500 g across both screening rounds, consistent with the delayed maturation of the hypothalamus-pituitary-thyroid axis in preterm or low-birth-weight infants, supporting re-screening at 2–4 weeks postnatal age.[35,36] The analysis of T4 levels (< 6.5, 6.5–10, > 10 μg/mL) demonstrated no significant impact on infant height or weight, representing that growth parameters are independent of T4. Similarly, T4 levels were not associated with delivery type (cesarean vs. vaginal). As expected, T4 < 6.5 μg/mL correlated with higher TSH levels.

Study limitations included incomplete maternal medical histories and the absence of comprehensive population-level data over five years, precluding comparisons between affected infants and the general newborn population.

## Conclusion

The findings of the present study indicated that although the prevalence of CH in Golestan province is lower than that reported in other Iranian provinces, it remains higher than in neighboring countries and substantially exceeds the global average. The occurrence of CH was approximately equal between both genders, with a slightly higher prevalence observed in girls. Alterations in the timing of the first neonatal screening failed to significantly affect the screening outcomes. Moreover, variations in intravenous T4 levels were not associated with differences in the height or weight of affected infants. Eventually, no relationship was identified between the mode of delivery and T4 levels in these patients.

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### Authors' Contribution

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### Competing Interests

The authors declare there is no conflict of interests in sending or publishing this article.

### Ethical Approval

Ethical considerations in this study included obtaining permission from the Ethics Committee of Golestan University of Medical Sciences (IR.GOUMS.REC.1401.125).

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### References

1. Peters C, Nicholas AK, Schoenmakers E, Lyons G, Langham S, Serra EG, et al. DUOX2/DUOXA2 mutations frequently cause congenital hypothyroidism that evades detection on newborn screening in the United Kingdom. Thyroid. 2019;29(6):790-801. doi: 10.1089/thy.2018.0587
2. Kollati Y, Akella RR, Naushad SM, Thalla M, Reddy GB, Dirisala VR. The rs1991517 polymorphism is a genetic risk factor for congenital hypothyroidism. 3 Biotech. 2020;10(6):285. doi: 10.1007/s13205-020-02273-7
3. McNally RJ, Jones JH, Shaikh MG, Donaldson MD, Blakey K, Cheetham TD. Congenital hypothyroidism: space-time clustering of thyroid dysgenesis indicates a role for environmental factors in disease etiology. Thyroid. 2021;31(6):876-83. doi: 10.1089/thy.2020.0005
4. Nicholas AK, Serra EG, Cangul H, Alyaarubi S, Ullah I, Schoenmakers E, et al. Comprehensive screening of eight known causative genes in congenital hypothyroidism with gland-in-situ. J Clin Endocrinol Metab. 2016;101(12):4521-

31. doi: 10.1210/jc.2016-1879
5. Hashemipour M, Samei P, Kelishadi R, Hovsepian S, Hani Tabaei Zavareh N. A systematic review on the risk factors of congenital hypothyroidism. J Pediatr Rev. 2019;7(4):199-210. doi: 10.32598/jpr.7.4.199
6. Bernal J. Thyroid hormones in brain development and function. In: Feingold KR, Ahmed SF, Anawalt B, Blackman MR, Boyce A, Chrousos G, et al, eds. Endotext [Internet]. South Dartmouth, MA: MDText.com, Inc; 2000. Available from: https://www.ncbi.nlm.nih.gov/books/NBK285549/. Updated September 29, 2025.
7. van Trotsenburg P, Stoupa A, Léger J, Rohrer T, Peters C, Fugazzola L, et al. Congenital hypothyroidism: a 2020-2021 consensus guidelines update-an ENDO-European reference network initiative endorsed by the European Society for Pediatric Endocrinology and the European Society for Endocrinology. Thyroid. 2021;31(3):387-419. doi: 10.1089/thy.2020.0333
8. Klosinska M, Kaczynska A, Ben-Skowronek I. Congenital hypothyroidism in preterm newborns - the challenges of diagnostics and treatment: a review. Front Endocrinol (Lausanne). 2022;13:860862. doi: 10.3389/fendo.2022.860862
9. Elsedfy H, Gamal R. Congenital hypothyroidism: a case report of an Egyptian child with congenital heart disease, pelvic kidney and cavernous transformation of portal vein. Egypt J Med Hum Genet. 2023;24(1):28. doi: 10.1186/s43042-023-00407-z
10. Cherella CE, Wassner AJ. Update on congenital hypothyroidism. Curr Opin Endocrinol Diabetes Obes. 2020;27(1):63-9. doi: 10.1097/med.0000000000000520
11. Said WP, Arto KS, Pratita W, Sufitni S. Intelligence quotient (IQ) outcome in children with early-treated congenital hypothyroidism: a systematic review and meta-analysis. Paediatr Indones. 2023;63(4):290-7. doi: 10.14238/pi63.4.2023.290-7
12. Korkmaz HA. Clinical insight into congenital hypothyroidism among children. Children (Basel). 2025;12(1):55. doi: 10.3390/children12010055
13. Saffari F, Karimzadeh T, Mostafaiee F, Mahram M. Screening of congenital hypothyroidism in Qazvin province (2006-2008). J Qazvin Univ Med Sci. 2009;12(4):43-9.
14. Zamani N, Mamdoohi Sh, Pashmkar F. The Incidence of congenital hypothyroidism in Boroujerd city. Proceeding of the 3rd Iranian Congress of Pediatric Endocrinology; 2010; Nov 30-Dec 3, Isfahan, Iran.
15. Ordookhani A, Mirmiran P, Hedayati M, Hajipour R, Azizi F. Screening for congenital hypothyroidism in Tehran and Damavand: an interim report on descriptive and etiologic findings, 1998-2001. Iran J Endocrinol Metab. 2002;4(3):153-60.
16. Habib A, Shojazadeh A, Molayemat M, Habib A, Jeddi M, Arabsolghar R, et al. Prevalence and predictive factors of transient and permanent congenital hypothyroidism in Fars province, Iran. BMC Pediatr. 2021;21(1):264. doi: 10.1186/s12887-021-02729-6
17. Aminzadeh M. Higher prevalence of permanent congenital hypothyroidism in the southwest of Iran mostly caused by dyshormonogenesis: a five-year follow-up study. Arch Endocrinol Metab. 2018;62(6):602-8. doi: 10.20945/2359-3997000000085
18. Beheshti Z, Rezaei R, Alipour A, Kosarian M, Saatsaz S. A 7-year study on the prevalence of congenital hypothyroidism in northern Iran. Electron Physician. 2018;10(4):6689-96. doi: 10.19082/6689
19. Razavi Z, Mohammadi L. Permanent and transient congenital hypothyroidism in Hamadan west province of Iran. Int J Endocrinol Metab. 2016;14(4):e38256. doi: 10.5812/ijem.38256
20. Bekhit OE, Yousef RM. Permanent and transient congenital hypothyroidism in Fayoum, Egypt: a descriptive retrospective study. PLoS One. 2013;8(6):e68048. doi: 10.1371/journal.pone.0068048
21. Abbas M, Tayrab E, Elmakki A, Tayrab J, Al-Shahrani A, Miskeen E, et al. Primary thyroid stimulating hormone screening for congenital hypothyroidism in King Abdullah hospital, Bisha, Saudi Arabia. Cureus. 2020;12(3):e7166. doi: 10.7759/cureus.7166
22. Ford GA, Denniston S, Sesser D, Skeels MR, LaFranchi SH. Transient versus permanent congenital hypothyroidism after the age of 3 years in infants detected on the first versus second newborn screening test in Oregon, USA. Horm Res Paediatr. 2016;86(3):169-77. doi: 10.1159/000448658
23. Pitts L, McCormick W, Mick GJ. Congenital hypothyroidism: 8-year experience using 2 newborn screens in Alabama. Horm Res Paediatr. 2019;91(5):319-28. doi: 10.1159/000501395
24. Delavari AR, Yarahmadi SH, Birjandi R, Mahdavi AR, Norouzi Nejad A, Dini M. Cost-benefit analysis of the neonatal screening program implementation for congenital hypothyroidism in IR Iran. Int J Endocrinol Metab. 2006;4(2):84-7.
25. Shahin Y, Nasreen A, Bahram N, Khalid R. The structure, implementation processes and achievements of the national screening program for neonatal hypothyroidism in the Islamic Republic of Iran. 2016: p. 64.
26. Ghatee MA, Manzouri L, Kheiri M, Parad M. Incidence rate and geographic distribution of congenital hypothyroidism in the southwest of Iran (Kohgiluyeh and Boyer Ahmad province) based on geographic information system since 2011-2020. BMC Pediatr. 2024;24(1):790. doi: 10.1186/s12887-024-05292-y
27. Amiri F, Sharifi H, Ghorbani E, Mirrashidi FS, Mirzaee M, Nasiri N. Prevalence of congenital hypothyroidism and some related factors in newborn infants in southern Kerman from April to March 2009. Iran J Epidemiol. 2019;15(2):188-94.
28. Dorreh F, Chaijan PY, Javaheri J, Zeinalzadeh AH. Epidemiology of congenital hypothyroidism in Markazi province, Iran. J Clin Res Pediatr Endocrinol. 2014;6(2):105-10. doi: 10.4274/Jcrpe.1287
29. Worth C, Hird B, Tetlow L, Wright N, Patel L, Banerjee I. Thyroid scintigraphy differentiates subtypes of congenital hypothyroidism. Arch Dis Child. 2021;106(1):77-9. doi: 10.1136/archdischild-2019-317665
30. Dilli D, Çzbaş S, Acıcan D, Yamak N, Ertek M, Dilmen U. Establishment and development of a national newborn screening programme for congenital hypothyroidism in Turkey. J Clin Res Pediatr Endocrinol. 2013;5(2):73-9. doi: 10.4274/Jcrpe.929
31. Saoud M, Al-Fahoum S, Kabalan Y. Congenital hypothyroidism: a five-year retrospective study at Children's University Hospital, Damascus, Syria. Qatar Med J. 2019;2019(1):7. doi: 10.5339/qmj.2019.7.
32. Al Shaikh A, Alsofyani A, Shirah B, Noaim KA, Ahmed ME, Babiker A, et al. Congenital hypothyroidism in Saudi population in two major cities: a retrospective study on prevalence and therapeutic outcomes. Int J Health Sci

(Qassim). 2021;15(1):17-21.
33. Ayyad AH, Hashemipour M, Hovsepian S, Mehrabi Kooshki A, Afshari M. The relation between serum and filter paper TSH level in neonates with congenital hypothyroidism. Adv Biomed Res. 2014;3:23. doi: 10.4103/2277-9175.124663
34. Yarahmadi S, Azhang N, Nikkhoo B, Rahmani K. Structures, processes and achievements of the national program of congenital hypothyroidism screening in the Islamic Republic of Iran. Sci J Kurdistan Univ Med Sci. 2019;24(4):10-21. doi: 10.29252/sjku.24.4.10
35. Cavarzere P, Camilot M, Popa FI, Lauriola S, Teofoli F, Gaudino R, et al. Congenital hypothyroidism with delayed TSH elevation in low-birth-weight infants: incidence, diagnosis and management. Eur J Endocrinol. 2016;175(5):395-402. doi: 10.1530/eje-15-1233
36. Hashemipour M, Hovsepian S, Ansari A, Keikha M, Khalighinejad P, Niknam N. Screening of congenital hypothyroidism in preterm, low birth weight and very low birth weight neonates: a systematic review. Pediatr Neonatol. 2018;59(1):3-14. doi: 10.1016/j.pedneo.2017.04.006