International Journal of Women's Health

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Association Between Maternal Subclinical Hypothyroidism and Growth Discordance in Twin Gestations: A Retrospective Study

Bing Zhang[1], Xiaoqin Chen[1], Xiaoxiao Zhao[1], Junbao Wu[1], Pan Qi[2], Weixing Zhang[1]

[1]Department of Neonatal Intensive Care Unit, Xinxiang Central Hospital, Xinxiang, Henan, 453000, People's Republic of China; [2]Department of Surgical Oncology, Xinxiang Central Hospital, Xinxiang, Henan, 453000, People's Republic of China

Correspondence: Weixing Zhang, Department of Neonatal Intensive Care Unit, Xinxiang Central Hospital, No. 56 Xinsui Avenue, Xinxiang, Henan, 453000, People's Republic of China, Email zhangweixing0420@126.com

Purpose: It is reported that there is a growth discordance of at least 20% in about 16% of twin gestations, which may be associated with maternal, fetal, or placental factors. This study was performed to investigate the relationship between maternal subclinical hypothyroidism (SCH) and growth discordance in twin gestations.

Patients and Methods: In this retrospective study, the clinical data of 106 women with twin gestations and their neonates were collected. The effect of maternal SCH on the growth discordance in twin gestations was analyzed using both linear and Logistic regression models.

Results: Among the 106 women enrolled in our study, 48 cases (45.28%) were diagnosed with SCH, and 46 twins (43.40%) experienced growth discordance. Compared with those with smaller weight, the neonates with larger weight had a higher proportion of males ($p<0.001$), larger birth weight ($p<0.001$), birth height ($p=0.009$) and birth head circumference ($p=0.001$). Women with SCH showed a higher proportion of growth discordance ($p=0.005$) and larger difference in the body weight ($p=0.021$). Logistic regression analysis showed that maternal SCH was an independent risk factor for birth weight discordance in twins (95% CI: 1.601–9.425, $p=0.003$). Linear analysis further revealed that maternal SCH was positively associated with the birth weight difference in twins (95% CI: 0.261–8.308, $p=0.037$).

Conclusion: Our findings suggest that maternal SCH may serve as an independent risk factor for birth weight discordance and is positively associated with the birth weight difference in twins.

Keywords: subclinical hypothyroidism, growth discordance, birth weight, twin gestations

Introduction

With the development of new-assisted reproductive techniques, the incidence of multiple gestations has increased dramatically worldwide. According to the practice bulletin on multiple gestations from American College of Obstetricians and Gynecologists (ACOG), growth discordance is correlated with the elevated risk of diverse adverse pregnancy outcomes, including preterm birth, stillbirth, anomalies, intrauterine growth restrictions, and more.[1] Among the multiple gestations, twin gestations are most common, approximately representing 3% of all births.[2] It is reported that there is a growth discordance of at least 20% in about 16% of twin gestations.[3] This growth discordance may be associated with maternal, fetal, or placental factors.

Hypothyroidism, a common endocrine disorder mainly induced by deficient secretion of thyroid hormones, has a significant impact on the maternal and infant health. During pregnancy, variations in hormones may affect the thyroid function in women by varying degrees.[4,5] Maternal hypothyroidism usually manifests as subclinical hypothyroidism (SCH), characterized by lack of typical clinical symptoms in most patients.[6] Only a small number of patients show clinical hypothyroidism or isolated low levels of thyroxine.[7] SCH, a mild form of hypothyroidism, has adverse effects on the course of pregnancy and child development.[8,9] In previous studies, SCH has been demonstrated to be not only

Received: 26 January 2025
Accepted: 18 June 2025
Published: 3 October 2025

associated with the increased risk of adverse pregnancy outcomes, such as preterm birth, low birth weight and hypertension,[10–12] but also correlated with neuropsychological dysfunctions in offspring, including decreased gray matter volumes and declining cognitive and psychomotor functions.[13–15] To date, however, it remains unclear about the association between maternal SCH and growth discordance in twin gestations, and there is also a lack of relevant studies.

To decrease the morbidity and mortality rates caused by discordant growth, in this study, we attempted to investigate the relationship between maternal SCH and growth discordance in twin gestations, aiming at further clarifying the risk factors related to discordant growth in twin gestations for early prevention and treatment.

Materials and Methods

Participants

In this retrospective study, women with twin gestations delivered at Xinxiang Central Hospital between January 1, 2018 and December 31, 2023 were enrolled. All the participants provided the written consent form. The study was approved by The Institutional Review Board of Xinxiang Central Hospital (Approval No.: 2024224) on April 28, 2024 and was performed in accordance with Declaration of Helsinki and local regulations.

Inclusion criteria of the participants included: (1) twin gestations diagnosed by the ultrasound examination; (2) complete maternal and neonatal data; (3) local permanent residents with follow-up conditions; (4) good compliance for follow-up visits and management. Exclusion criteria included: (1) singleton or multiple pregnancies; (2) bilateral fallopian pregnancies, ectopic pregnancies, or embryo arrest; (3) overt thyroid disease, receiving thyroid medication or previous treatment for hyperthyroidism; (4) history of alcohol consumption or smoking during pregnancy.

Data Collection

The clinical data of mothers and neonates were both collected through review of the electronic medical records in our hospital. The maternal data mainly included age, pre-pregnancy body weight, antepartum body weight, increased body weight during pregnancy, gestational weeks and times, parity, as well as complications during pregnancy, while the data for neonates primarily comprised gender, birth order, birth body weight, body height and head circumference.

Definition of Important Variables

In the first trimester of pregnancy, the levels of thyroid hormones, including thyroid-stimulating hormone (TSH), free triiodothyronine (FT_3) and free thyroxine (FT_4), were measured by the chemiluminescent microparticle immunoassay. If the TSH level was >2.5 μIU/mL but the FT_4 level was normal, the thyroid function test needed to be performed again in combination with examination of the thyroid antibodies after three months, and the electrochemiluminescence method was used. If the TSH level was >3.0 μIU/mL but the FT_4 level was still normal, SCH would be defined.[16]

Growth discordance is defined according to the formula of the difference between the larger estimated or actual weight and smaller estimated or actual weight divided by the larger estimate or actual weight. The difference of 15%-25% in actual weight is considered to be discordant by ACOG.[1] In this study, the difference of >20% in actual weight was defined as the growth discordance.

Statistical Analysis

Statistical analyses were performed using SAS software (version 9.4). Continuous variables were compared by the *t* test, showing as the mean ± standard deviation ($\bar{x} \pm s$). Categories variables were compared using Chi-square test or McNemar's test, or Fisher's exact test, presenting as frequencies and percentages [n(%)]. Mann–Whitney *U*-test or Wilcoxon signed-rank test was used for the data with unknown overall distribution or abnormal distribution. The effect of maternal SCH on the growth discordance in twin gestations was analyzed using linear-regression analysis, and Logistic regression models were employed for analyzing the influence of maternal SCH on the birth weight discordance in twin gestations. All the *p* values were two-sided, with significant differences at $p<0.05$.

Results

Baseline Characteristics of Participants

Between January 1, 2018 and December 31, 2023, a total of 112 women gave birth to twins at our hospital. Due to 5 cases lacking maternal data and 1 lacking neonatal data, 106 women were eligible for the final analysis. The mean age of these participants was (29.59±5.15) years, with the increased body weight of (16.58±5.33) kg during pregnancy. Monochorionicity occurred in 20 (18.87%, 20/106) cases. 16 of them (15.09%, 16/106) were complicated by gestational diabetes mellitus, and 26 (24.53%, 26/106) were complicated by gestational hypertension.

Among the 106 women, 48 cases (45.28%) were diagnosed with SCH, while 58 cases (54.72%) were not. Among 48 cases of SCH, 11 needed to be treated. The baseline characteristics of women with and without SCH were compared in Table 1. It could be observed that there were no significant differences between them in age, pre-pregnancy body weight, antepartum body weight, increased body weight during pregnancy, gestational weeks, parity, FT_4 levels at termination of pregnancy, monochorionicity and presence or absence of gestational complications (all $p>0.05$). 60.42% of women with SCH had gestational times of ≥1, significantly lower than 65.52% of women without SCH ($p=0.038$). Compared with the women without SCH, the levels of TSH at termination of pregnancy were significantly higher in women with SCH ($p<0.001$; Table 1).

Table 1 Baseline Characteristics of Participants with and without SCH, n(%)

Characteristics	SCH Group (n=48)	Non-SCH Group (n=58)	Total	*p*
Age, years, $\bar{x} \pm s$	29.02 ±4.70	30.05±5.49	29.59±5.15	0.307*
Pre-pregnancy body weight, kg, $\bar{x} \pm s$	57.48±5.83	56.97±6.12	57.20±5.97	0.661*
Antepartum body weight, kg, $\bar{x} \pm s$	73.83±7.51	73.72±8.67	73.77±8.13	0.946*
Increased body weight during pregnancy, $\bar{x} \pm s$	16.35±5.54	16.76±5.20	16.58±5.33	0.700*
Gestational weeks	34.19±2.19	34.38±1.97	34.29±2.07	0.636*
TSH levels at termination of pregnancy, mU/L	8.75±2.53	1.45±0.58	4.30±2.60	<0.001#
FT_4 levels at termination of pregnancy, pmol/L	13.61±1.61	13.94±1.53	13.79±1.56	0.291*
Gestational times				0.038&
0	19 (39.58)	20 (34.48)	39 (36.79)	
≥1	29 (60.42)	38 (65.52)	67 (63.21)	
Parity				0.212&
0	29 (60.42)	28 (48.28)	57 (53.77)	
≥1	19 (39.58)	30 (51.72)	49 (46.23)	
Accordant gender of twins				0.521&
No	21 (43.75)	29 (50.00)	50 (47.17)	
Yes	27 (56.25)	29 (50.00)	56 (52.83)	
Monochorionicity				0.978&
No	39 (81.25)	47 (81.03)	86 (81.13)	
Yes	9 (18.75)	11 (18.97)	20 (18.87)	
Gestational diabetes mellitus				0.340&
No	39 (81.25)	51 (87.93)	90 (84.91)	
Yes	9 (18.75)	7 (12.07)	16 (15.09)	
Gestational hypertension				0.055&
No	32 (66.67)	48 (82.76)	80 (75.47)	
Yes	16 (33.33)	10 (17.24)	26 (24.53)	
Other gestational complications				0.744&
No	28 (58.33)	32 (55.17)	60 (56.60)	
Yes	20 (41.67)	26 (44.82)	46 (43.40)	

Notes: "*,# and &" represent that the data are analyzed by the *t* test, Mann–Whitney *U*-test and Chi-square test, respectively.
Abbreviations: SCH, subclinical hypothyroidism; TSH, thyroid-stimulating hormone; FT_4, free thyroxine.

Comparison on the Birth Data of Neonates with Larger and Smaller Weight

As shown in Table 2, most neonates with larger weight were males, accounting for 63.21%, which was higher than the 42.45% of the neonates with smaller weight ($p<0.001$). Compared with those with smaller weight, the neonates with larger weight had larger birth weight ($p<0.001$), birth height ($p=0.009$) and birth head circumference ($p=0.001$). Regarding the birth order, no significant differences were presented ($p>0.05$).

Effect of SCH on the Growth Discordance in Twin Gestations

A total of 46 twins (43.40%, 46/106) experienced growth discordance, including 28 twins (58.33%) in the women with SCH and 18 twins (31.03%) in those without SCH. Compared with those without SCH, the women with SCH had a higher proportion of growth discordance (58.33% vs 31.03%, $p=0.0048$) and larger difference in the body weight (16.34 ±11.12 vs 11.69±9.35, $p=0.021$), while no significant differences were presented regarding the differences in body height and head circumference (Table 3).

Relationship Between Maternal SCH and Growth Discordance in Twins

With the birth weight difference in twins as a dependent variable and SCH as an independent variable, the covariates including maternal age, gestational weeks and monochorionicity were controlled in the Logistic regression model. The results showed that maternal SCH was an independent risk factor for birth weight discordance in twins, and the women with SCH had a risk of 3.884 folds in birth weight discordance higher than those without SCH (95% CI: 1.601–9.425, $p=0.003$).

As shown in Table 4, linear regression analysis of maternal SCH and growth discordance in twins revealed that maternal SCH was positively associated with the birth weight difference in twins (95% CI: 0.261–8.308, $p=0.037$), but not the difference in birth height ($p=0.326$) and head circumference ($p=0.549$).

Table 2 Comparison on the Birth Data Between Neonates with Larger and Smaller Weight (n=106), n(%)

Characteristics	Neonates with Larger Weight	Neonates with Smaller Weight	Total	*p*
Gender				<0.001#
Male	67 (63.21)	45 (42.45)	112 (52.83)	
Female	39 (36.79)	61 (57.54)	100 (47.17)	
Birth order				0.919#
1	58 (54.71)	49 (46.23)	107 (50.47)	
2	48 (45.28)	57 (53.77)	105 (49.52)	
Birth weight, g, $\bar{x} \pm s$	2334.6±434.9	2017.8±436.5	2168.53±468.15	<0.001*
Birth height, cm, $\bar{x} \pm s$	46.58±3.11	45.39±3.46	45.99±3.33	0.009*
Birth head circumference, cm, $\bar{x} \pm s$	31.25±1.95	30.29±2.21	30.77±2.14	0.001*

Notes: "* and #" represent that the data are analyzed by the *t* test and McNemar's test, respectively.

Table 3 Effect of SCH on the Growth Discordance in Twin Gestations, n(%)

Variables	SCH Group (*n*=48)	Non-SCH Group (*n*=58)	Total	*p*
Birth weight difference g, $\bar{x} \pm s$	16.34 ±11.12	11.69±9.35	13.80±10.40	0.021*
Birth height difference cm, $\bar{x} \pm s$	1.93±5.24	2.87±3.97	2.45±4.59	0.296*
Head circumference difference cm, $\bar{x} \pm s$	3.41±3.71	2.55±3.43	2.94±3.57	0.218*
Growth discordance				0.005[&]
No	20 (41.67)	40 (68.97)	60 (56.60)	
Yes	28 (58.33)	18 (31.03)	46 (43.40)	

Notes: "* and [&]" represent that the data are analyzed by the *t* test and Chi-square test, respectively.

Table 4 Linear Regression Analysis of Maternal SCH and Growth Discordance in Twins

Variables	*β*	95% CI	Standard Deviations	*p*
Birth weight difference	4.284	0.261–8.308	2.028	0.037
Birth height difference	0.902	−0.916–2.719	0.910	0.326
Head circumference difference	0.469	−1.089–2.027	0.779	0.549

Notes: When the birth weight difference was as a dependent variable Y and subclinical hypothyroidism was as an independent variable X, covariates including maternal age, gestational weeks and monochorionicity were controlled.

Discussion

Although current evidence intensifies the association of maternal SCH with maternofetal adverse outcomes,[10–15] it is still unknown regarding the correlation between maternal SCH and growth discordance in twins. In this study, we first retrospectively analyzed the clinical data of women with twin gestations and their neonates, and demonstrated that maternal SCH, a major determinant of birth weight discordance, is positively correlated with the birth weight difference in twins, which may provide novel insights into the early prevention and treatment of discordant growth in women with twin gestations.

Thyroid hormones play a crucial role in maintaining energy metabolism and temperature of the body. Before 12–14 weeks of pregnancy, the fetal thyroid hormones specially originate from the mothers. During pregnancy, however, the demand for maternal thyroid hormones increases due to fetal needs, elevated renal iodide clearance, increased recession of thyroid hormones through placental deiodinase type 3 and raised concentrations of serum thyroxine-binding globulin.[17,18] SCH, a common diagnosis in women of reproductive age, is reported to have a prevalence of 1.5%-42.9% in pregnant women.[19] In our study, the incidence of SCH was identified to be 45.28% in women with twin gestations. This great difference in prevalence may be attributed to multiple factors, including the TSH cutoff value used, iodine status, gestational age at screening, ethnic background, and geographic regions.[20]

Growth discordance, one of the major determinants of perinatal adverse outcomes in twin gestations, can occur in every trimester of pregnancy. Despite its representation of normal physiological variations, a certain degree of growth discordance is thought to be associated with an elevated risk of perinatal adverse outcomes without consideration of chorionicity.[21] Currently, there still exist conflicts about the actual cutoff of growth discordance. ACOG specifies that it will be discordant if the twins have a 15%-25% difference in actual weight.[1] According to the consensus statement formulated by the Society of Obstetricians and Gynecologists of Canada, growth discordance is defined as the estimated fetal weight difference of 20% or abdominal circumference difference of 20 mm.[22] National Collaborating Centre for Women′s and Children′s Health considers a birth weight difference of >25% as the diagnostic criteria.[23] Additionally, a birth weight difference of >20% is proposed in a multi-center study on the growth discordance in twins.[24] In our study, an actual weight difference of >20% was used for growth discordance, and up to 43.40% of twins experienced discordant growth, including 58.33% in SCH women and 31.03% in non-SCH women. In a previous study, the proportion of 22.7% in birth weight difference of twins was reported, significantly lower than the data in our study, which might be partially associated with more high-risk pregnant women in our center.

In both mothers and fetuses, thyroid hormones modulate multiple metabolic and anabolic processes via gestation, which can command the fetal growth by promoting placentation, regulating metabolism, fetal oxygen, and glucose consumption, as well as other factors that directly impact fetal tissue differentiation and skeletal growth.[25–27] Sufficient fetal supply of FT_4 plays a key role in the development of both pituitary-thyroid axis and uterine physiological cardiovascular homeostasis.[28] Hypothyroidism during pregnancy may result in abnormal fetal-placental glucose metabolism and fetal growth.[29] Specifically, the more serious the hypothyroidism, the lower fetal weight and brain volume. Additionally, high concentrations of TSH during pregnancy was also found to be associated with a higher risk of low birth weight, with the 3-fold elevated risk at the presence of thyroid-positive autoimmunity.[30] Importantly, neonates born by mothers with SCH were more likely to experience lower birth weight compared with those delivered by euthyroid mothers.[11,31]

In this study, we first investigated the association between maternal SCH and growth discordance in twin gestations and demonstrated that maternal SCH was an independent risk factor for birth weight discordance, and positively correlated with the birth weight difference in twins. Notably, there were several limitations in our study that should be

concerned. First, this was a retrospective study with a relatively small sample size, and the single-center design limited the source of participants, which may affect the generalizability and causal inference of the findings. Second, there may be a lack of several important variables, such as zygosity and use of assisted reproduction. Additionally, the long-term neonatal outcome data were also missing. In the future, multi-center studies with the large sample size should be further conducted to validate our findings.

Conclusion

Maternal SCH may serve as an independent risk factor for birth weight discordance and is positively associated with the birth weight difference in twins. These findings may offer potential evidence for the early prevention and treatment of discordant growth in women with twin gestations.

Data Sharing Statement

The data that support the findings of this study are available from the first author and corresponding author upon reasonable request.

Ethical Approval and Consent to Participate

The study was approved by The Institutional Review Board of Xinxiang Central Hospital and was performed in accordance with Declaration of Helsinki and local regulations. All patients signed the written consent form.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This study was supported by the projects "Effects of the Difference in Birth Weight Discordance of Twins on the Occurence of Respiratory Diseases and Prognosis (SBGJ202402104)" and Study on Changes of Cortisol Levels in Neonatal Spetic Shock Before and After Treatment (LHGJ20230889).

Disclosure

The authors report no conflicts of interest in this work.

References

1. American College of Obstetricians and Gynecologists.*Multiple Gestation: Complicated Twin, Triplet and Higher Order Multifetal Pregnancy.*ACOG practice bulletin no. 56.Washington, DC;The College;2004.reaffirmed 2009
2. Blumenfeld YJ, Anderson JN. Fetal growth disorders in twin gestations. *Curr Opin Obstet Gynecol*. 2023;35:106–112. doi:10.1097/GCO.0000000000000856
3. Miller J, Chauhan SP, Abuhamad AZ. Discordant twins: diagnosis, evaluation and management. *Am J Obstet Gynecol*. 2012;206:10–20.
4. Visser WE, Peeters RP. Peeters RP. Interpretation of thyroid function tests during pregnancy. *Best Pract Res Clin Endocrinol Metab*. 2020;34:101431. doi:10.1016/j.beem.2020.101431
5. Rodriguez-Diaz E. Pearce EN. Iodine status and supplementation before, during, and after pregnancy. *Best Pract Res Clin Endocrinol Metab*. 2020;34:101430.
6. Chen A, Luo Z, Zhang J, et al. Emerging research themes in maternal hypothyroidism: a bibliometric exploration. *Front Immunol*. 2024;15:1370707. doi:10.3389/fimmu.2024.1370707
7. Lopez-Munoz E, Mateos-Sanchez L, Mejia-Terrazas GE, et al. Hypothyroidism and isolated hypothyroxinemia in pregnancy, from physiology to the clinic. *Taiwan. J Obstet Gynecol*. 2019;58:757–763.
8. Maraka S, Ospina NM, O'Keeffe DT, et al. Subclinical hypothyroidism in pregnancy: a systematic review and meta-analysis. *Thyroid*. 2016;26:580–590. doi:10.1089/thy.2015.0418
9. Teng W, Shan Z, Patil-Sisodia K, et al. Hypothyroidism in pregnancy. *Lancet Diabetes Endocrinol*. 2013;1:228–237. doi:10.1016/S2213-8587(13)70109-8

10. Wang S, Teng WP, Li JX, et al. Effects of maternal subclinical hypothyroidism on obstetrical outcomes during early pregnancy. *J Endocrinol Invest*. 2012;35:322–325. doi:10.3275/7772
11. Derakhshan A, Peeters RP, Taylor PN, et al. Association of maternal thyroid function with birthweight: a systematic review and individual-participant data meta-analysis. *Lancet Diabetes Endocrinol*. 2020;8:501–510. doi:10.1016/S2213-8587(20)30061-9
12. Korevaar TIM, Derakhshan A, Taylor PN. Consortium on Thyroid and Pregnancy-Study Group on Preterm Birth. et al. Association of thyroid function test abnormalities and thyroid autoimmunity with preterm birth: a systematic review and meta-analysis. *JAMA*. 322;2019:632–641. doi:10.1001/jama.2019.10931
13. Jansen TA, Korevaar TIM, Mulder TA, et al. Maternal thyroid function during pregnancy and child brain morphology: a time window-specific analysis of a prospective cohort. *Lancet Diabetes Endocrinol*. 2019;7:629–637. doi:10.1016/S2213-8587(19)30153-6
14. Haddow JE, Palomaki GE, Allan WC, et al. Maternal thyroid deficiency during pregnancy and subsequent neuropsychological development of the child. *N Engl J Med*. 1999;341:549–555. doi:10.1056/NEJM199908193410801
15. Li Y, Shan Z, Teng W, et al. Abnormalities of maternal thyroid function during pregnancy affect neuropsychological development of their children at 25-30 months. *Clin Endocrinol*. 2010;72:825–829. doi:10.1111/j.1365-2265.2009.03743.x
16. Biondi B, Cappola AR, Cooper DS. Subclinical hypothyroidism: a review. *JAMA*. 2019;322:153–160. doi:10.1001/jama.2019.9052
17. Glinoer D. The regulation of thyroid function in pregnancy: pathways of endocrine adaptation from physiology to pathology. *Endocr Rev*. 1997;18:404–433. doi:10.1210/edrv.18.3.0300
18. Springer D, Jiskra J, Limanova Z, et al. Thyroid in pregnancy: from physiology to screening. *Crit Rev Clin Lab Sci*. 2017;54:102–116. doi:10.1080/10408363.2016.1269309
19. Dong AC, Stagnaro-Green A. Differences in diagnostic criteria mask the true prevalence of thyroid disease in pregnancy: a systematic review and meta-analysis. *Thyroid*. 2019;29:278–289. doi:10.1089/thy.2018.0475
20. Toloza FJK, Abedzadeh-Anaraki S, Maraka S. Subclinical hypothyroidism in pregnancy. *Curr Opin Endocrinol Diabetes Obes*. 2019;26:225–231. doi:10.1097/MED.0000000000000491
21. Cerra C, D'Antonio F. Discordance in twins: association versus prediction. *Best Pract Res Clin Obstet Gynaecol*. 2022;84:33–42. doi:10.1016/j.bpobgyn.2022.08.001
22. Barrett J, Bocking A. *The SOGC Consensus Statement: Management of Twin Pregnancies: Soc Obstet Gynaecol Canada*. Toronto: Elsevier Inc; 2000:607–610.
23. National Collaborating Centre for Women′s and Children′s Health. *Multiple Pregnancy: The Management of Twin and Triplet Pregnancies in the Antenatal Period*. London: RCOG Press; 2011:18.
24. Halling C, Malone FD, Breathnach FM, et al. Neuro-developmental outcome of a large cohort of growth discordant twins. *Eur J Pediatr*. 2016;175(3):381–389. doi:10.1007/s00431-015-2648-8
25. Barjaktarovic M, Korevaar TI, Chaker L, et al. The association of maternal thyroid function with placental hemodynamics. *Hum Reprod*. 2017;32:653–661. doi:10.1093/humrep/dew357
26. Forhead AJ, Fowden AL. Thyroid hormones in fetal growth and prepartum maturation. *J Endocrinol*. 2014;221:R87–103.
27. Fowden AL, Forhead AJ. Endocrine mechanisms of intrauterine programming. *Reproduction*. 2004;127:515–526.
28. Klein I, Ojamaa K. Thyroid hormone and the cardiovascular system. *N Engl J Med*. 2001;344:501–509.
29. Pickard MR, Leonard AJ, Ogilvie LM, et al. Maternal hypothyroidism in the rat influences placental and liver glycogen stores: fetal growth retardation near term is unrelated to maternal and placental glucose metabolic compromise. *J Endocrinol*. 2003;176:247–255. doi:10.1677/joe.0.1760247
30. Karakosta P, Alegakis D, Georgiou V, et al. Thyroid dysfunction and autoantibodies in early pregnancy are associated with increased risk of gestational diabetes and adverse birth outcomes. *J Clin Endocrinol Metab*. 2012;97:4464–4472. doi:10.1210/jc.2012-2540
31. Lucaccioni L, Ficara M, Cenciarelli V, et al. Long term outcomes of infants born by mothers with thyroid dysfunction during pregnancy. *Acta Biomed*. 2020;92:e2021010. doi:10.23750/abm.v92i1.9696