International Journal of Public Health Science (IJPHS)
Vol. 13, No. 4, December 2024, pp. 1554~1559
ISSN: 2252-8806, DOI: 10.11591/ijphs.v13i4.24091

Incidence of congenital hypothyroidism in Special Region of Yogyakarta in 2018-2020

Rhea Sabella Rahmawati[1], Tri Ratnaningsih[2], Windarwati[2], Suryono Yudha Patria
[1]Medical Professional Study Program, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Yogyakarta, Indonesia
[2]Department of Clinical Pathology and Laboratory Medicine, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Yogyakarta, Indonesia
[3]Department of Pediatric, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Yogyakarta, Indonesia

Article Info

Article history:

Received Oct 20, 2023
Revised Feb 1, 2024
Accepted Feb 21, 2024

Keywords:

Congenital hypothyroid screening
Congenital hypothyroidism incidence
Free T4
Newborn screening
Thyroid stimulating hormone

ABSTRACT

Congenital hypothyroidism (CH) is an inadequate thyroid hormone in newborns and is one of the most common causes of preventable mental retardation. It is crucial to do CH screening in newborns aged a few days to detect early occurrences of CH so that intervention can be done immediately. Screening for CH was introduced in Indonesia in 2000, and by 2014, the percentage of newborns screened remained less than 1% of the total. The Special Region of Yogyakarta, one of Indonesia's provinces, has not been the subject of any research regarding the incidence of CH. Hence, this study aimed to investigate the incidence of CH in the Special Region of Yogyakarta during the period from 2018 to 2020. This study, conducted from January 2018 to December 2020, investigated CH incidence in Yogyakarta using data from 23,787 screened newborns. Nine were diagnosed with primary CH. Incidence of CH in this study was higher in males than females, small for gestational age (SGA) than appropriate for gestational age (AGA), and preterm than term, with no significant differences between the variables and CH incidence. Therefore, the incidence in the Special Region of Yogyakarta in 2018-2020 was found to be 1:2,643.

Corresponding Author:

Tri Ratnaningsih
Department of Pediatric, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University
Yogyakarta, Indonesia
Email: triratnaningsih@ugm.ac.id

1. INTRODUCTION

Congenital hypothyroidism (CH) is when the thyroid gland does not produce sufficient thyroid hormone to meet the body's needs since birth [1]. The role of the thyroid hormone is crucial in the first two years of life, in which the growth and development of the brain occur rapidly [2]. If CH is left untreated, babies will develop mental retardation [3]. Age at first treatment correlated with the quality of life of children with CH [4]. A study from Iran showed three and a half years old children with CH exhibit some limited developmental challenge compared to their healthy peers [5]. Research conducted in India demonstrated that screening is the best prevention method because the lifetime costs of caring for children with intellectual disabilities due to CH are three times greater than those screening and confirmation tests [6].

Before the era of newborn screening programs, the clinical incidence of CH was in the range of 1:7,000-1:1,0000 [7]. Since the early 1970s, screening programs for CH and other preventable causes of mental retardation have been promoted in the United States. It is reported that the global incidence of CH affects 1 in 3,000 to 4,000 newborns [8]. A high incidence of CH underscores the significance of newborn screening [9].

CH screening in Indonesia has only been implemented since 2000, and until 2014, the screened percentage was less than 1% of the total number of newborn**s** [10]. Special Region of Yogyakarta is one of the provinces in Indonesia. There has been no study on the incidence of CH in the Special Region of Yogyakarta. Therefore, this study intends to determine the incidence of CH in the Special Region of Yogyakarta period 2018-2020.

2. METHOD

This study was a descriptive study obtained by retrospective observation using data on all newborns who participated in the Special Region of Yogyakarta screening program from January 2018-December 2020. We collect the data from the Clinical Laboratory Installation of Central General Hospital Dr. Sardjito and the Department of Clinical Pathology and Laboratory Medicine, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University in the Special Region of Yogyakarta.

Newborns from 25 hospitals and 42 health centers in the Special Region of Yogyakarta who agreed to participate in the screening program will have a blood sample taken from the lateral surface of the newborn's foot or the medial part of the heel. The blood that comes out is dripped on a special filter paper until the paper circle is full of blood. After drying, the filter paper will be sent to the Clinical Laboratory Installation of Central General Hospital Dr. Sardjito to be tested for TSH analysis using the fluorometry immunoassay (FIA) method.

For newborns with TSH levels >20 IU/mL or suspected, the hospital will immediately contact the parents for a confirmation test with repeated TSH and free T4 (fT4) using the electrochemiluminescent assay (ECLIA) method. From the confirmation test, we can find the cases of CH. The data taken in this study included TSH levels, gender, weight, and gestational age. Data were analyzed using Microsoft Excel and SPSS 16.0 software. The data is presented in a descriptive analysis tested for normality by Kolmogorov-Smirnov and then displayed in tables. This research has been approved by the Ethics Commission of the Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, under the number KE/FK/1304/EC/2021.

3. RESULTS AND DISCUSSION

3.1. Results

From January 2018 to December 2020, 23,787 newborns in the Special Region of Yogyakarta participated in the CH screening program. They comprised 12,124 males (50.9%) and 11,663 females (49.1%). The male-to-female ratio was 1.00/0.96. Before the data was analyzed, a normality test was conducted using the Kolmogorov-Smirnov test on the "TSH", "body weight", and "gestational age" variables. The result showed a significance level of <0.05, indicating that the sample data for these variables is not normally distributed. In contrast, the "gender" variable could not undergo a normality test as it is not a numerical scale but rather a nominal scale. The data then were analyzed using Microsoft Excel and SPSS 16.0 software.

The TSH threshold in this study is 20 µIU/mL. A total of 22 newborns (recall rate 0.009%) were found to have TSH levels exceeding the threshold, so the parents or guardians of the newborns were directly notified for a confirmation test. However, only 16 (72.7%) of the response rate agreed. Seven newborns had normal TSH and fT4 results, while the 9 others were CH-positive. The characteristics of the sample and the results of this study can be seen in Table 1.

The confirmation test results showed seven with normal TSH and fT4 levels, so they were classified as "Not CH." Six of the nine newborns had high TSH and low fT4 levels, so the diagnosis was immediately made as "Primary CH." The other nine newborns had second TSH values above the threshold. The 6 newborns should be directly examined and treated with levothyroxine. The 3 out of 9 newborns had a high TSH, but the fT4 level was within the reference significance. Recent European guidelines recommend starting therapy when TSH is persistently above 20 mU/L, even if fT4 concentration is expected [11]. It can be explained that in this study, nine patients of CH were found out of 23,787 newborns. The description of the confirmation test sample can be seen in Table 2.

The incidence rate per 100,000 population for males in this study was 41.24 with a 95% confidence interval (CI) of 17.17-99.06 (1 in 2,425). In contrast, for females, the incidence rate was 34.4 with a 95% CI of 12.87-91.36 (1 in 2,907). The incidence rate of newborns classified as small for gestational age (SGA) was 89.53 with a 95% CI of 22.4-357.74 (1 in 1,117); whereas, for newborns classified as appropriate for gestational age (AGA), the rate was 33.09 with a 95% CI of 15.78-69.39 (1 in 3,022). Additionally, the incidence rate for preterm newborns was 106.5 with a 95% CI of 26.65-425.51 (1 in 939), while for term newborns, it was 32.16 with a 95% CI of 15.34-67.46 (1 in 3,109). The table can be seen in Table 3.

Table 1. Sample characteristic

Characteristic	n (%)
Number of newborns screened	23,787 (100%)
Gender	
Male	12,124 (50.9%)
Female	11,663 (49.1%)
Gestational age	
Preterm (<37 weeks)	1,878 (7.9%)
Term (37–41 weeks)	21,764 (91.5%)
Post-term (>41 weeks)	145 (0.06%)
Weight	
Small for gestational age	2,234 (9.3%)
Appropriate for gestational age	21,157 (88.9%)
Large for gestational age	396 (1.8%)
Recall rate	22/23,787
Response rate	16/22
Positive confirmation	9

Table 2. Confirmation test sample characteristic

No	Sex (M/F)	Weight (gram)	Gestational week	Early TSH (µIU/mL)	Repeated TSH (µIU/mL)	fT4 (ng/dL)	Category
1	M	2,500	40	380.00	>100	0.33	Primary CH
2	F	2,300	39	192.00	>100	0.16	Primary CH
3	M	2,785	37	114.00	100	0.18	Primary CH
4	F	3,195	36	46.00	45.57	1.02	Primary CH
5	M	2,760	40	45.90	100	0.78	Primary CH
6	M	3,350	38	32.00	>100	0.45	Primary CH
7	F	2,950	37	24.80	29.6	1.41	Primary CH
8	M	1,590	31	21.10	11.13	0.63	Primary CH
9	F	3,570	39	20.60	34.65	1.49	Primary CH
10	M	2,850	38	40.70	9.39	2.27	Not CH
11	F	3,750	40	21.30	7.63	24.14	Not CH
12	M	4,575	41	27.20	3.25	1.68	Not CH
13	F	2,970	37	31.00	3.2	2	Not CH
14	F	3,140	38	22.20	1.93	1.87	Not CH
15	F	2,510	40	21.60	1.03	1.66	Not CH
16	F	3,750	40	21.30	7.63	24.14	Not CH
17	F	3,200	39	373.00	-	-	Unknown
18	F	1,850	36	189,00	-	-	Unknown
19	M	3,680	36	46,00	-	-	Unknown
20	F	2,915	37	37.20	-	-	Unknown
21	F	3,085	39	26.60	-	-	Unknown
22	M	3,050	40	20.30	-	-	Unknown

Table 3. Univariate analysis of characteristics of the newborns with primary CH

Variable	CH (n)	Incidence rate/100.000 CI 95%
Gender		
Male	5	41.24 (17.17-99.06)
Female	4	34.4 (12.87-91.36)
Birth weight		
SGA	2	89.53 (22.4-357.74)
AGA	7	33.09 (15.78-69.39)
Gestational age		
Preterm	2	106.5 (26.65-425.51)
Term	7	32.16 (15.34-67.46)

3.2. Discussion

The CH screening program in Indonesia is aimed mainly at detecting primary CH. The initial priority of newborn screening (NBS) for CH is detecting all forms of primary CH (mild, moderate, and severe), with the most sensitive test being TSH [11]. Since 1999, the International Atomic Energy Agency (IAEA) has assisted Indonesia in starting NBS for CH and found a temporary prevalence in two national-level hospitals in Jakarta and Bandung at 1:3,469 [12]. The Ministry of Health Republic of Indonesia passed the screening program in 2014 and was first implemented in 14 provinces between years 2000-2014 with a temporary incidence of 1:2,513 [13]. The overall incidence of CH in this study found 9 cases out of 23.787. The incidence of CH in the Special Region of Yogyakarta in 2018-2020 is 1:2,643, or the incidence rate is 37.8 cases of CH

in every 100,000 live births. Compared with Asian countries, the incidence of CH in this study is almost the same as in neighboring countries in Asia. Incidence of CH in Thailand was 1:4274, Philipines was 1:3,678, Singapore was 1:2,007, India was 1:3,400, Japan was 1:3,472, and China was 1:2,047 [14]–[16].

The number of live births in the Special Region of Yogyakarta in 2018-2020 was 126,487. CH screening program in the Special Region of Yogyakarta in 2018-2020 includes 23,787 samples. It can be concluded that about 18.8% of the total live newborns in 2018-2020 were screened for CH. The remaining 81.2% have no known thyroid status. Cases of CH in 81.2% of newborns can be found. However, the percentage of newborns screened in this study was higher compared to the nationwide coverage, with reports indicating it was only 2.3% in 2022 [17]. In Indonesia, there is scarcity of CH studies, and they are primarily focused on specific cities. Moreover, incidence studies have only been conducted as pilot studies for CH and congenital adrenal hyperplasia (CAH) [18]. If we compare the coverage with neighboring countries in Southeast Asia, there is a big difference in the percentage of the population screened for CH. There is only <1% of the population in Indonesia is screened. In comparison, Singapore is 99%, Thailand at 97%, Malaysia at 95%, the Philippines at 28%, and Laos and Vietnam at 7% [16].

The TSH threshold used in this research follows IAEA, which is 20 µIU/mL [12]. Lowering the threshold can increase the recall rate because it improves the detection of mild cases of CH. According to Ford and LaFranchi [16], reducing the TSH from 20-25 µIU/mL to 6-10 µIU/mL will increase the incidence of CH by 2.2 times. However, this will increase parental stress and pain for the newborns and command more additional. A study from Greece did a lowering cut-off from 20 µIU/mL to 10 µIU/mL and resulted in an increase of children recalled for confirmation tests ten-fold higher (from 0.12% to 1.2%) but the rate of confirmed CH increased but just 39%, from 1:2162 to 1:1557 [19]. According to Hashemipour *et al.* [20], lowering the threshold to 6 µIU/mL is not wise as it will increase false positives. Comprehensive data regarding the long-term consequences of transient CH and potential harms from false positive is still lacking [21].

After the screening program, 22 (0.009%) newborns were found with CH suspects. The CH recall rate at the world level ranges from 0.01%-13.3% depending on the screening strategy (TSH or T4 or both), laboratory technique, specimen collection site, cut-off recall, iodine status, human error, and incidence of CH [22]. It was concluded that the recall rate in this research is low. It could be because the population in this study was low compared to other studies. A total of 16 (72.7%) of the 22 parents or guardians of the newborns were willing to undergo confirmatory tests in the form of repeat TSH and fT4 to confirm the diagnosis of CH. Mehran *et al.* [22] also said that in Asian populations, the response rate to CH screening programs is low due to transportation difficulties, low levels of education, fake addresses, cultural beliefs, and being considered taboo. In this study, the possible reason why not all CH suspects were registered to perform confirmation tests was that they carried out confirmation tests in their respective areas outside the Central General Hospital Dr. Sardjito.

Out of the nine cases of CH found in this study, females have a 19% lower incidence than males (1:119). This is different from most screening programs in various countries, where the ratio of females to males is 2:1 [3]. A study conducted in the United States of newborns in 1993-2000 to determine the sex ratio in cases of CH showed that the ratio varied in various regions in cases of permanent CH but found that the percentage of females was consistently higher than males. However, there is no significant difference between females and males in cases of transient CH [23]. A study in Malaysia also found a female predominance (60% p=0.019) in the incidence of CH with thyroid dysgenesis and transient hypothyroid etiology [24]. However, another study aligned with this research—the incidence of CH in children in Shahre-Kord, western Iran, in 2006-2014, said the ratio of females and males obtained 1:1.16 [25].

The incidence of CH in preterm is said to be higher compared with term newborns due to immaturity of the hypothalamic axis and weak TSH surge [2]. It is in line with this study where the incidence in preterm was 1:939 and in term was 1:3,109. A screening program in Wisconsin between 2012 and 2016 said the same thing as mentioned earlier, whereas the incidence of CH in 32-36 weeks gestation was higher (1:579) than in term newborns (1:1,488). A study in Iran shows 63.9% of premature babies who had a negative on the first test got positive on the second test, and 58% who had a negative on the first and second tests got positive on the third test [26]. McGrath *et al.* [27] also believed that performing repetition of the screening test in preterm is essential to prevent cases where TSH elevation occurs later. In this study, only the newborns with elevated TSH got repeated tests, so there is a chance of delayed TSH elevation in other preterm newborns.

In this study, the incidence of CH in SGA was 1:1,117, higher than in AGA (1:3,022). This is in line with Liu research, which said SGA group displayed significantly higher TSH level and increased incident of thyroid dysfunction [28]. Meanwhile, according to Hashemipour *et al.* [20], SGA with <2,000 grams increased the incidence of CH twofold or more. According to a survey conducted in Quebec in 1990-2008, there was no significant increase in the incidence of CH to SGA (<2,500 grams) [29]. A systematic review by Hashemipour *et al.* [20] recommends to re-screen preterms and SGA newborns at the two, six, and ten weeks by measuring both TSH and fT4 concentration simultaneously and taking into consideration using TSH cut-off above 10 µIU/mL for positive and suspicious cases. Retesting for CH at 36 weeks of corrected gestational age in VLBL

infants with normal screening test could identify infants who needs continuous monitoring until thyroid function is confirmed. This study said altering cutoffs is not effective for detecting potential CH cases in very low birth weight (VLBW) infants due to lack of sensitivity and unacceptable false-positive and false negative rates [30]. In this study, the screening was done on these newborns only once. So, there is a possibility that there are cases of CH that were not detected at the first screening. The limitation of our study is that the sample size is small (18.8% of total newborns) despite meeting the required minimum number of subjects. The other limitation is that 6 out of 22 newborns with high TSH were not registered to perform confirmation tests.

4. CONCLUSION

This study revealed that the incidence of CH in the Special Region of Yogyakarta in 2018-2020 was found at 1:2,643. The findings suggest that the incidence of CH in this study was greater in males than females, higher in SGA compared to those AGA, and higher in preterm newborns than term newborns. However, no significant differences were observed between the variables and CH incidence. The study's limitations underscore the importance of conducting broader population studies to gain a comprehensive understanding of the incidence of CH. Future research efforts should strive for larger sample sizes and detailed data collection to provide better interventions.

REFERENCES

[1] J. Brady, A. Cannupp, J. Myers, and A. J. Jnah, "Congenital hypothyroidism," *Neonatal Network*, vol. 40, no. 6, pp. 377–385, Nov. 2021, doi: 10.1891/11-T-699.

[2] A. K. Chapman, Z. J. Farmer, L. D. Mastrandrea, and K. A. Matlock, "Neonatal thyroid function and disorders," *Clinical Obstetrics and Gynecology*, vol. 62, no. 2, pp. 373–387, Jun. 2019, doi: 10.1097/GRF.0000000000000434.

[3] Bowden SA, Goldis M. "Congenital Hypothyroidism," Treasure Island (FL): *StatPearls Publishing*, 2024 Jan. Accessed: Feb 2024. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK558913/.

[4] N. Rochmah, M. Faizi, C. Dewanti, and A. Suryawan, "Pediatric quality of life in congenital hypothyroidism: an Indonesian study," *International Journal of Thyroidology*, vol. 13, no. 2, pp. 150–154, Nov. 2020, doi: 10.11106/ijt.2020.13.2.150.

[5] J. Nazari *et al.*, "Physical and mental growth and development in children with congenital hypothyroidism: a case–control study," *Orphanet Journal of Rare Diseases*, vol. 16, no. 1, p. 393, Dec. 2021, doi: 10.1186/s13023-021-02017-7.

[6] R. Vidavalur, "Human and economic cost of disease burden due to congenital hypothyroidism in India: too little, but not too late," *Frontiers Pediatrics*, vol. 10, p. 788589, May 2022, doi: 10.3389/fped.2022.788589.

[7] J. Alm, A. Larsson, and R. Zetterstrom, "Congenital hypothyroidism in Sweden incidence and age at diagnosis," *Acta Paediatrica*, vol. 67, no. 1, pp. 1–3, Jan. 1978, doi: 10.1111/j.1651-2227.1978.tb16268.x.

[8] D. A. Fisher, "Second international conference on neonatalThyroid screening: progress report," *The Journal of Pediatrics*, vol. 102, no. 5, pp. 653–654, May 1983, doi: 10.1016/S0022-3476(83)80228-5.

[9] İ. Toktaş, Ö. Erdem, S. Saribaş, and M. N. Özbek, "Evaluation of patients diagnosed with congenital hypothyroidism by newborn screening between 2011–2019 in Diyarbakir, Turkey," *Medicine*, vol. 102, no. 51, p. e36778, Dec. 2023, doi: 10.1097/MD.0000000000036778.

[10] C. D. Padilla, D. Krotoski, and B. L. Therrell, "Newborn screening progress in developing countries-overcoming internal barriers," *Seminars in Perinatology*, vol. 34, no. 2, pp. 145–155, 2010, doi: 10.1053/j.semperi.2009.12.007.

[11] P. van Trotsenburg *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*, vol. 31, no. 3, pp. 387–419, Mar. 2021, doi: 10.1089/thy.2020.0333.

[12] Internationale Atomenergie-Organisation, *Screening of newborns for congenital hypothyroidism: guidance for developing programmes*. Vienna: International Atomic Energy Agency, pp. 16-35, 2005. Accessed: Jan. 23, 2024. [Online]. Available: https://www-pub.iaea.org/MTCD/publications/PDF/Pub1234_web.pdf.

[13] Indonesian Peaditrician Association, *Diagnosis and management of congenital hypothyroidism*. Jakarta: Indonesian Peaditrician Association, 2017.

[14] S. Jaruratanasirikul, J. Piriyaphan, T. Saengkaew, W. Janjindamai, and H. Sriplung, "The etiologies and incidences of congenital hypothyroidism before and after neonatal TSH screening program implementation: a study in Southern Thailand," *Journal of Pediatric Endocrinology and Metabolism*, vol. 31, no. 6, pp. 609–617, 2018, doi: 10.1515/jpem-2017-0340.

[15] C. S. Lau, R. Joseph, and T. C. Aw, "Screening for congenital hypothyroidism," *Annals of the Academy of Medicine, Singapore*, vol. 49, no. 12, pp. 934–936, Dec. 2020, doi: 10.47102/annals-acadmedsg.2020618.

[16] G. Ford and S. H. Lafranchi, "Screening for congenital hypothyroidism: a worldwide view of strategies," *Best Practice and Research: Clinical Endocrinology and Metabolism*, vol. 28, no. 2, pp. 175–187, 2014, doi: 10.1016/j.beem.2013.05.008.

[17] A. B. Pulungan, H. A. Puteri, M. Faizi, P. L. Hofman, A. Utari, and J.-P. Chanoine, "Experiences and challenges with congenital hypothyroidism newborn screening in Indonesia: a national cross-sectional survey," *IJNS*, vol. 10, no. 1, p. 8, Jan. 2024, doi: 10.3390/ijns10010008.

[18] G. S. Octavius, V. A. Daleni, and Y. D. S. Sagala, "An insight into Indonesia's challenges in implementing newborn screening programs and their future implications," *Children*, vol. 10, no. 7, p. 1216, Jul. 2023, doi: 10.3390/children10071216.

[19] C. Mengreli *et al.*, "Screening for congenital hypothyroidism: the significance of threshold limit in false-negative results," *Journal of Clinical Endocrinology and Metabolism*, vol. 95, no. 9, pp. 4283–4290, 2010, doi: 10.1210/jc.2010-0057.

[20] M. Hashemipour, S. Hovsepian, A. Ansari, M. Keikha, P. Khalighinejad, and N. Niknam, "Screening of congenital hypothyroidism in preterm, low birth weight and very low birth weight neonates: a systematic review," *Pediatrics and Neonatology*, vol. 59, no. 1, pp. 3–14, 2018, doi: 10.1016/j.pedneo.2017.04.006.

[21] A. Yu, N. Alder, S. J. Lain, V. Wiley, N. Nassar, and M. Jack, "Outcomes of lowered newborn screening thresholds for congenital hypothyroidism," *Journal of Paediatrics and Child Health*, vol. 59, no. 8, pp. 955–961, Aug. 2023, doi: 10.1111/jpc.16425.

[22] L. Mehran *et al.*, "Worldwide recall rate in newborn screening programs for congenital hypothyroidism," *International Journal of Endocrinology and Metabolism*, vol. 15, no. 3, 2017, doi: 10.5812/ijem.55451.

[23] J. S. Parks *et al.*, "The impact of transient hypothyroidism on the increasing rate of congenital hypothyroidism in the United States," *Pediatrics*, vol. 125, no. 2, pp. 54–63, 2010, doi: 10.1542/peds.2009-1975F.
[24] A. A. Zaini, Y. F. Tung, N. F. A. Bahuri, and M. Y. Jalaludin, "Congenital hypothyroidism in children – a cross-sectional study in a tertiary centre in Malaysia," *Journal of the ASEAN Federation of Endocrine Societies*, vol. 35, no. 1, pp. 62–67, 2020, doi: 10.15605/jafes.035.01.11.
[25] M. Taheri Soodejani, S. M. Tabatabaei, H. R. Shoraka, H. Fallahzadeh, and A. Ghaderi, "Trend of congenital hypothyroidismincidence and its affecting factors in shahr-e-kord, western Iran," *Ijph*, Jun. 2020, doi: 10.18502/ijph.v49i5.3218.
[26] F. Hemmati, M. Moghtaderi, and P. Hasanshahi, "Congenital hypothyroidism in preterm newborns: a retrospective study arising from a screening program in Fars Province, Southwestern Iran," *Oman Medical Journal*, vol. 34, no. 3, pp. 262–265, 2019, doi: 10.5001/omj.2019.50.
[27] N. McGrath, C. P. Hawkes, P. Mayne, and N. P. Murphy, "Optimal timing of repeat newborn screening for congenital hypothyroidism in preterm infants to detect delayed thyroid-stimulating hormone elevation," *The Journal of Pediatrics*, vol. 205, pp. 77–82, Feb. 2019, doi: 10.1016/j.jpeds.2018.09.044.
[28] C. Liu *et al.*, "Small for gestational age is a risk factor for thyroid dysfunction in preterm newborns," *BMC Pediatr*, vol. 20, no. 1, p. 179, Dec. 2020, doi: 10.1186/s12887-020-02089-7.
[29] J. Deladoëy, J. Ruel, Y. Giguère, and G. Van Vliet, "Is the incidence of congenital hypothyroidism really increasing? a 20-year retrospective population-based study in Québec," *Journal of Clinical Endocrinology and Metabolism*, vol. 96, no. 8, pp. 2422–2429, 2011, doi: 10.1210/jc.2011-1073.
[30] S. R. Rose, C. E. Blunden, O. O. Jarrett, K. Kaplan, R. Caravantes, and H. T. Akinbi, "Utility of repeat testing for congenital hypothyroidism in infants with very low birth weight," *The Journal of Pediatrics*, vol. 242, pp. 152-158.e1, Mar. 2022, doi: 10.1016/j.jpeds.2021.11.003.

BIOGRAPHIES OF AUTHORS

Rhea Sabella Rahmawati is a young doctor. She is a student at the Department of Medical Profession, Gadjah Mada University, Special Region of Yogyakarta, Indonesia. She is interested in preventable diseases in newborns and children. She can be contacted at email: rheasabellarahmawati@mail.ugm.ac.id.

Tri Ratnaningsih is a Clinical Pathologist and Hematology and Transfusion Medicine Consultant. She is currently working as a Lecturer and holds the position of Head of the Department of Clinical Pathology and Laboratory Medicine, Universitas Gadjah Mada, Special Region of Yogyakarta, Indonesia. She is actively doing research in hematology and transfusion. She can be contacted at email: triratnaningsih@ugm.ac.id.

Windarwati is a subspecialist in the field of endocrinology laboratory. Her activities include teaching at the UGM Faculty of Medicine and Clinical Pathology Medical staff at Sarjito Hospital. She is currently active in the national newborn hypothyroid screening program. She can be contacted at email: windarwati21@gmail.com.

Suryono Yudha Patria is a Pediatrician and Endocrinology Consultant at Central General Hospital Dr. Sardjito and a lecturer at Gadjah Mada University, Special Region of Yogyakarta, Indonesia. He does research in Neurology, Genetic Epidemiology, and Pediatrics. His current project is 'Molecular Genetic Analysis on disorders of sex development (DSD), Chromosomal Analysis in DSD, Association pubertal and feeding disorders. He can be contacted at email: yudhap64@yahoo.com.